

Deep Sea Ostracoda and their Micro-Environmental Characteristics from Upper Abyssal Short Core (2540 Metres Water Depth), Off Visakhapatnam, Bay of Bengal, India

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Abstract: Deep sea Ostracods and their relationship to the variations in the sedimentological characteristics is the prime focus of the present work. We report two deep sea Ostracod taxa namely *Krithesp.* and *Cytherpteron sp.* belonging to suborder Podocopa, order Podocopida, have recovered from the subsurface (core length 33 cm) sediments at a water depth of 2540 metres. Throughout the core, fine grained muddy substrate is dominant, which indicates prevalence of low energy condition in the region and the fine sedimentation accounts from the suspended load of shallow region. Along the depth 24-27cm in the core, showing an abnormal fluctuation of Organic matter and Calcium carbonate in the region. This, along with the occurrence of broken planktic Foraminifera with well-preserved Benthic foraminifers and Ostracods, lights on to a high turbulence in the surface waters during the period of sediment deposition during the time. Element weight percentage has determined using EDS for Mg, Ca, Mn, Fe, Sr and Ba and the results shows that a different trend in elemental concentration exists between these two species, even though the carapace is calcareous. Ostracod occurrence and distribution denotes that a direct relationship exists between the sediment characteristics, shell chemistry and the water column depth.

Keywords: Ostracods, Shell chemistry, Organic Matter, Calcium carbonate, Sand-Silt-Clay

1. Introduction

Deep sea Ostracods studies are receiving less attention compared with the other group of microfossils, even though they are capable of deriving valuable datum on paleoclimate, palaeoceanography and paleo salinity. Ostracods are Crustacean microorganisms that have adapted to almost all aquatic and some terrestrial habitats (Smith *et al.*, 2015). This peculiarity of Ostracod species makes them an important proxy over Foraminifera in studying different environments. They do have complex life cycle, adapted to environmental conditions of particular kind needed for them to hatch from eggs, reproduce and grow (Ito and Forester, 2009). Potentially, Ostracod species can yield information on the paleo environment of deep ocean (Anna and Mitchell, 2014). Usually, there is an increase in number of species with increasing salinity (Nishath, 2015 *et al.*). But salinity alone could never be a factor for Ostracod abundance and diversity. Many previous studies confirmed that sedimentological parameters have a direct influence on the abundance and diversity of species in marine and marginal marine environments. In general, for faunal richness of Ostracods either the sediment should be fine grained or a complex of sand grade with a sorting is needed. Even this could be affected, if the salinity, temperature, oxygen micro variations in sediment grains, water flow etc. changes (Dennis Barker, 1983). The total Ostracoda population is also dependent on the water depth (Baskar *et al.* 2015). Both water chemistry and sediment chemistry have an influence in the occurrence and distribution of Ostracod shells.

The sampling station (Fig.1) is located at the geographical co-ordinates $17^{\circ}05'46''$ N and $83^{\circ}38'46''$ E, from a water depth of 2540 metres. This work is an investigation on the

micro environmental behaviours of the area with respect to sediment parameters.

