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GRANULOMETRIC STUDIES, RATE OF SEDIMENTATION AND OSTRACOD DISTRIBUTION FROM A SHORT CORE OFF ONGOLE COAST, ANDHRA PRADESH, BAY OF BENGAL

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ABSTRACT

A preliminary study on the marine Ostracoda is carried out from a shallow short core of length 20 cm collected from the region of Bay of Bengal, off the coast of Ongole using a multicorer during the ORV Sagar Kanya cruise (SK-308 Leg 1), at a water depth of 47 metres. The core is further sampled at an interval of 1cm and thus, a total of 20 samples were obtained and are subjected to standard micropaleontological and sedimentological analyses. The classification by Hartmann and Puri (1974) is followed through which 41 ostracod taxa belonging to 33 genera of the order Podocopida have been identified, from which 2 species belong to suborder Platycopa and the remaining to suborder Podocopa. Ostracod assemblage recorded is characteristic of shallow *in-situ* marine, inner shelf and tropical in nature.

Sedimentological parameters such as $CaCO_3$, Organic matter and sand-silt-clay ratios were estimated and their down core distribution is discussed. Granulometric studies reveal that fine grained silt and clay are more than sand in the core sample reflecting on low energy condition of sediment deposition. Ostracods from the area are larger in size, ornamented and well preserved. Approximate averages of only 42 specimens are found per 10 grams. The ratio between the carapaces and open valves has been taken into consideration for determining the relative rate of sedimentation and it has been identified as slower rate of sedimentation prevailing in the area.

Keywords: Ostracoda, Granulometric studies, $CaCO_3$, Organic matter, Rate of sedimentation, Bay of Bengal.

INTRODUCTION

The calcareous microfauna Ostracoda belongs to phylum Arthropoda, having a great importance because of their sensitiveness to a very feeble environmental changes. Due to their minute size, wide geographic distribution and their presence in almost all aquatic environments, the practical values of ostracods are immense. A relatively small amount of sediment sample would yield much microfossils for the application of quantitative methods of analysis and have been useful for ecologic/ paleoecological applications. Ostracoda have small bivalved carapaces, hinged along the dorsal margin and most of them are bottom dwellers, swimming, crawling or burrowing at bottom aquatic sediments. The structure and composition of micro-organisms are associated with sediment characteristics (Snelgrove and Butman 1994). With the high variation of grain size of sediment more species coexist. This is consistent with the hypothesis that species partition the sediments with respect to size. In addition, several species exhibit inter specific differences in particle size preference (Fenchel *et al*. 1975; Fenchel and Kofoed 1976; Whitlatch 1980), suggesting that the sediments may be partitioned by size in some shallow-water communities. The study of ostracoda shells possibly reflects a light into the sedimentation patterns as well as the sediment characteristics.

AREA OF STUDY

The Bay of Bengal is located on the north-eastern part of the Indian Ocean. A core sample was collected through the Sagar Kanya ORV SK 308 leg 1, at a depth of 47 metres from off Ongole, Andhra Pradesh, Bay of Bengal (Fig. 1). The surface sea water temperature of the study area is observed as 24.9° C. pH value is 8.14 which is feebly basic and salinity is 31.74 psu. Geographical coordinates of core sampling station in Bay of Bengal are 15°29’08” N (Latitude) 80°29’08” E (Longitude).

METHODOLOGY

Determination of Organic matter, Calcium Carbonate, Sand, Silt and Clay percentages

Organic matter is determined to assess its role in observing its association with carapace growth and was determined by adopting the titration method of Gaudette *et al*. (1974). $CaCO_3$ percentage was determined by adopting the procedure proposed by Loring and Nota (1973). Sand-silt-clay ratio estimation was carried out using combination of sieving and pipette procedures in accordance with that of Krumbein and Pettijohn (1938). Trilinear plots (fig. 2) were prepared and sediment descriptions have been done based on Trefethen’s (1950) textural nomenclature. A litholog is prepared and down core variation of these sediment parameters and ostracod population is shown (fig. 3).

