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Distribution of ostracode Fauna and Environment of Deposition of Early Miocene (Aquitanian-Burdigalian) Sediments in Kachchh, Gujarat

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Abstract**: *Kachchh is a pericratonic basin in which Early Miocene sedimentation took place in a shallow marine environment. During the course of study of ostracods from these beds a detailed sampling carried out from a hill section (N 23°24',E 68°49') exposed about eight kilometres from Rampar village, towards Goyela-Matanomadh road. The sediment logical data and ostracod assemblage together reveals the fluctuation in relative sea-level. The change in ostracod assemblage in middle part indicating deepening i.e. middle shelf environment. This is followed by progressive shallowing of the basin marked by deposition of marl. The top part composed of limestone with full of mega fauna indicates again deeper water condition prevail in the area. The paleoecology of the genera viz. Actinocythereis, Neomonoceratina, Alocopocythere, Cytherelloidea, Pontocypris, Propontocypris, Pseudocythere, Semicytherura, Xestoleberis, Cytheropteron, Miocyprideis, Pokornyella and Occultocythereis is discussed in the paper.The overall evidence suggests that majority of the genera thrive well in near-shore to shallow marine environment and hence it is inferred that the beds of Early Miocene might have been deposited in near-shore to shallow marine conditions.***
Keywords: Kachchh, Early Miocene, Khari nadi Formation and Chhasra Formation, Paleoecology and Ostracods.

I. INTRODUCTION

In Kachchhbasin the Tertiary rocks occur as narrow strip fringing the Mesozoic outcrops of the highlands. The rocks of Tertiary period are exposed in the western part of the basin. The Early Miocene rocks composed of mixed carbonate-siliciclastic sediments. The sedimentation in this basin took place largely in shallow marine environment. Lithostratigraphically it is referred as Khari Nadi Formation at the base and Chhasra Formation at the top. The Khari Nadi Formation uncomfortably overlies the Maniyara Fort Formation of Oligocene age, while the upper contact of the Chhasra Formation is unconformable with Sandhan Formation of Pliocene. On the basis of larger foraminifera, the Khari Nadi Formation is assigned Aquitanian age, while Chhasra Formation is of a Burdigalian age (Raju, 1974, 1991). During the course of study of ostracods from these beds a detailed sampling carried out from a hill section, which is about 55 feet in height (N 23°24',E 68°49') exposed about eight kilometres from Rampar village, towards Goyela-Matanomadhroad (Fig. 1).The sedimentation at this hill section ((N 23°24', E 68°49') commenced, with deposition of clay at the base, followed by siltstone, marl, siltstone, marl and limestone at the top.

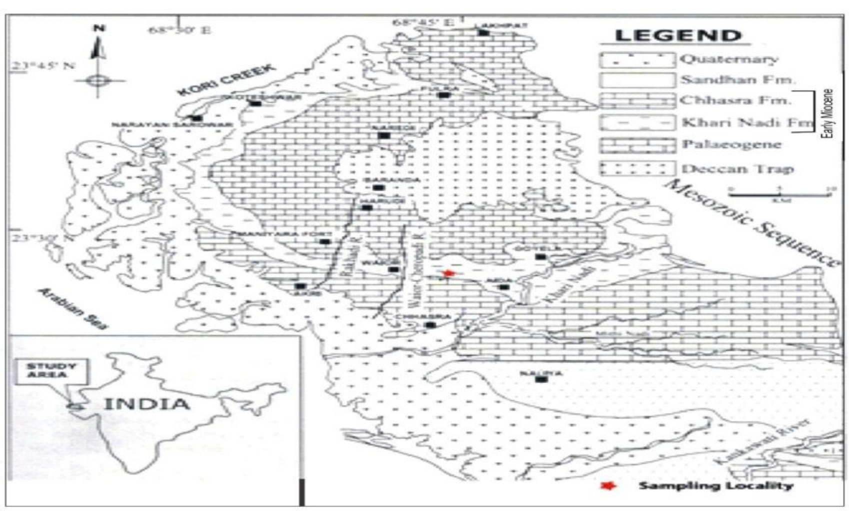


Fig. 1. Location and Geological map of the study area, Kachchh (after Biswas, 1992)

95

II. PALEOECOLOGY

The sediments at this hill section commenced with deposition of clay (ADK1/1 to ADK1/4) at the base upto six feet in height. In the lower part it is devoid of any fauna, while in upper part rare occurrence of genera like Alocopocythere, Actinocythereis, Miocyprideis, Paijenborchellina, Stigmatocy there etc. appeared first time.

