Journal of the Palaeontological Society of India
Volume 60(2), December 2015: 85-87

ISSN 0522-9630

PRELIMINARY REPORT ON THE WALL OVERGROWTH IN SOME LOWER OLIGOCENE RETICULATE *NUMMULITES* (FORAMINIFERIDA), SW KUTCH, INDIA

S. SENGUPTA*, ROSINA SYED and **SAMPA SARKAR**

DEPARTMENT OF GEOLOGY, CALCUTTA UNIVERSITY, 35 BALLYGAUNGE CIRCULAR ROAD, KOLKATA 700019

*E-MAIL: ssggeol@gmail.com

ABSTRACT

Carbonate accretion in the larger foraminifera *Nummulites* Lamarck proceeds with the individual laminae being laid down on the sediment-free test surface at the time of chamber addition. In a marked departure from this general pattern, a few microspheric specimens of reticulate *Nummulites* collected from the Lower Oligocene rocks of southwestern Kutch, India were found to exhibit overgrowth of the test wall upon other benthonic foraminifera (OBF). It seems that wall overgrowth may have constrained the OBF specimens that plausibly thrived on the reticulate *Nummulites*.

Keywords: Foraminifera, wall overgrowth, Oligocene, reticulate *Nummulites*, Kutch, India

INTRODUCTION

The shallow marine Lower Oligocene rocks of Kutch, India are excellent repository of reticulate *Nummulites* (Foraminiferida), see Adams (1986), Biswas (1992) and Sengupta *et al*. (2011a). Morphology and diversity of these reticulate *Nummulites* have been examined by Nuttall (1925), Mohan (1965), Dasgupta (1970), Roveda (1970), Sengupta (2000 and 2002), Sarangi *et al*. (2001), Shukla (2008) and Sengupta *et al*. (2011a and 2014). In this communication, we report the hitherto unaccounted nature of the test wall encountered in some Lower Oligocene microspheric specimens of reticulate *Nummulites* collected from southwestern Kutch. The examined specimens reveal overgrowth of the test wall upon other benthonic foraminifera (OBF).

MATERIALS AND METHOD

Materials for the present study were isolated from the yellowish brown glauconitic marl of the Lower Oligocene Basal Member, which constitutes the lowest unit of the Maniyara Fort Formation (Biswas, 1992), see Figs. 1A-B. The limestone (R22) and marl (R23-R25) samples were collected from the flanks of Rakhdi river near Khari (23° 28′ N, 68° 41′ E) in southwestern Kutch. The marl samples were crushed and boiled in water mixed with sodium carbonate to obtain matrix free foraminiferal tests as stated in Glaessner (1963). The marl samples yielded abundant specimens of reticulate *Nummulites*; the megalospheric tests were nearly 6 times more abundant than the microspheric ones. Thirty microspheric tests of reticulate *Nummulites* were recovered from the marl samples, of which 5 tests from the samples R 23 and R 25 revealed the overgrowth feature. These 5 specimens were externally examined under the stereomicroscope; one of the specimens was subsequently examined under the scanning electron microscope (SEM). Lack of adequate specimens for the preparation and examination of the oriented sections deterred the taxonomic exercise, and as such, the identity of the OBF specimens remains elusive at the present stage of the investigation.

OBSERVATION

The OBF specimens are small in size (D 2.0 – 3.5 mm)