Sample collection, separation, picking and mounting

The core sample was collected using a multicorer in the Sagar Kanya ORV cruise SK 308 leg 1, at a depth of 47 metres water depth. The core was sub-sampled and physiochemical parameters like depth, temperature, pH, salinity were measured on-board in the research vessel itself. Thirty gram of each dried sub-sample was wet sieved using ASTM 230 mesh. The

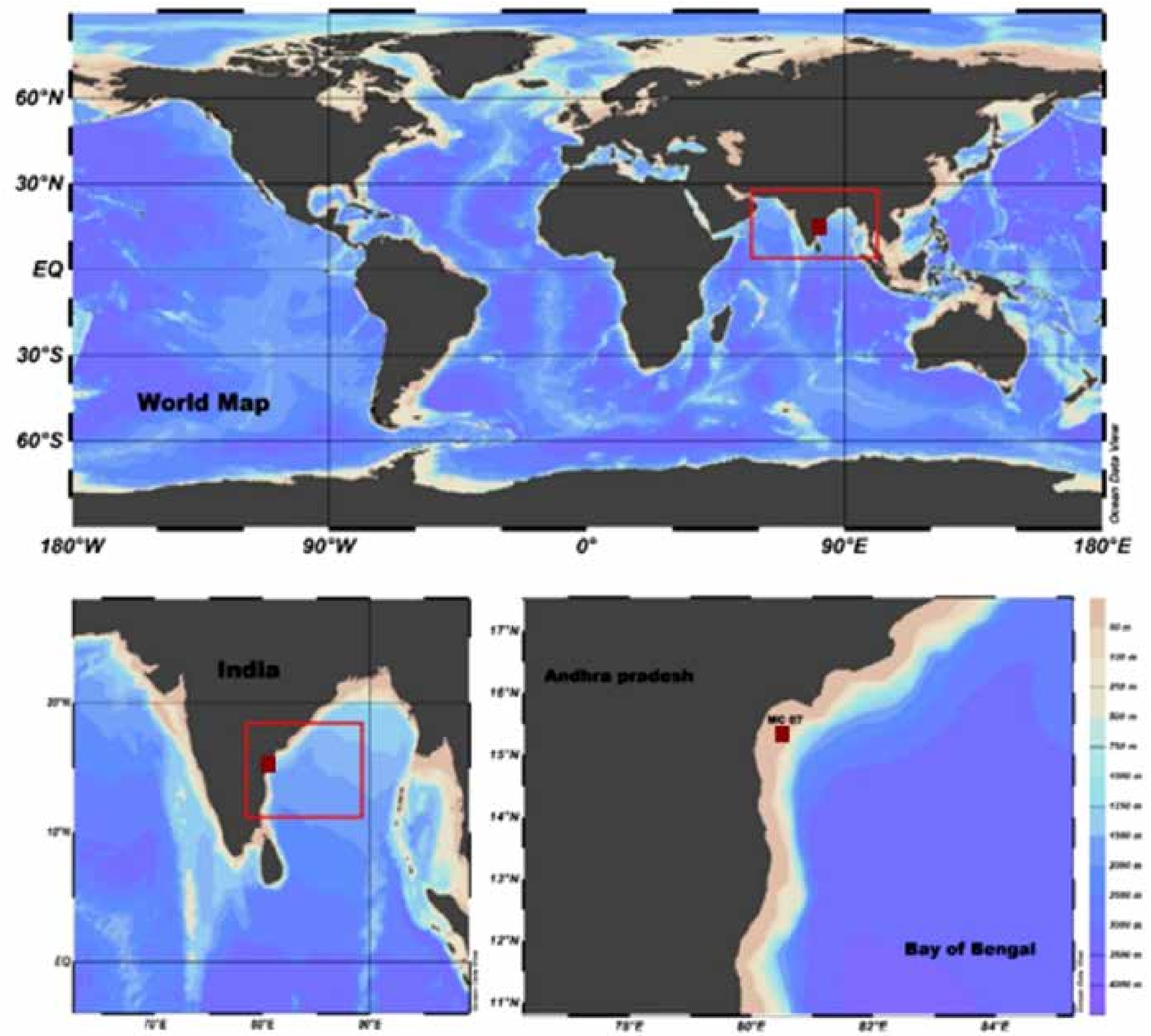

Fig. 1. Study Area Map.

sediment retained on the sieve was oven dried at 50^0 C. The Ostracod specimens were handpicked from all sub-samples using a 0.00 haired brush. The handpicked faunal specimens from each sample were transferred and mounted to 24-chambered micropaleontological slides.