The ecological data pertaining to certain Recent species of Alocopocy there from the Persian Gulf (Bate, 1971; Paik, 1977) and the Mandvi Beach (Jain, 1978) shows that the genus occurs commonly in lagoonal and shallow marine environments, while the studies of living species of the genus Actinocy there is from the Persian Gulf (Paik, 1977) and the Mandvi Beach (Jain, 1978) suggest that the genus thrive well in near-shore to shallow marine environments. The living species of the genus also occurs in the off central Bay of Bengal from inner shelf and outer shelf ranging at the depth 47 meters to 105 meters from sandy clay substrate (Nishath et al., 2017).

The genus Miocyprideis, according to Ducasse and Moyes(1971), is characteristic of littoral environment. A species of the genus has been observed to inhabit the coastal waters of Gulf of Kachchh, near Okha Port, Saurashtra (Khosla, 1988). Studies of certain living species of the genus Paijenborchellina from the Abu Dhabi Lagoon, Persian Gulf (Bate, 1971) shows that it occurs from near-shore shelf to lagoonal environments. The living species of the genus also occurs in the off central Bay of Bengal from Lower-bathyal, ranging at the depth 1487 meters from silty clay substrate (Nishath et al., 2017). Of the various ostracods which occur in this section, little is known about the ecology of the genus Stigmatocy there as this does not occur in the present day. The litho logical and above ostracod appearance indicates that first marine incursion took place in this region.

This is overlain by 2-3 feet thick siltstone bed (ADK1/5 to ADK1/6) with moderate occurrence of above genera, with appearance of the genus Cytheropteron. The genus inhabits in marine waters of all the depths in the present day seas. Deep water species are generally thin-shelled and smooth (Morkhoven, 1963). The species of the genus occurs in the Sendai Bay region on the inner shelf at depths less than 60 meters and middle shelf at depth near the 70 meters from the Pacific coast of north-eastern Japan, (Ikeya and Itoh 1991). Ikeya and Suzuki, 1992, recorded Cytheropeteron species from outer-shelf (80-150m deep) from off Shimane Peninsula, south western Japan sea. The genus Cytheropteron is a eurybathic, reported from the Gaindorf formation of Mühlbach, Molasse Basin, Lower Austria from deeper environments by Zorn (2003). The living species of the genus also occurs in the off central Bay of Bengal from Inner-shelf to upper-abyssal ranging at the depth 47 meters to 2386 meters from clayey silt substrate (Nishath et al., (2017). This is indicative of slight deepening of the basin i.e. inner-shelf to outer-shelf. The siltstone bed is overlain by approximately 7 feet thick marly(ADK1/7 to ADK1/10)bed, with moderate occurrence of all the above genera, with first appearance of genus Cytherelloidea. The genus Cytherelloidea is essentially a marine form but can also adapt to polyhaline conditions (Morkhoven, 1963; Keen, 1977; Omatsola, 1972; Sohn, 1962, 1964). The genus occurs in various temperatures and depth ranges in marine environments and is a good paleo temperature indicator and in the present day seas it does not survive in temperature less than 10°C. Nishath et al., 2017, recorded the living species of the genus from the off central Bay of Bengal from outer-shelf and middle-bathyal ranging at the depth 749 meters from silty clay substrate.

In the overlying marl (sample ADK 1/9), Pokornyella appeared first timeand the genus is suggestive of epi-neritic environment (Morkhoven, 1963). The ecological data pertaining to certain living species of the genus from the Uranouchi Bay, Japan (Ishizaki, 1968) shows that it occurs in depths from 2-25 metres, being commonly found in depths from 14 to 32 metres. In upper part firm marine conditions established and abundant occurrence of all the above genera.