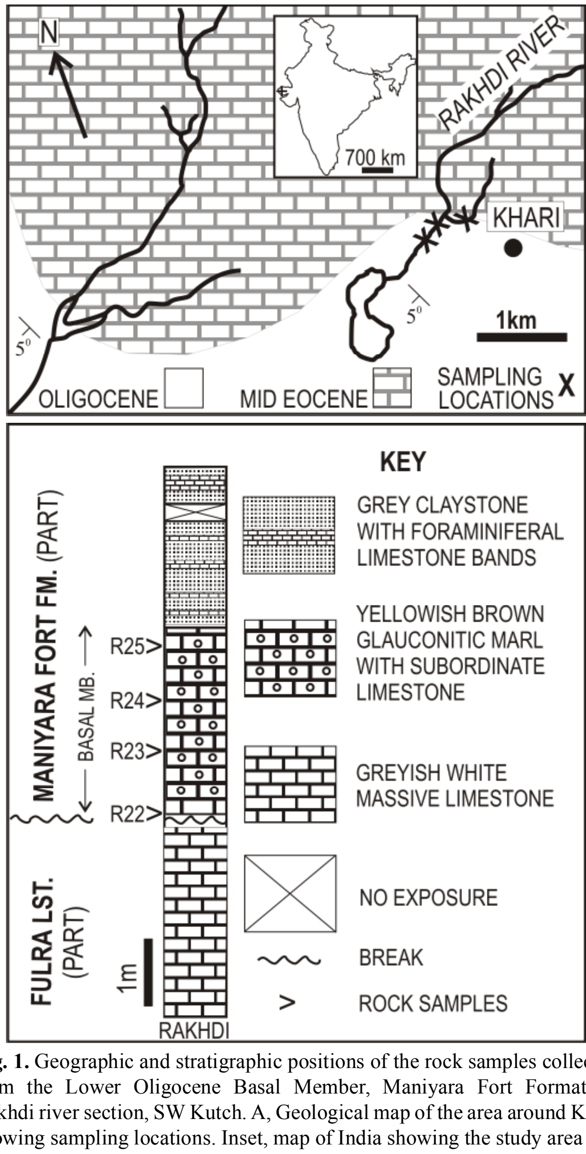

Fig. 1. Geographic and stratigraphic positions of the rock samples collected from the Lower Oligocene Basal Member, Maniyara Fort Formation, Rakhdi river section, SW Kutch. A, Geological map of the area around Khari showing sampling locations. Inset, map of India showing the study area (+). B, Stratigraphic position of rock samples.

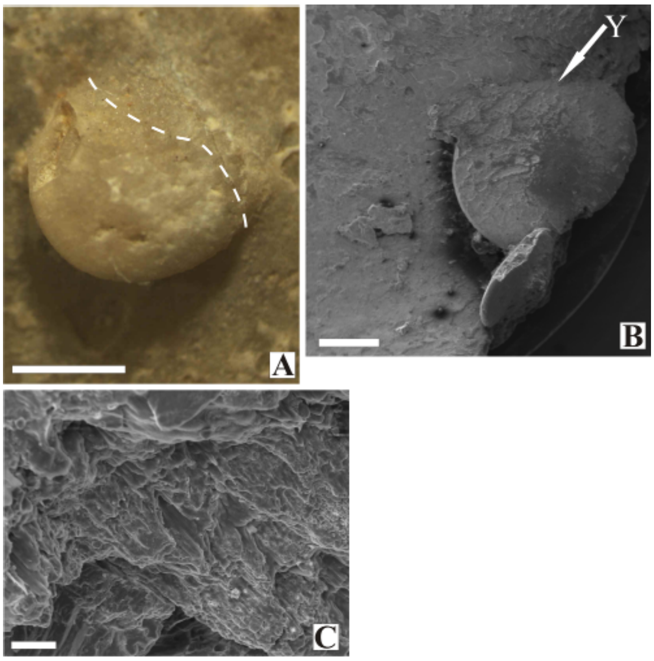

Fig. 2. Microspheric tests of reticulate *Nummulites* with wall overgrowth, Basal Member, Maniyara Fort Formation, Rakhdi river section, SW Kutch. A, Light microscope photograph; B-C, SEM photographs. A, OBF specimen (foreground) overgrown by reticulate *Nummulites* (background), specimen recovered from rock sample R23. Extent of overgrowth on OBF specimen is marked by broken line. B, Reticulate *Nummulites* (background) overgrows OBF specimen (foreground, marked by arrow), specimen recovered from rock sample R25. Overgrowth by reticulate *Nummulites* is seen near arrowhead marked Y. Vertically oriented foraminifera at the bottom is not overgrown. C, Laminae of overgrowing wall near arrowhead marked Y in Fig. 2B; note absence of pores in overgrowing wall. Scale bars: 1 mm in A-B, 30 µ in C.