Open valve/Carapace ratio

Open valve/Carapace ratio is determined by counting the open valves and closed carapaces and taking its ratio. Pokorny (1965) found out that carapace-valve ratio can yield paleoecological information. Oertli (1971) studied the carapace-open valve in detail and made a conclusion that if the ratio is high, the sedimentation rate is rapid, means the complete carapaces are more compared with open valves.

Scanning Electron Microscopy (SEM)

The identification of species is done and the hypotypes are taken for detailed studies of Scanning Electron Microphotography and SEM plate has been made (fig. 4).

RESULTS

To understand the sediment characteristics of the study area, organic matter percentage, calcium carbonate percentage, sand silt and clay are done (Table 1). Organic matter percentage through out the core is showing slight fluctuations. The content of the organic matter available ranges from 1.05% to 1.64% with an average value of 1.38%. The calcium carbonate percentage in the study area ranges from 10.5 to 14 %. The lowest values are located in sample number 4 and highest values in sample number 6, 12 and 17. Silt percentage is higher than sand and clay in all sections of the core. The silt percentage ranges from 48.9 to 95.8 having an average of 79.6. The sand and clay percentages ranges from 2.2 to 38.5 and 1.9 to 37.6, respectively. The ratio between the carapaces and open valves has been taken into consideration for determining the relative rate of sedimentation. In this shallow sea core sample from Bay of Bengal, as many as 848 ostracod shells were recovered. Among these, 804 specimens are open valves, while the remaining 44 specimens are complete carapaces. The distribution of carapaces and open valves, for all the stations put together, reveals that the open valves outnumber closed carapaces, which is an indicator of slower rate of sedimentation.

TAXONOMY OF OSTRACODA

The classification proposed by Hartmann and Puri (1974) has been followed through which 41 ostracod taxa (Table 2) belonging to 33 genera of the order Podocopida have been identified. For specific identifications, the present taxa have been compared with the hypotypes reported from off the coast of Tuticorin (Hussain, 1998), Karikkattukuppam (Mohan *et al.2001*), Rameswaram (Sridhar *et al, 2002*), Malabar coast (Gopalakrishna *et al, 2007*) and numerous other relevant publications have been referred to.

1. Loxoconcha cercinata (RV External view) *2. Actinocytherisis scutigera* (LV External view) *3.Neocytheretta murilineata* (RV External view) *4. Pistocythereis bradyi* (RV External view) *5. Pterygocythereis chennaiensis* (RV External view) *6. Keijella karwarensis* (LV External view) *7. Chrysocythere keiji* (LV External view) *8. Keijella reticulata* (RV External view) *9. Loxoconcha gruendeli* (RV External view) RV – Right valve. LV – Left valve.

DISCUSSION

The more or less consistent organic matter shows that the accumulation of organic matter is constant. The calcium carbonate percentage is showing slight fluctuation from 10.5% to 14%. This variation is because of the presence of shell fragments of ostracoda along with foraminifera and other molluscans in the core. It is evident from the litholog that more influx of clay is deposited from estuarine or near estuarine environment at a depth of 5 cm and 6 cm. These can be identified by the presence of more number of foraminifera species *Ammonia beccarii* in this depth along with the change of nature of sediments. From the depth of 11cm to 20cm of the core it can be seen that the complete carapaces are present more in comparison with the younger sediments, it represents a slight change in the rate of sedimentation. Out of the 44 carapace 36 are retrieved from this bottom portion. Granulometric studies shows that silt is dominating the entire core than sand and clay in all samples. The granulometric deposition pattern upto 7 cm in the core is not unique. Silt percentage is varying highly from 48.9% to 86.2%, which is an indicator of fluctuating energy level condition and differential deposition pattern. From 8 cm onwards except in subsample 17 all others are showing a unique deposition pattern. Ostracods are comparatively higher in numbers in the bottom portion of the core indicates the less disturbed condition and sufficient availability of oxygen and nutrients. Disarticulation of the majority of the carapace indicates that a slower rate of deposition existed in the core which caused the valves get opened.