In the upper marly bed (ADK 1/12) rare to moderate occurrence of the genera listed earlier, indicates possibly marine regression took place. In addition, genus Occultocythereis appeared first time, which shows that the genusis marine form and mostly inhabits in epi-neritic water (Morkhoven, 1963).Above to this 20 feet thick sequence of alternating bands of siltstone and silty shale (ADK 1/13 to ADK 1/24) with abundant earlierostracods with emergence of new genera like Xestoleberis, Semicytherura, Psudocythere, Propontocypris and Pontocypris.The genus Xestoleberis though occurs commonly in littoral to epi-neritic environments, can also survive even in brackish water conditions (Morkhoven, 1963; Bold, 1971). Swain (1955), while describing the food of ostracods near La Jolla and San Deigo, California, observed that the genus is a plant feeder and favours a turbulent environment. Benson (1964), while studying the Recent Cytheraceanostracods found the presence of most of the Xestoleberis species upto depths of 75 metres. The same genus also reported by Elewa (2004) from Eocene of Cairo, Egypt, indicates a typical steep continental margin of the shallow marine environment. Xestoleberis has also been reported by Pezelj etal., (2007) from Late Badenian of Croatia which indicates Middle shelf / Outer shelf environment.

The genus Semicytherurais characteristics of shallow marine i.e. littoral environment (Morkhoven, 1963). The same genus also reported by Elewa (2004) from Eocene of Cairo, Egypt, indicates a typical steep continental margin of shallow marine environment.

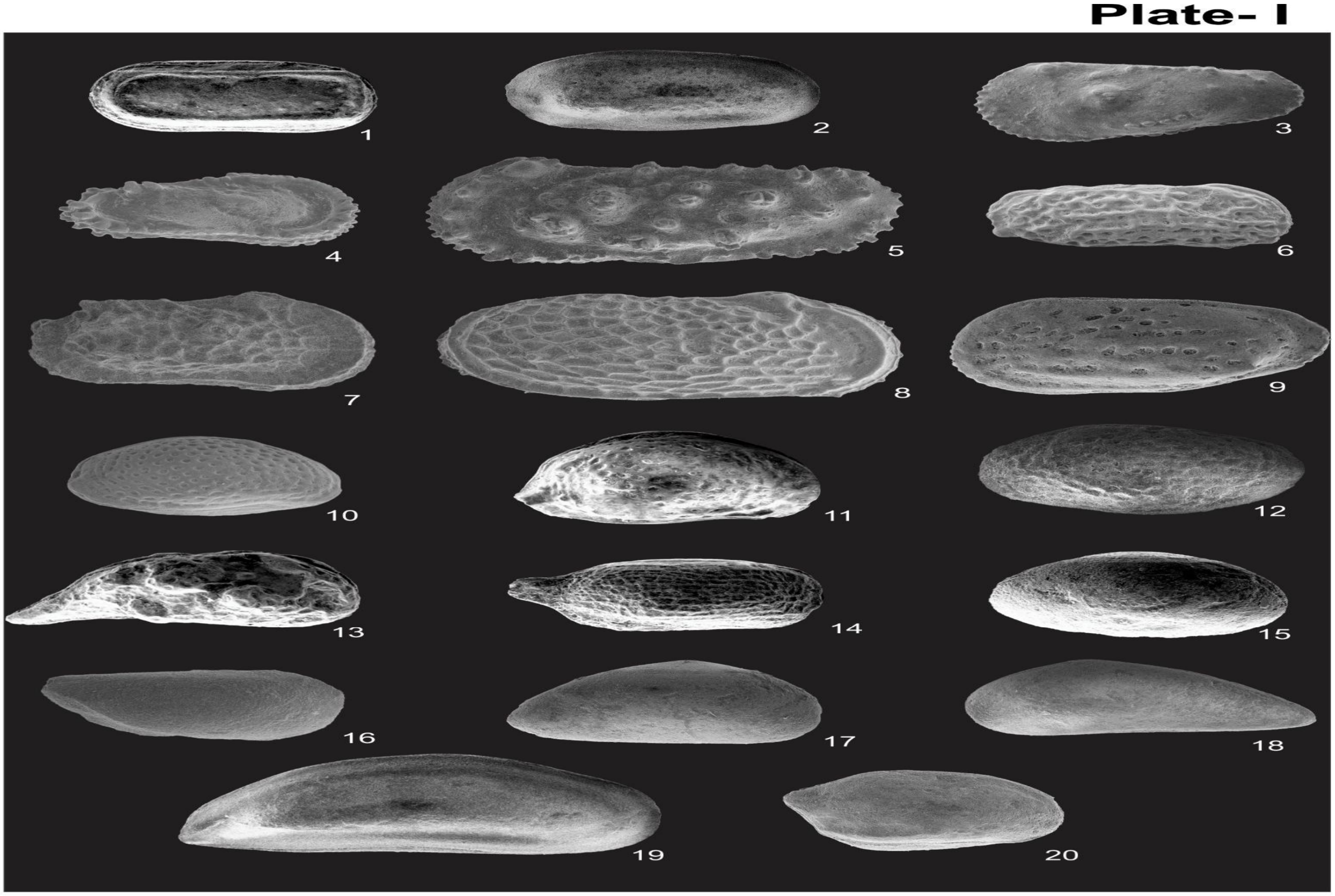
The representatives of the genus Pseudocy there in the present day sea inhabit at all depths (Morkhoven, 1963), Maddocks (1969), recorded certain living species of the genus Propontocypris and Pontocypris from Indian ocean which are characteristics of shallow-water near shore environments, especially those offering abundant phytal and coralline micro habitats and are never found at bathyal or abyssal depths and only rarely in offshore shelf sediments. The living species of the genus Propontocypris reported from the off central Bay of Bengal from the inner shelf to middle bathyal ranging at the depth 29 meters to 763 meters from sandy clay substrate by Nishath et al., (2017). From above it is concluded that again marine regression took place in the area.

