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Taxonomical study of Foraminifera from the Vinjhan Stage from Lower Miocene, Kachchh, Gujarat, India

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Abstract:
The current study, viz. Globothalamea, Tubothalamea, Nodosariata and these three order of three classes viz. Rotaliida, Textulariida, Miliolida have been recognised six species of benthic foraminifera in lower Miocene Vinjhan stage limestone bed. This study provides taxonomical identification of foraminifera as Rotalidium Sp., Elphidium Hispudilum, Lagena Sp., Triloculina Sp.,Bolivina Sp., and Quiqualoculina Sp. These species generally shows palaeoenvironmental depth of water upto 50 meters and low to high energy condition.

Keywords: Morphology, Taxonomy, Benthic foraminifera, Limestone, Vinjhan section.

INTRODUCTION

The Great Rann of Kachchh basin is structurally precratonic rift basin shows tilted horst blocks having east-west orientation with dominant half grabens towards north boreder (Biswas 2005). This basin experienced marine transgression at regular intervals from late Paleocene to mid Eocene overlapping Deccan Volcanic Provenience (DVP) and disconformably on Mesozoic rocks (Biswas, 2016a). Marine Paleogene-Neogene deposits of this basin are widespread (Fig. 1) and deposited during transgression (Raju, 2011). About 900m thickness indicated by entire Cenozoic succession from which Sonar et. al., (2022) described Thalamoporellidae bryozoan's foddild recently.

Complete successions from Palaeocene to Holocene are well preserved in this region. The limestone and silty–claystone of Murachbann

section consists of large quantity of bryozoans, ichnofossils, ostracods, gastropods, bivalves and foraminifers. Several scientist recorded foraminifera from Cenozoic of Kachchh (Tewari, 1956)

The record of foraminifers from Cenozoic of Kachchh is documented by (Tewari, 1956; Tewari et al., 1968; Dasgupta, 1973; Raju, 1974; Raju & Drooger, 1978; Jauhri, 1981, 1991,1994; Saraswati, 1994; Saraswati, 1994, 1995; Kumar, 2022; Saraswati, 1997; Sengupta, 2009; Kundal, 2014; Talib *et al*. 2017; Khanolkar et. al., 2019). The lower Miocene deposits exposed at Chhasra and Vinjhan (Fig. 2) village assigned with the marker species *Miogypsina* (Jhauri, 1990). Further Catuneanua and Dave (2017) based on the occurrence of *Miogypsinoides* sp., *Miogypsina dehaarti* and *Miogypsina indica* assigned lower Miocene age to Chhasra Formation. The present studied section is belongs to this Chhasra Formation.

This study, six benthic foraminifera species belong to three classes viz. Tubothalamea, Globothalamea Pawlowski *et al*. (2013), Nodosariata emen. Rigaud et al. (2015), Mikhalevich (1992) and four orders viz., Rotaliida and Miliolida Delage *et al*. (1896), Textulariida and Polytmorphinida Mikhalevich (1980) recognised from the Vinjhan stage limestone bed of the lower Miocene (Fig. 1).

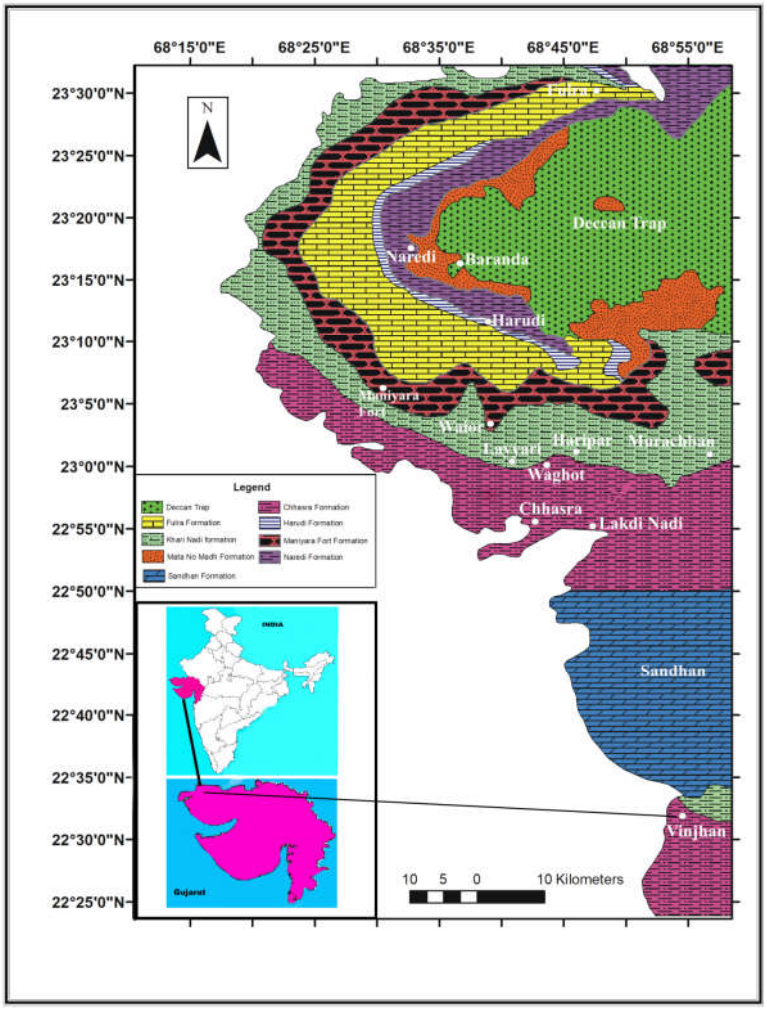

Figure 1: Location and Geological map of Kachchh, Gujarat, India (Modified after Biswas 2005; Sonar *et al. 2022*)