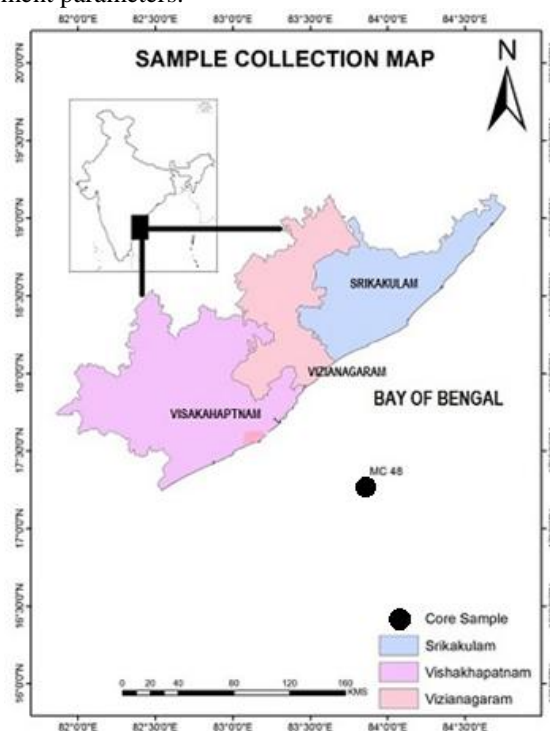


Figure 1: Sample Location map

2. Materials and Methods

A short core of length 33cm, which was collected during the ORV Sagar Kanya cruise SK-308 Leg 1 fieldwork using a multicorer, from Off Visakhapatnam, Bay of Bengal, India, at a water depth of 2540 metres is taken for the present

study. Eleven samples were obtained after sub-sampling the short core at 3 centimetres interval, which is later subjected to micropaleontological, sedimentological and shell chemistry analyses.

Proposed classification of Hartmann and Puri (1974) has been followed in the present study for Ostracod identification. Organic matter estimation was done after the titration analysis of Gaudette *et al.* (1974). Estimation of CaCO_3 was carried out, following Loring and Nota (1973). Sand-silt-clay ratios were estimated and calculated using combination of sieving and pipette procedures in accordance with that of Krumbein and Pettijohn (1938).

Ostracods were separated from the sediments, by wet sieving the samples through ASTM 230. An amount of 50 gm samples was taken and soaked in distilled water for 24 hours. Soaked samples have been transferred to the 230 ASTM sieve and washed. The samples obtained through the sieve mesh is dried under 50°C and the species were handpicked using picking brush. For illustration the SEM photograph of selected hypotypes were taken. EDS is done to determine the general shell chemistry in the Ostracod valves.

3. Result and Discussion

3.1 Ostracod Characteristics

Two Ostracod species (left under open nomenclature) belonging to 2 genera of suborder Podocopa, Order Podocopida have been identified. *Krithe* sp. and *Cytheropteron* sp. are the two forms figured out from the location. Today, Order Podocopida are the widespread and most diverse Ostracods, which could be encountered in all kinds of aquatic environments (Athersuch *et al.*, 1989, Neale, 1988). In numbers, 29 *Cytheropteron* sp. and 13 *Krithe* sp. have been recovered from the study location. Distribution of the species is not regular though down core and both the forms reported are morphologically different in all aspects. *Krithe* sp. is a smooth form with extremely fragile and delicate shell. *Cytheropteron* sp. however is comparatively harder shell and is well preserved with ornamentations. Secondary pores are well visible in both the species. Morphometrical studies indicate that the average dorso-ventral length of *Krithe* sp. is $794.41\ \mu\text{m}$ and the average anterior-posterior measure is $211.51\ \mu\text{m}$ and *Cytheropteron* sp. is having an average dorso-ventral length of $581.91\ \mu\text{m}$ and the average anterior-posterior calculations are $327.42\ \mu\text{m}$ to the right of the valve and to left it is tapering to $179.58\ \mu\text{m}$ (Fig.2).