The upper part of siltsone (ADK 1/24 to ADK 1/27) the frequency of ostracods reduces, mainly represented by genera Actinocythereis, Alocopocythere, Cytherelloidea, Pontocypris, Propontocypris, Loxoconcha, Paijenborchellina and Stigmatocythere, indicating a regressive phase of deposition of sediments. he overlying marl (ADK1/28 to ADK 1/32) having rare occurrence of ostracods like Actinocythereis, Alocopocythere, Miocyprideis, Pokornyella, Xestoleberis, Cytherelloidea etc., indicating that the above beds might have been deposited in a regressive phase, with a very shallow depth. This is overlain by about 15 feet thick, hard limestone bands, which is rich in megafauna indicates again slight deeper water conditions in the area.

From the above distribution it is evident that genera like Actinocythereis, Alocopocy there and Neomonoceratina occurs almost throughout in the Khari Nadi formation and Chhasra formation, while genera like Pontocypris, Propontocypris, Pseudocythere, Semicytherura, Xestoleberis, Cytheropteronappears in the middle part. Ostracods in the top marly part represented byrare occurrence of genera like Actinocythereis, Neomonoceratina, Alocopocythere, Cytherella, Cytherelloideaetc. (Plate 1).

On the basis of ostracods and lithological association it is concluded that the sediments of the Early Miocene, ages in Kachchh region (as is true of other marine coastal deposits in India) were formed as a result of marine transgression. The deposits thus formed are generally characterized by (1) shallow water depositional environment (2) coarse nature of sediments (3) moderate thickness of beds and (4) their occurrence as thin strips near the existing coast line. The marine transgressions commenced with a gradual advance of shallow epeiric seas over slowly submerging land. Such transgressions bring with them the littoral environment, which is subsequently replaced by comparatively deeper infra-littoral or shallow circa-littoral environments.

Plate- I



Explanation of Plate I

1. Cytherelloidea, male carapace, length 0.56mm, left valve view, X64; 2. Miocyprideis, male carapace, length 0.55mm, right valve view, X73; 3. Archicy there is, male carapace, length 0.47mm, left valve view, X87; 4. Occultocythereis, male carapace, length 0.33mm, right valve view, X115; 5. Actinocythereis, male carapace, length 0.91mm, left valve view, X66; 6. Chrysocythere, male carapace, length 0.47mm, right valve view, X102; 7. Stigmatocythere, male carapace, length 0.65mm, right valve view, X72; 8. Alocopocythere, male carapace, length 0.90mm, right valve view, X71; 9. Ruggieria, male carapace, length 0.64mm, left valve view, X81; 10. Aurila, male carapace, length 0.44mm, left valve view, X107; 11. Pokornyella, male carapace, length 0.51mm, right valve view, X82; 12. Loxoconcha, male carapace, length 0.42mm, left valve view, X107; 13. Paijenborchellina, male carapace, length 0.66mm, right valve view, X74;14. Semicytherura, male carapace, length 0.37mm, right valve view, X119;15. Xestoleberis, female carapace, length 0.36mm, right valve view, X114;16. Pseudocythere, male carapace, length 0.29mm, right valve view, X145;17. Pontocypris, male carapace, length 0.57mm, left valve view, X84;18. Propontocypris, male carapace, length 0.58mm, right valve view, X74;19. Phlyctenophora, male carapace, length 0.94mm, right valve view, X89; 20. Cytheropteron, female carapace, length 0.28mm, right valve view, X136.