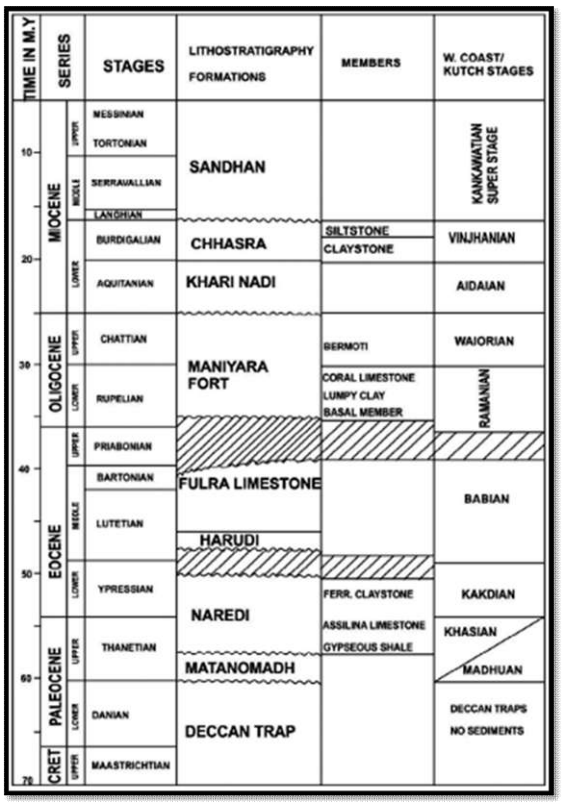

Figure: 2 Chronostratigraphic units and Lithostratigraphic classification of the Cenozoic of Kachchh (After Biswas, 1992)

MATERIALS AND METHODS

Sampling was carried out in the month of February 2018 at Murachbann section (23°30'05" N, 68°53'00" E), which is located at 2 km distance from Walaram Teerthdham in the western Kachchh, Gujarat. Approximately, 1 Kg of each rock sample was collected from the field during sampling, from sample bagh nearly about 1/4th quantity of the sample was taken for analysis and soak in concentrated H_2O_2 for 48-72 hours and processed for sieve analysis. The Foraminifers were picked under a light microscope fixed with Olympus Canon Camera. Selected Foraminifers were photographed using Well-preserved foraminifera are photographed using a SZ61TR Trinocular zoom Stereo Microscope (LED), Government Institute of Science, Aurangabad, Maharashtra, India.

The microscope photographs were paying attention on the different morphological features of the foraminifers. The recognition of benthic foraminifera based on the description given by Loeblich and Tappan (1987, 1988, 1992, 1994) for supragenic and generic classification. However, Parker, 1962; Murray, 1971; Jones, 1994; Szarek, 2001; Kaminski *et. al*., 2002; Murray, 2003; Javaux and Scott, 2003; Riveiros and Patterson, 2008; Margreh, 2010; Milker and Schmied, 2012; Debenay, 2012; Tabita and Nathan, 2019, these scientits are also reffered for identification. The World Register of Marine Species (WoRMS) used to revised the names of the species.

SYSTEMATIC PALAEONTOLOGY

Phylum: Foraminifera d'Orbigny, 1826
Class: Globothalamea Pawlowski, Holzmann & Tyszka, 2013
Subclass: Rotaliana Mikhalevich, 1980
Order: Rotaliida Delage & Herouard, 1896
Family: Ammoniidae Ehrenberg, 1839
Subfamily: Ammoniinae Saidova, 1981
Genus *Rotalidium* Asano, 1936
Rotalidium annectens (Parker & Jones, 1865)
(Fig. A-C)

Description. The test is large with uniform thickness, biconvex shape. The chambers length increasing towards the opening and width is greater than the length of the chamber. The coiling of the test is dextral in nature. Chambers are rhomboidal; per whorl 8-10 chambers are present, while aperture occurs without any connection with interior of chambers. The final chamber is normal in nature. Last whorl consists of thirteen chambers. In ventral and dorsal views sutures are distinct, and they are nearly straight- raised in dorsal view (Fig. A–C), coiling is oblique in nature and thick on Limbate, ventral side depressed, blunt periphery and uniform, in the apertural view periphery is sub rounded with keeled (plate I-Fig1B). Test calcareous, finely perforated. Umbilicus with irregular calcitic knobs. It is of benthic habitat.
Distribution. Western and Kra basins in the western gulf of Thailand (Morley 2011).