compared to the large microspheric tests of reticulate *Nummulites* (D 12.5 – 19.0 mm). The OBF specimens are lenticular and have smooth surface; one of the specimens shows mesh-like appearance on the surface (Fig. 2 B). Wall overgrowth is readily discernible under the stereomicroscope as spiral laminae of the reticulate *Nummulites* grows upon the OBF specimens (Figs. 2A-C). These overgrowths cover only small portion of the OBF specimens at and around their periphery. SEM examination reveals that the individual laminae of the overgrowth wall are solid in nature due to absence of pores (Fig. 2C).

DISCUSSION

Carbonate layers are accreted on the surface of *Nummulites* during episodes of chamber addition (Smout, 1954 and Hansen, 1999). Instars, representing the boundaries between the adjacent accretional layers, mark the former test surfaces. The overwhelming ability of the *Nummulites* to maintain the test surface free of ambient sediments (including bioclasts) is evident from the smooth course of the instars. This mode of wall accretion is crucial in facilitating the development and uninterrupted propagation of the respiration facilitating pores within the spiral laminae (Leutenegger and Hansen, 1979; Hottinger, 2000 and 2001). In this backdrop, the wall overgrowth may appear to disrupt the pore-forming accretional milieu because the OBF specimens get attached to the surface of the reticulate *Nummulites*. The possibility of the wall overgrowth being an aberrant morphological development can be ruled out because overgrowth involves only the OBF in complete exclusion of the ambient detritus, viz. mineral grains and skeletal fragments. In fact, the exclusion of random detritus in the overgrowth feature possibly indicates that the overgrown OBF were live individuals rather than dead bioclasts. It seems likely that the live OBF individuals interacted with the live specimens of reticulate *Nummulites* before being overgrown by the latter. This live-live interaction among foraminifera may have been in the form of stubborn attachment of the OBF on to the surface of the reticulate *Nummulites* (Walker *et al*., 2011). The basis of such attachment may have been pseudopodial anchorage, bioadhesion or both. High tensile strength and elastic properties of the pseudopodial network in *Astrammina rara* and *Amphisorus hemprichii* provide good analogue for the strong pseudopodial anchorage (Bowser *et al*., 1992 and Travis *et al*., 1988), while Langer's (1992 and 1993) observation that *Rosalina globularis* secrets an organic glue for the temporary fixation of the tests provides a close analogue for the bioadhesion.

Nigam *et al*. (1993) and Mazumdar *et al*. (2012) reported barnacle growth on the dead Holocene foraminifera from the west coast of India. Sengupta and Nielsen (2009), Sengupta *et al*. (2011b) and Syed *et al*. (2015) reported activities of algae, worms, bivalves, corals and bryozoans upon the bioclasts of Middle Eocene *Nummulites*, while Sengupta (1999) reported bioerosion of acrothoracican cirriped (crustacean) in the dead tests of Oligocene reticulate *Nummulites* from Kutch. Evidence favoring the live-live interaction among the benthonic biota involving foraminifera is rather rare (Syed *et al*., 2014 and Skinner, 2014). So far, Mukhopadhyay's (2003 and 2007) account of sexual reproduction (plastogamy) among paired Middle Eocene *Nummulites* from the Cambay Basin constitutes the only Indian record of the live-live interaction among *Nummulites*. The present account appears to be a case of embedment (*sensu* Tapanila and Ekdale, 2007) of the live OBF by the reticulate *Nummulites*. Strategic embedment at and around the growing end may have stalled the growth and development of the OBF specimens. In the present study, only a few microspheric individuals of reticulate *Nummulites* were found to exhibit the overgrowth feature. Further investigations are necessary to understand the prevalence of the overgrowth phenomenon in the larger foraminifera in general and *Nummulites* in particular.