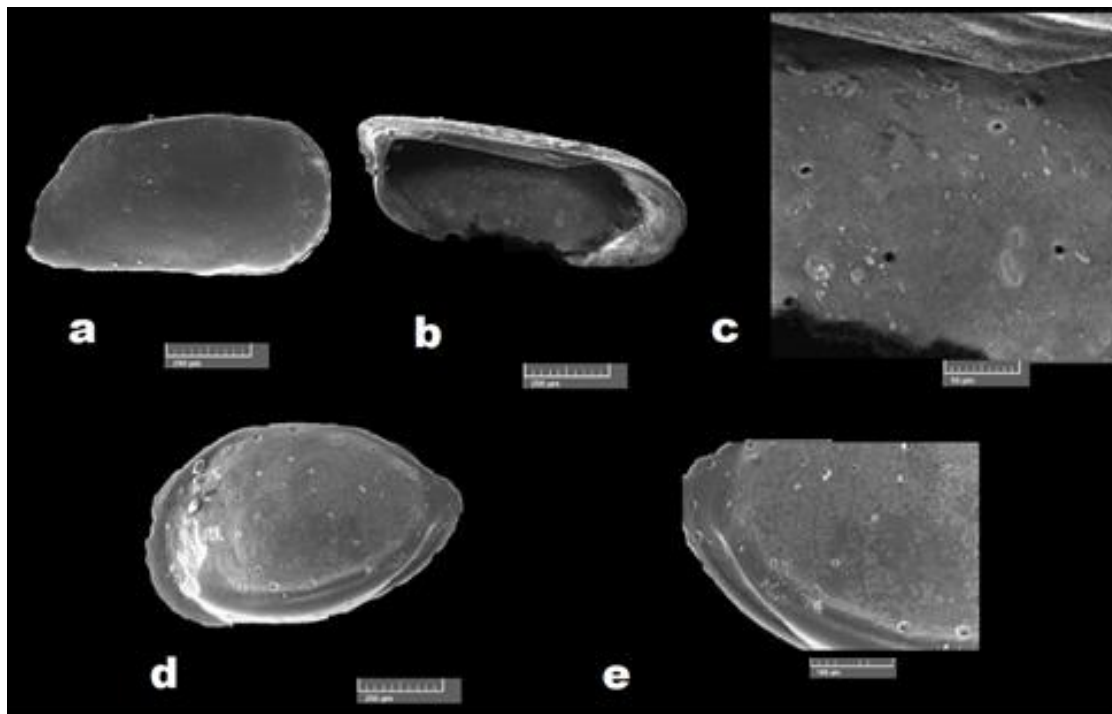


Figure 2: a- *Krithe* sp. R.V External view., b- *Krithe* sp. R.V Internal view, c- *Krithe* sp. R.V internal view zoomed, d- *Cytheropteron* sp. R.V External view., e- *Cytheropteron* sp. R.V. External zoomed. (R.V-Right valve)

3.2 Micro environmental characteristics

Ostracod abundance and diversity is controlled by many environmental factors such as type of substrate, hydrodynamic conditions, temperature and salinity (Aiello *et al.* 2006). Species diversity and Ostracod population increases away from the shore with respect to water depth, temperature and salinity (Zhao *et al.* 1985). However, the present study is finding an exact reverse relationship, moving to deep water Ostracod population and diversity is

reduced. A check on the sedimentological parameters and shell chemistry throws light into the micro environmental characteristics of the region. CaCO_3 studies on the sediments vary from 2.15 to 4.61 %, with an average value of 3.72 %. Organic matter (OM%) shows a slight variation, ranging from 1.97 to 3.01 %, having an average value of 2.45%.

A complete absence of Sand grains has been noted throughout the core, it depicts the lower energy condition of

deposition of the region. The granulometric studies reveals that clay sized particles are dominant than silt particles in all samples (Table.1). Clay varies from 68.23 to 80.92% with an average value of 78.74%. Silt percentage ranges between 19.08 to 31.77 %.

Table 1: Estimation of Sedimentological Parameters

| Sample No | CaCO ₃ % | OM% | Sand % | Silt % | Clay % |
|-----------|---------------------|-------|--------|--------|--------|
| 1 | 4.13 | 2.21 | 0 | 31.77 | 68.23 |
| 2 | 4.02 | 2.43 | 0 | 23.56 | 76.44 |
| 3 | 3.82 | 2.76 | 0 | 19.08 | 80.92 |
| 4 | 2.95 | 2.31 | 0 | 20.60 | 79.40 |
| 5 | 3.98 | 2.6 | 0 | 19.98 | 80.02 |
| 6 | 3.92 | 3.01 | 0 | 19.17 | 80.83 |
| 7 | 3.90 | 2.88 | 0 | 20.47 | 79.53 |
| 8 | 4.20 | 2.34 | 0 | 19.91 | 80.09 |
| 9 | 2.15 | 1.97 | 0 | 19.8 | 80.20 |
| 10 | 4.61 | 2.12 | 0 | 20.01 | 79.99 |
| 11 | 3.25 | 2.41 | 0 | 19.45 | 80.55 |
| Average | 3.721 | 2.458 | 0 | 21.25 | 78.74 |
| Maximum | 4.61 | 3.01 | 0 | 31.77 | 80.92 |
| Minimum | 2.15 | 1.97 | 0 | 19.08 | 68.23 |