Superfamily: Nodosarioidea Ehrenberg, 1938
Family: Lagenidae Reuss, 1862
Genus: Lagena Walker & Jacob, 1798
Lagena Sp. d'Orbigny, 1839
(Fig. D–F)

Description. Test free, wall rounded along side view also rounded end view, wall calcareous and perforate, aperture apical, situated on the very slightly protruded neck.
Dimensions. The species length is 213µm and width 393 µm.
Distribution. South-central coast of Chile (Finger, K.L. 2013).

Family: Elphidium Galloway, 1933
Subfamily Elphidinae Galloway, 1933
Genus: Elphidium Montfirt, 1808
Elphidium hispidulum Cushman, 1936
(Fig. G-I)
1936 *Elphidium hispidulum* Cushman, 83, Pl-14, Fig. (13a-b).
2007 *Elphidium hispidulum* Cushman, 1936; Horton *et. al*., 58, Pl-1, (Fig-9a-b).
2012 *Parrellina hispidula* Cushman, 1936; Debenay, 229.

Description. Test large, biconvex in shape, calcareous in nature. Indistinct chambers, final chamber slightly inflated, arranged planispirally. Normal curved shape depressed sutures. The shape of periphery rounded blunt with uniform thickness. The test is coarsely perforated. The aperture sub-rounded with thick lip at the end of the test. It is benthic habitat.
Distribution. In the south china sea south-western (Szarek 2001), Central Japan, Tanabe Bay & Kii Peninsula (Chiji 1968), Port Blair, South Andaman (Muruganantham 2017).

Family**:** Hauerinidae Schwager, 1876
Genus: Triloculina d'Orbigny, 1826
Trioculina Sp.
(Fig. J–L)
Description. Trangular or triloculine with smooth surface, imperforated, with calcareous wall. Aperture arc shape at terminal end with short neck. Three chambers visible along cross section. It is a benthic habitat.

Superfamily: Cassidulinoidea d'Orbigny, 1839
Family: Bolivinitidae Cushman, 1927
Subfamily: Bolivinitinae Cushman, 1937
Genus **Bolivina** d' Orbigny, 1839
***Bolivina* sp**.
(Fig. M–O)
Description. Test agglutinated, aboral end tapering, very small size, chambers are biserially arranged, test perforated, with 7 to 8 in biserial pairs of chambers. The chambers are parallel to one another. Aperture at the terminal not well preserved.
Dimensions. The species length is 110 µm and width 173 µm.
Distribution. Brasso Formation of Central Trinidad (Wilson, B.R.E.N.T. 2004), Transylvanian basin and SE Carpathian Foredeep (Romania) (Sant *et. al.* 2019).

Order: Miliolida Dalage & Herouard, 1896
Suborder: Miliolina Dalage & Herouard, 1896
Superfamily: Milioloidea Ehreberg, 1839
Family: Hauerinidae Schwager, 1876
Subfamily Hauerininae Schwager, 1876
Quinqualoculina Sp. d'Orbigny, 1826
(Fig. P-Q)
2006 *Quinqualoculina bosciana* Oflaz, 160-161, Pl-11, Fig.06
2012 *Quinqualoculina bosciana* Debenay, 120
Description. The test is large, alongated, apertural view sub oval, apertural end truncate, aboral end round, wall calcareous, surface

smooth; chambers distinct, slightly oblique, chamber arrangement quinqualoculine; periphery rounded, sutures distinct; aperture terminal, circular, on a short, broad neck.

Distribution. Limon Basin of Costa Rica (Cassal, D. T., 1989). northeastern Gulf of Mexico (Bandy, O. L. 1956).

RESULTS AND DISCUSSIONS

The basal part of the Vinjhan section is made up of very thin layer of grey shale which is non-fossiliferous overlain by limestone upto 1m thick. Variations in the sea level during the deposition of these sediments are shown by the sediments unique characteristics from bottom to top and its varying fossil concentration. The region has mostly experienced the maritime transgression phase, along with the regression phase over a lesser period of time, according to the overall findings. *Miogypinoids* Sp., a marker species found in Vinjhan formation, indicates a depositional environment that fluctuates between shallow inner shelf and marginal marine (Jhauri, 1990; Catuneanua and Dave, 2017). *Rotalidium* Sp., *Textularia* Sp., Bolivina Sp., and *Elphidium* Sp., were found in abundance in the basal limestone of the Vinjhan formation, while *Rotalidium* Sp., *Textularia* Sp., and were found in the upper limestone beds, suggesting that the water depth of the deposition was shallow marine, with a maximum depth of 50m. (Reiss and Hottinger 1984; Kumar and Saraswati 1997; Kundal 2014; Nouradini *et al.,* 2015).

CONCLUSION

The taxonomical study of foraminifera Vinjhan stage from lower Miocene period limestone bed observed, *Rotalidium* Sp., *Elphidium Hispudilum*, *Lagena* Sp., *Triloculina* Sp., *Bolivina* Sp., and *Quiqualoculina* Sp. These species generally shows palaeoenvironmental depth of water upto 50 meters and low to high energy condition

CONFLICT OF INTREST

There is no conflict of intrest among all the authours.

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