ACKNOWLEDGEMENTS

This research is supported by the UGC fellowship [F4-3/2006(BSR)/7-47/2007(BSR)] of R. Syed, the CSIR fellowship [09/028(0908)/2012-EMR-I] of S. Sarkar and the University of Calcutta research grant of S. Sengupta. SEM study was carried out in the Palaeontology Division of Geological Survey of India, Kolkata. Comments from the reviewer upgraded the manuscript.

REFERENCES

Adams, C.G., Butterlin, J. and Samanta, B.K. 1986. Larger foraminifera and events at the Eocene-Oligocene boundary in the Indo-West Pacific region, p. 237-252. In: *Terminal Eocene Events* (Eds. Pomerol, Ch. and Premoli-Silva, I.), Elsevier, Amsterdam.

Biswas, S.K. 1992. Tertiary stratigraphy of Kutch. *Journal of the Palaeontological Society of India*, **37**(1): 1-29.

Bowser, S. S., Alexander, S. P., Stockton, W. L. and DeLaca, T. 1992. Extracellular matrix augments mechanical properties of pseudopodia in the carnivorous foraminiferan *Astrammina rara*: role in prey capture. *The Journal of Protozoology*, **39**(6): 724-732.

Dasgupta, A. 1970. Further studies on reticulate *Nummulites* (Foraminifera) from Oligocene Beds of Cutch, India. *Quarterly Journal of the Geological Mining and Metallurgical Society of India*, **42**(4): 159-172.

Glaessner, M. F. 1963. *Principles of Micropalaeontology*. Hafner Publishing Company, New York.

Hansen, H.J. 1999. Shell construction in modern calcareous foraminifera, p. 57- 70. In: *Mordern Foraminifera* (Eds. Sen Gupta, B.K.), Kluwer Academic Publishers, Great Britain.

Hottinger, L. 2000. Functional morphology of benthic foraminiferal shells, envelopes of cell beyond measure. *Micropaleontology*, **46** (Suppl. No. 1): 57-86.

Hottinger, L. 2001. The shell cavity systems in elphidiid and pellatispirine bilamellar foraminifera. *Micropaleontology*, **47**: 1-4.

Langer, M.R. 1992. Biosynthesis of glycosaminoglycans in foraminifera: A review. *Marine Micropaleontology*, **19**(3): 245-255.

Langer, M.R. 1993. Epiphytic foraminifera. *Marine Micropaleontology*, **20**(3-4): 235-265.

Leutenegger, S. and Hansen, H.J. 1979. Ultrastructural and radiotracer studies of pore function in foraminifera. *Marine Biology*, **54**: 11-16.

Mazumder, A., Nigam, R. and Henriques, P.J. 2012. Deterioration of Early Holocene coral reef due to sea level rise along west coast of India: benthic foraminiferal testimony. *Geoscience Frontires*, **3**(5): 697-705.

Mohan, M. 1965. Variation in *Nummulites fichteli* Michelotti. *Bulletin of the Geological Society of India*, **2**(4): 93-96.

Mukhopadhyay, S. 2003. Plastogamy and its early morphological indication in *Nummulites boninensis* Hanzawa from the Middle Eocene of Cambay basin, India. *Revue de Paléobiologie*, **22**(1): 231-242.

Mukhopadhyay, S. 2007. Conjoined tests of *Nummulites* from the Paleogene of the Cambay basin, India and their possible origin. *Journal of Foraminiferal Research*, **37**(1): 41-45.

Nigam, R., Henriques, P.J. and Wagh, A.B. 1993. Barnacle fouling on relict foraminiferal specimens from the western continental margin of India: an indicator of paleosea level. *Continental Shelf Research*, **13**(2-3): 279-286.

Nuttall, W.L.F. 1925. Indian reticulate *Nummulites*. *Annals and Magazine of Natural History*, **15**(9): 661-669.

Roveda, V. 1970. Revision of the *Nummulites* (Foraminiferida) of the *N. fabianii-fichteli* Group. *Rivista Italiana di Paleontologia e Stratigrafia*, **76**(2): 235-324.

Sarangi, S., Sarkar, A., Sarin, M.M., Bhattacharya, S.K. Ebihara, M. and Ray, A.K. 2001. Growth rate and life span of Eocene/Oligocene *Nummulites* tests: inferences from Sr/Ca ratio. *Terra Nova*, **13**(4): 264-269.