Clay percentage is comparatively low with respect to other depths in the top core, which implies that the energy

condition of the area has been increasing. More silt has been carried from shallower part and deposited in the region and further, a good quantity of clay particles remains in suspension in shallow regions, get transported to deeper part of the ocean.

Organic matter and Calcium carbonate percentage shows a smaller range of fluctuation throughout the core. In sample number 9 both CaCO₃ percentage and Organic matter percentage are having least values. The reason may be because of a high surface disturbance and higher surface turbidity, occurred in the surface waters during the sedimentation. Also it could be noted that planktic foraminifera in this particular depth is very less as well as most of them are broken to fragments, with Ostracod *Krithe* sp. is well preserved, which is a delicate benthic form.

Matrix graph is plotted using past software (Fig.3) to know the relationship between these sedimentological parameters. Evident from the plot also the recent times has shown an increase in the energy of deposition in the region. The surface sample is having a higher percentage of silt and comparatively a less percentage of clay devoid of sand.

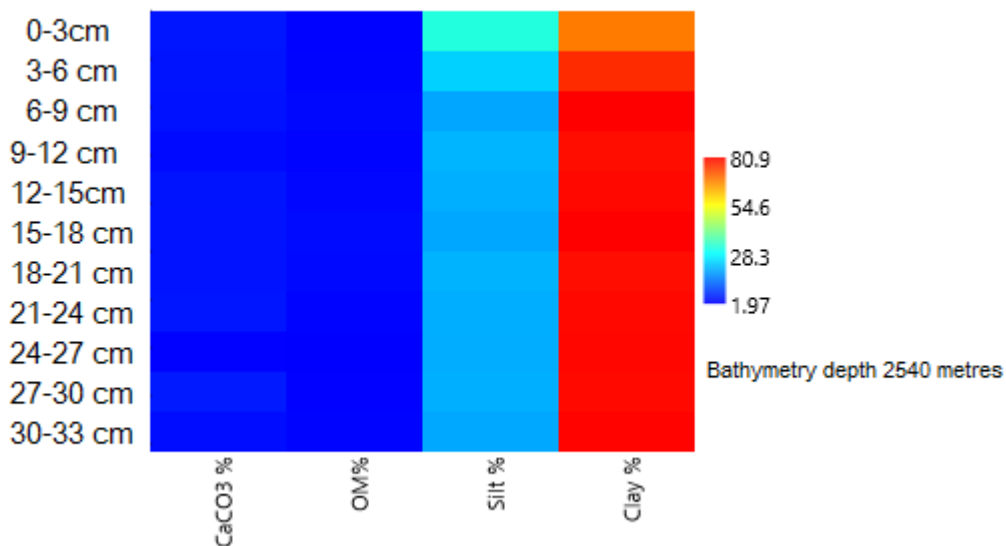


Figure 3: Matrix plot showing CaCO₃ %, OM%, Silt and Clay percentages

For biological reasons, Ostracods make shells and usually species, follow their own evolutionary physiologic pathways for calcifying their shell (Ito and Forester, 2009). Trace element presence in Ostracoda shells could be related to seasonal environmental changes (Xia et al., 1997a). An illustration in the variation of Elemental percentage in

weight percentage has shown in Fig.4. *Cytheropteron* sp. comparatively have a high percentage of Calcium in their exoskeleton which has resulted in the well preservation of the shell. *Krithe* sp. is also having Calcium as its dominant composition, but have a huge variation in Mg with respect to *Cytheropteron* sp.