Table 1. Estimated values of $CaCO_3$, Organic Matter, Sand, Silt and Clay percentages and Ostracoda population with respect to depth of the core collected from off Ongole coast.

DEPTH in cm	OM %	$CaCO_3$ %	Sand %	Silt %	Clay %	Ostracoda Population		
						Carapace	Open Valve	Total
1	1.40	11	14.7	72.9	12.4	3	13	16
2	1.50	10.5	11.2	86.2	2.6	0	27	27
3	1.64	11	15.1	82	2.9	2	22	24
4	1.64	10.5	17.2	80.3	2.5	1	41	42
5	1.20	12	13.5	48.9	37.6	2	30	32
6	1.30	14	10.9	57.6	31.5	0	8	8
7	1.54	12	38.5	58.8	2.7	0	30	30
8	1.64	13.9	9.3	87.2	3.5	0	13	13
9	1.54	12	14.8	80	5.2	0	5	5
10	1.59	12.5	2.2	95.8	2	0	11	11
11	1.05	12	10.7	86.8	2.5	4	64	68
12	1.16	14	10.6	86.6	2.8	5	68	73
13	1.40	11.5	9.1	89	1.9	5	50	55
14	1.16	12	8.9	88.7	2.4	2	51	53
15	1.30	12.5	13.6	84	2.4	1	50	51
16	1.20	12	12.9	85	2.1	2	22	24
17	1.35	14	27.2	70.5	2.3	5	39	44
18	1.35	13.5	12.9	83.5	3.6	4	73	77
19	1.30	13	10.7	85.8	3.5	6	106	112
20	1.44	11.5	14.4	82.5	3.1	2	81	83
Avg	1.38	12.27	13.92	79.6	6.48	**Total** **44**	**804**	**848**
Max	1.64	14	38.5	95.8	37.6			
Min	1.05	10.5	2.2	48.9	1.9			

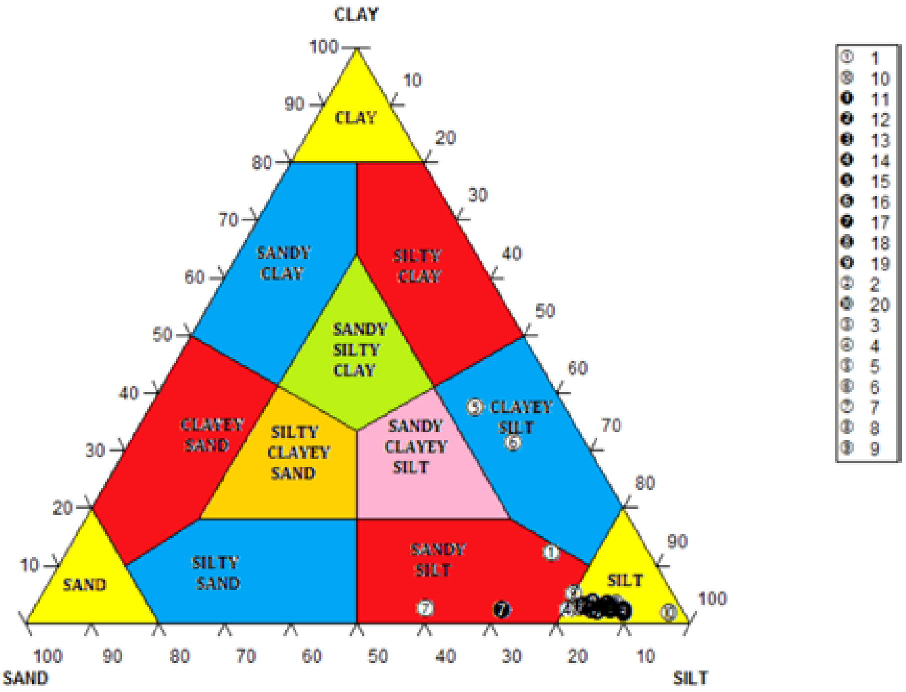

Fig. 2. Trefethen Trilinear (1950) diagram showing sand, silt and clay distribution in the core sample off Ongole coast, Andhra Pradesh, Bay of Bengal.