Sengupta, S. 1999. Acrothoracican cirripeds (:Crustacea) from Lower Oligocene, southwestern Kutch, Gujarat, India. *Indian Journal of Earth Science*, **26**(1-7): 70-72.

Sengupta, S. 2000. Problems of classifying early Oligocene reticulate *Nummulites* (Foraminiferida) from southwestern Kutch, Gujarat. *Journal of the Geological Society of India*, **56**(6): 673–677.

Sengupta, S. 2002. A note on test shape of *Nummulites* cf. *fichteli* Michelloti Form A (:Foraminiferida) from the Early Oligocene deposit of southwestern Kutch, India. *Journal of the Geological Society of India*, **60**(2): 223-224.

Sengupta, S. 2009. Striate *Nummulites* (:Foraminiferida) from the Early Oligocene rocks of southwestern Kutch. *Journal of the Geological Society of India*, **74**(5): 597-600.

Sengupta, S. and Nielsen, J.K. 2009. Bioerosion in Middle Eocene larger foraminifera *Nummulites obtusus* (Sowerby) from Lakhpat, northwest Kutch, Gujarat, India. *Indian Journal of Geosciences*, **63**(1): 81-86.

Sengupta, S., Sarkar, S. and Mukhopadhyay, S. 2011a. Saddle-shaped reticulate *Nummulites* from Early Oligocene rocks of Khari area, SW Kutch, India. *Journal of Earth System Science*, **120**(2): 263-268.

Sengupta, S., Syed, R., Sarkar, S. and Halder, K. 2011b. *Nummulites* Lamarck (foraminifera) as substrate for other benthonic taxa: A case study from the Middle Eocene of western Kutch, Gujarat. *Indian Journal of Geosciences*, **65**(4): 265-274.

Sengupta, S., Sarkar, S. and Syed, R. 2014. New morphotype of reticulate *Nummulites* (Foraminiferida) from the Lower Oligocene of southwestern Kutch, India. *Journal of the Palaeontological Society of India*, **59**(2): 193-198.

Shukla, S. 2008. Atlas of taxonomic and bio-chronostratigraphic studies on Paleogene larger benthic foraminifera from Indian sedimentary basins. *Paleontographica Indica*, no. **9**: 1-183.

Skinner, L.F. 2014. Foraminifera as predators on encrusting bryozoans. *Journal of Foraminiferal Research*, **44**(1): 58-61.

Smout, A.H. 1954. Lower Tertiary foraminifera of the Qatar Peninsula. *Bulletin of the British Museum (Natural History)*, p. 1-80.

Syed, R., Sarkar, S. and Sengupta, S. 2014. Predatory drilling in Tertiary larger foraminifera from India. *Current Science*, **106**(8): 1130-1133.

Syed, R., Sarkar, S. and Sengupta, S. 2015. New evidences of shell-gravel taxa from Harudi Formation (Middle Eocene), western Kutch. India; *Journal of the Geological Society of India*, **85**(5): 586-590.

Tapanila, L. and Ekdale, A.A. 2007. Early History of Symbiosis in Living Substrates: Trace-Fossil Evidence from the Marine Record, p. 345-355. In*: Trace fossils concepts, problems, prospects* (Ed. W. Miller), Elsevier, Amsterdam.

Travis, J.L., Bowser, S.S., Calvin, J.G. and Lee, J.J. 1988. Pseudopodial tension in *Amphisorous hemprichii*, a giant Red Sea foraminifer. *Protoplasma* [Suppl. 1]: 64-71.

Walker, S.E., Parsons-Hubbard, K., Richardson-White, S., Brett, C. and Powell, E. 2011. Alpha and beta diversity of encrusting foraminifera that recruit to long term experiments along a carbonate platform-to-slope gradient: paleoceological and palaeoenvironmental implications. *Palaeogeography, Palaeoclimatology, Palaeoecology,* **312**(3-4): 325-349.

Manuscript Accepted July 2015