Table 2: Elemental weight percentage in Ostracod shell

| | Magnesium | Calcium | Manganese | Iron | Strontium | Barium |
|--------------------------|-----------|---------|-----------|------|-----------|--------|
| <i>Krithe</i> sp. | 7.21 | 91.47 | 0.01 | 0.5 | 0.82 | 0.44 |
| <i>Cytheropteron</i> sp. | 0.6 | 98.03 | 0.5 | 0.5 | 0 | 0.37 |

*Values in weight percentage (wt%)

Calcium is abundant in both the forms, but have a slight difference in its concentration and that difference accounts for Magnesium in *Krithe* sp. Strontium is absent in

Cytheropteron sp., but a small amount of 0.82 percentage is present in *Krithe* sp. However, Barium has almost same values in both the species. It is noted that Iron (Fe)

imbibition capacity is exactly similar for both the species (Table.2). The difference in the shell composition is the only notable difference, except the morphological variations and

believed to be the reason for the occurrence of two different species.

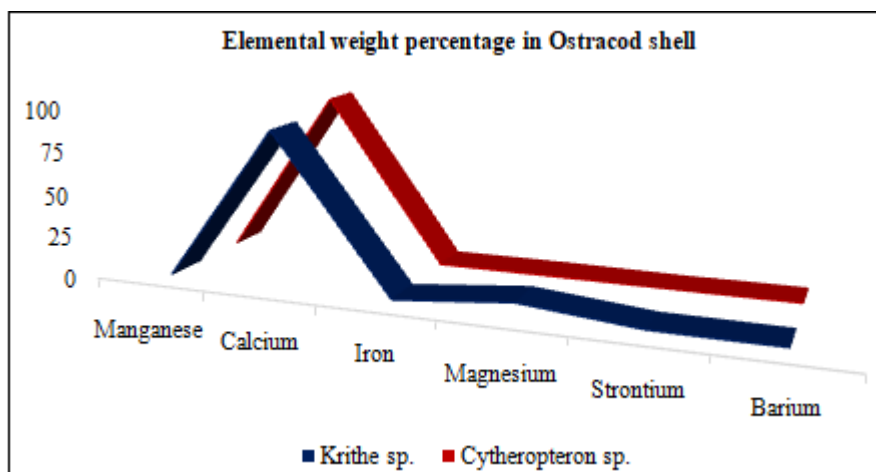


Figure 4: Elemental weight percentage in Ostracod shell

4. Conclusion

Entire absence of the Sand grains in the region indicates that a low energy condition, less disturbance in the substrate of the region and the shallow sands are not reaching to this depth. The sand content in fact has been re-deposited to the shallow as well as the coastal zone. The species recovered are typical deep water forms. It is found that shell chemistry has a very important role in the species distribution. No other notable difference in sedimentological parameters has been observed, except for sample number 9 (24-27 cm) which could be an impact of a high surface water turbulence and (0-6 cm) due to an increase in the energy level conditions in the recent geological time. *Cytheropteron* sp. found from this area are comparatively well preserved and durable, however the form, *Krithe* sp. recovered are very fragile in nature. This is because of the comparatively higher accumulation percentage of Calcium in the *Cytheropteron* sp. shell. It is observed that the taxa *Krithe* sp. and *Cytheropteron* sp. reported from the study area are near similar to the glacial taxa reported by Anna and Mitchell (2014) from Eastern equatorial pacific. A very low productivity has been observed in this area, expected to be, because of the changes in ocean temperature and increased depth, along with variations in sedimentation.

5. Acknowledgements

The financial support extended to the work was funded to Mohammed Noohu Nazeer, by UGC-Maulana Azad National Fellowship, under University Grants Commission is greatly acknowledged. Thanks to Dr. Rajiv Saraswat, Scientist NIO, Goa for the helps and support in various capacities during the field work. Immensely grateful to both the Directors of SAIF, IIT Madras and NCESS, Thiruvananthapuram, for the permission to utilize SEM and EDS facility. Thanks to Mr. Tharun R, Assistant. Professor, Christ College for the GIS map. Last but not least, thanks to the Head of the Department, University of Madras for the permission to access the departmental facilities.

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