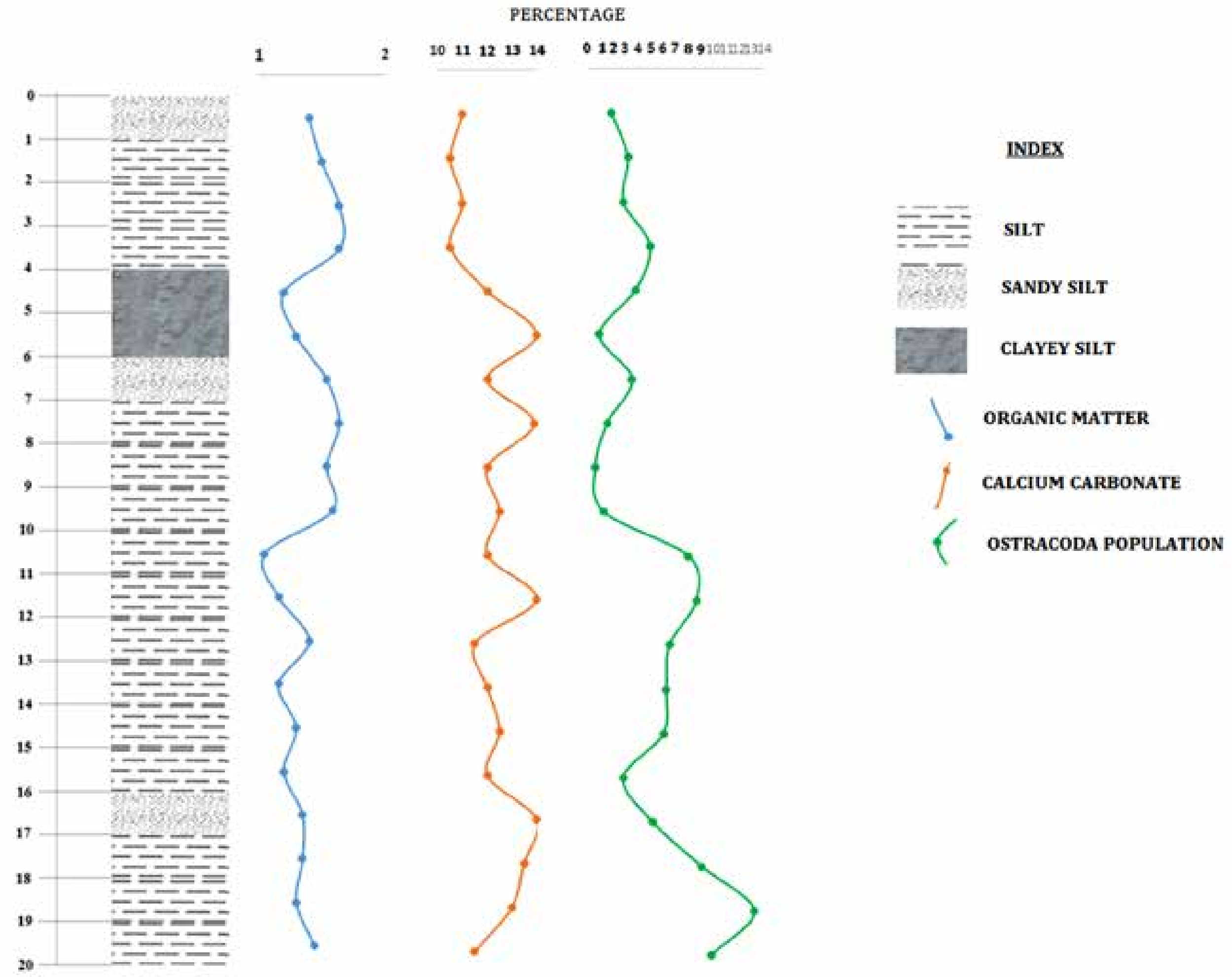

Fig. 3. Litholog of the core along with the graphs showing the percentage of Organic matter, Calcium carbonate and Ostracod population.

Table 2. Taxonomic Chart of Ostracoda in the core sample off Ongole, East coast of India.