III. ACKNOWLEDGMENT

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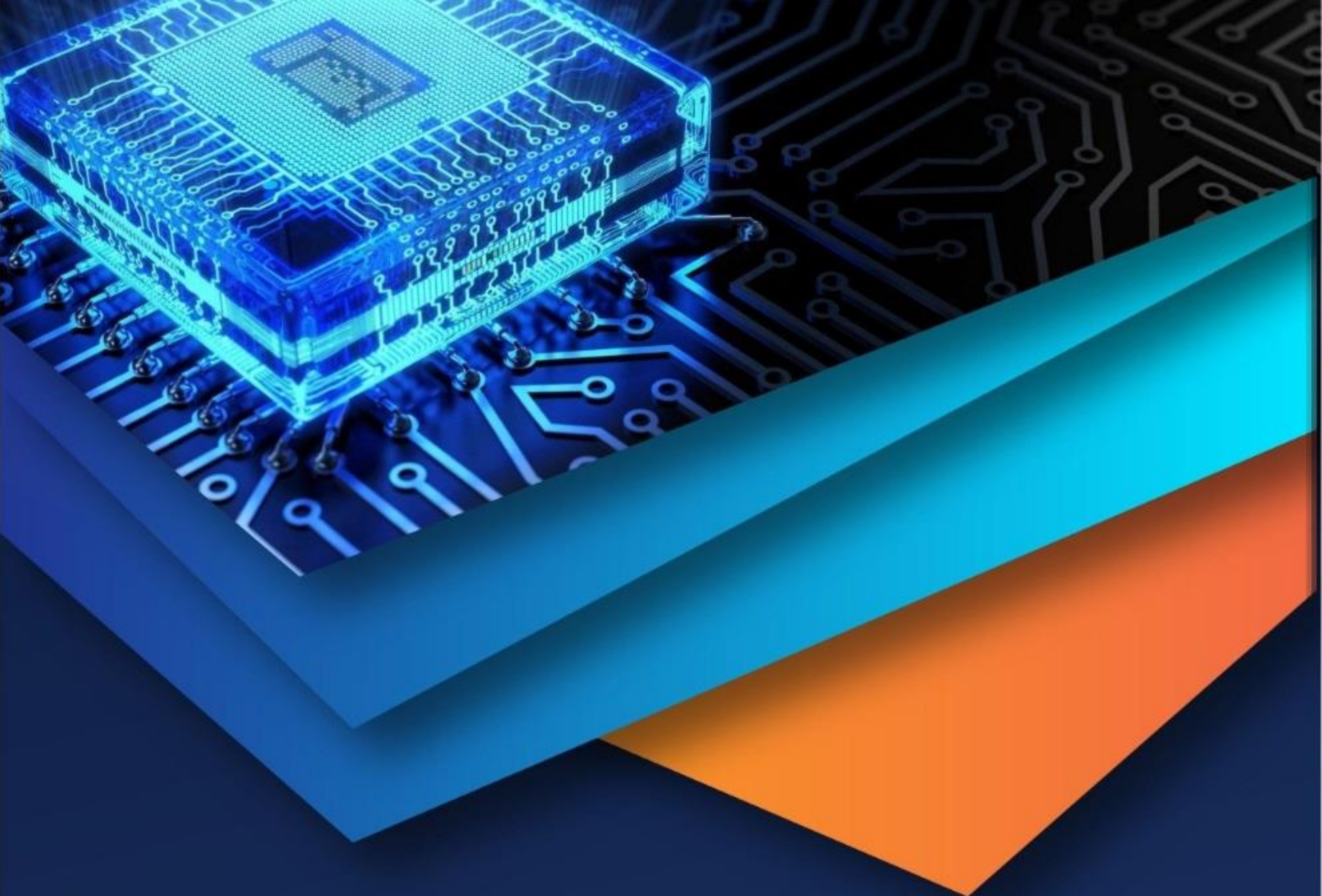

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