Order	Sub order	Superfamily	Family	Genus	Species
Podocopida	Platycopa		Cytherellidae	*Cytherelloidea*	*Cytherelloidea leroyi*
					Cytherelloidea sp.
	Podocopa	Baidiacea	Bairdiidae	*Bairdoppilata*	*Bairdoppilata alcyonicola*
				Neonesidea	*Neonesidea cracenticlavula*
				Hemicytheridea	*Hemicytheridea reticulata*
			Cytheridae	*Neomonoceratina*	*Neomonoceratina iniqua*
					Neomonoceratina delicate
				Spinoceratina	*Spinoceratina spinose*
			Pectocytheridae	*Keijia*	*Keijia demissa*
			Leptocytheridae	*Callistocythere*	*Callistocythere flavidofusca intricatoides*
				Tanella	*Tanella gracilis*
			Cushmanidae	*Cushmanidea*	*Cushmanidea guhai*
					Cushmanidea sp.
			Krithidae	*Hemikrithe*	*Hemikrithe peterseni*
				Actinocythereis	*Actinocythereis scutigera*
				Chrysocythere	*Chrysocythere keiji*
				Stigmatocythere	*Stigmatocythere indica*
					Stigmatocythere kingmai
				Alocopocythere	*Alocopocythere reticulata indoaustralica*
			Trachyleberididae	*Keijella*	*Keijella karwarensis*
					Keijella reticulata
		Cytheroicea			*Keijella whatleyi*
				Echinocythereis	*Echinocythereis spinata*
				Hemitrachyleberis	*Hemitrachyleberis siddiqui*
				Pistocythereis	*Pistocythereis bradyi*
			Brachycytheridae	*Pterygocythereis*	*Pterygocythereis chennaiensis*
				Bradleya	*Bradleya (Quasibradleya) plicocarinata*
			Hemicytheridae	*Caudites*	*Caudites javana*
				Neocytheromorpha	*Neocytheromorpha* sp.
			Cytherettidae	*Cytheretta*	*Cytheretta trifurcata*
				Neocytheretta	*Neocytheretta murilineata*
			Loxoconchidae	*Loxoconcha*	*Loxoconcha cercinata*
					Loxoconcha gruendeli
			Paracytherideidae	*Paracytheridea*	*Paracytheridea* sp.
				Hemicytherura	*Hemicytherura subulata*
			Cytheruridae	*Semicytherura*	*Semicytherura contraria*
				Cytheropteron	*Cytheropteron* sp.
			Xestoleberididae	*Xestoleberis*	*Xestoleberis* sp.
				Ornatolebris	*Ornatolebris* sp.
		Cypridacea	Candonidae	*Paracypris*	*Paracypris* sp.
				Phlyctenophora	*Phlyctenophora orientalis*

CONCLUSIONS

The calcium carbonate, organic matter, sand, silt and clay percentages are done and its association with the sediments and ostracoda faunal assemblages is studied. The organic matter is showing only slight fluctuations and is less in the area of study but calcium carbonate percentage is having comparatively higher values. The increased percentage of calcium carbonate is mainly due to the presence of foraminifera, micro-gastropods and broken molluscan shells. It has been noted that the percentage of silt showing abnormal variation up to 7cm and from 8cm onwards the percentage of silt is more or less consistent. Ornamentation of ostracod carapace in the upper part of the core is highly complex type where which smooth, spinose and pitted forms are equally present. But to the downcore smooth forms are dominant. The above conditions implies that older sediments from a depth of 7 cm to 20 cm has been deposited in a less disturbed environment which is having normal riverine siltation, but the top portion which is having comparatively younger sediments from a depth to 0-6 cm, are deposited in a moderately disturbed condition.

Granulometric studies reveals that silt is dominant than clay and sand in these area. Ostracods from the area are larger in size, well ornamented and highly preserved, but number of specimens in the sediments is less. Approximate averages of only 42 specimens are found per 10 grams of sediment.

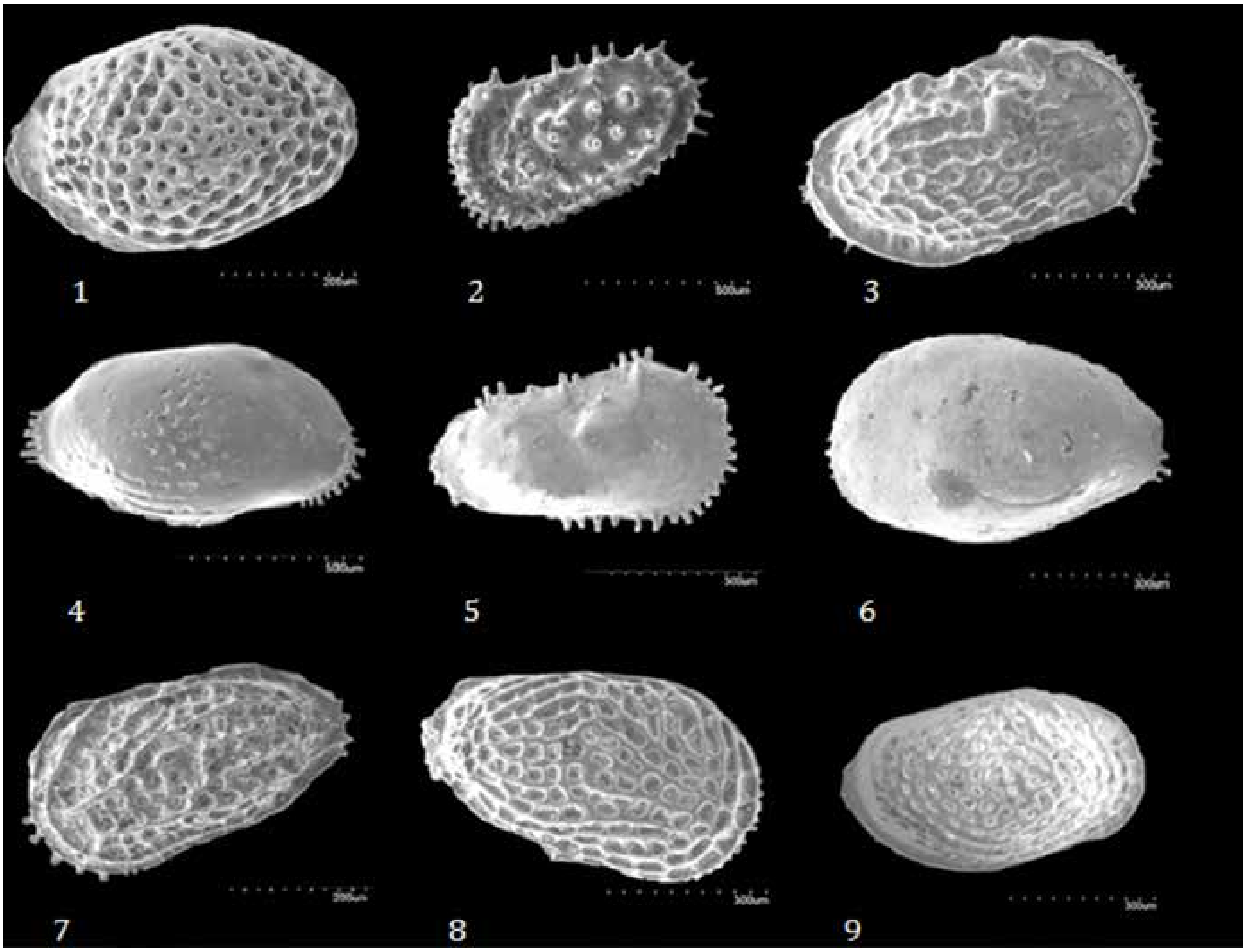

Fig. 4. SEM Images of Ostracoda recorded in the study area.

The taxonomic studies of Ostracoda through which 41 species belonging to 33 genera of the order Podocopida have been identified. Among these, 2 species belong to suborder Platycopa and the remaining falls under suborder Podocopa. The ostracoda species recorded are characteristic of shallow, inner shelf and tropical in nature and having Indo-Pacific affinity.

The ratio between the carapaces and open valves has been taken into consideration for determining the relative rate of sedimentation in the core studied. A total of 848 ostracod shells were recovered (specimens of all the 41 species put together). Among these, 804 specimens are open valves, while the remaining 44 specimens are complete carapaces. Open valve/ Closed carapace ratio can be used as an aid for determining the rate of sedimentation of the area. Disarticulation of the majority of the carapace indicates that a slower rate of deposition existed in the core. The colour of the ostracod carapace is whitish to light yellow which indicates that the sediments are deposited under normal oxygenated environment.

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