JOURNAL GEOLOGICAL SOCIETY OF INDIA
Vol. 44, Oct., 1994, pp. 451-455

RESEARCH NOTE

A NOTE ON THE MICROSTRUCTURES OF THREE GENERA OF LATE OLIGOCENE NUMMULITIDAE FROM KUTCH

Abstract: Electron microscopic studies are carried out to examine wall structure, stolon and canal system of *Heterostegina*, *Operculina* and *Spiroclypeus* from the Late Oligocene section of Kutch. Walls are made of preferentially oriented prismatic crystals of calcium carbonate while septa contain randomly oriented polygonal crystals. *Heterostegina* and *Spiroclypeus* are characterised by Y-shaped radial stolons in the median plane. Canal system, comprising of marginal, septal and secondary septal canals are described and illustrated.

Keywords: Nummulitidae, Oligocene, Kutch, Gujarat

The foraminifera belonging to the family Nummulitidae constitute an important faunal element in the fossiliferous, shallow marine sequences of the Palaeocene and younger age. Its modern representatives, *Heterostegina* and *Operculina*, are found along the marine shelf of many tropical regions. They are characterised by involute or evolute planispiral tests with numerous median chambers which are simple or subdivided into chamberlets and may be with or without lateral chambers (Loeblich and Tappan, 1988).

The microstructures of living nummulitid species, *Heterostegina apogama*, *Heterostegina depressa* and *Operculina ammonodies*, are described by Hansen and Reiss (1971), Spindler (1978), Hottinger (1978), Reiss and Hottinger (1984) and Rottger (1987). The description of wall structures and canal system of an Early Eocene species *Nummulites planulatus* by Bignot *et al* (1972) is one of the very few such observations on fossil Nummulitidae. The wall microstructures, stolons and canal system of three genera, *Heterostegina*, *Operculina* and *Spiroclypeus*, of Late Oligocene age are described and illustrated in this study.

Samples are from the Waior Stage of Bermoti Series in its type locality near village Waior (Fig.1). Half-cut sections of a large number of individuals of each type are prepared. The cleaned sections are mounted on stubs and coated with gold film of 200 Å thickness for electron microscopic observation.

Nummulitidae are known to have radial microstructure in which the calcareous perforate wall have crystals of calcium carbonate oriented with their c-aixs perpendicular to the surface. The lateral wall and the protoconchal wall are found to be perforate while the septa are imperforate. The surface pores are about one micron in size in most of the examined forms and no difference is found in the pore size of different genera. The perforation is primarily due to preferred orientation of crystals. In the protoconchal and the lateral walls the prismatic crystals are oriented normal to the wall but in septa the polygonal crystal are randomly arranged (Pl.1, Figs.1-3). The crystals along the keel in all the genera are larger, equant and with no preferred orientation (Pl.1, Fig.4).

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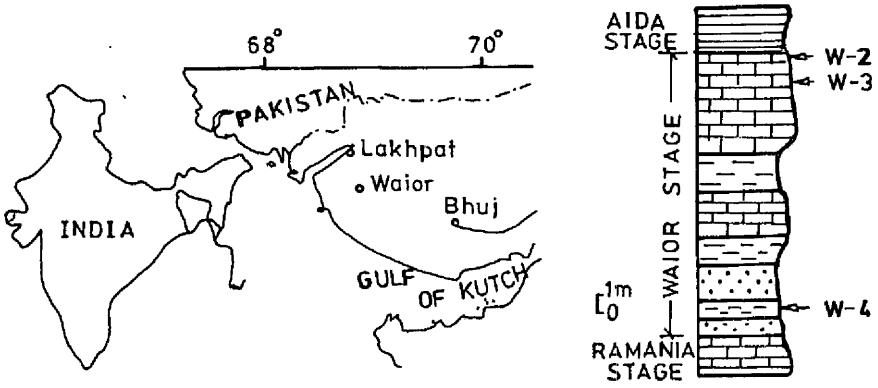

Fig.1. Location map and sample positions.

The continuity of the protoplasmic mass in the chamber lumen of living foraminifera is maintained through apertures and stolon systems (Hottinger, 1978). Aperture in *Operculina* is either a large and triangular opening or two arched openings at the base of the apertural face (Pl.1, Fig.5). Row of multiple apertures in interio - marginal position as observed in living *Operculina* (Hansen and Reiss, 1971) are not seen in any of the Late Oligocene operculines from Kutch. Besides aperture, *Operculina* may also have one or more stolons on the apertural face (Pl.1, Fig.5) which are small tubular passages between successive chambers of chamberlets.

Both, the tangential and radial stolons are found in *Heterostegina* and *Spiroclypeus*. The tangential stolons connect the two chamberlets of a chamber and the radial stolons connect two chambers of the adjacent chambers (Pl.1, Figs.6-8). In both the genera, two chamberlets of an older chamber are seen to be connected with one chamberlet of the younger chamber (Pl.1, Figs.7,8) forming Y-shaped stolons (Hottinger, 1978). It is also observed that in *Spiroclypeus* the protoconch not only communicates with the first chamber but it may simultaneously maintain contact with the other equatorial chambers (Pl.2, Fig.1). It is, however, not a consistent feature and in general no difference is observed in the stolon system of *Heterostegina* and *Spiroclypeus*.

Canals are the subdivided parts of the inter-locular space and are situated within keel, septa and secondary septa. A multilayered and reticular system of marginal canal lying within the keel is characteristic of the family Nummulitidae. The marginal cord and marginal canals in the examined genera are distinctly seen in the peripheral part and median section respectively. (Pl.2, Figs.2,3). The marginal canal is joined by septal canal, which lies within septa. Each septum may have one or two canals (Pl.2, Figs.4-6). *Heterostegina* and *Spiroclypeus*, both having chamberlets, also contain secondary septal canals (Pl.2, Figs.4,5). The marginal canals communicate with the exterior by trabeculae whose openings can be seen on the periphery (Pl.2, Fig.7). Similar openings for septal canals seen along the sutures of *Operculina* are distinguishable from the wall perforation by its larger pore size (Pl.2, Fig.8).

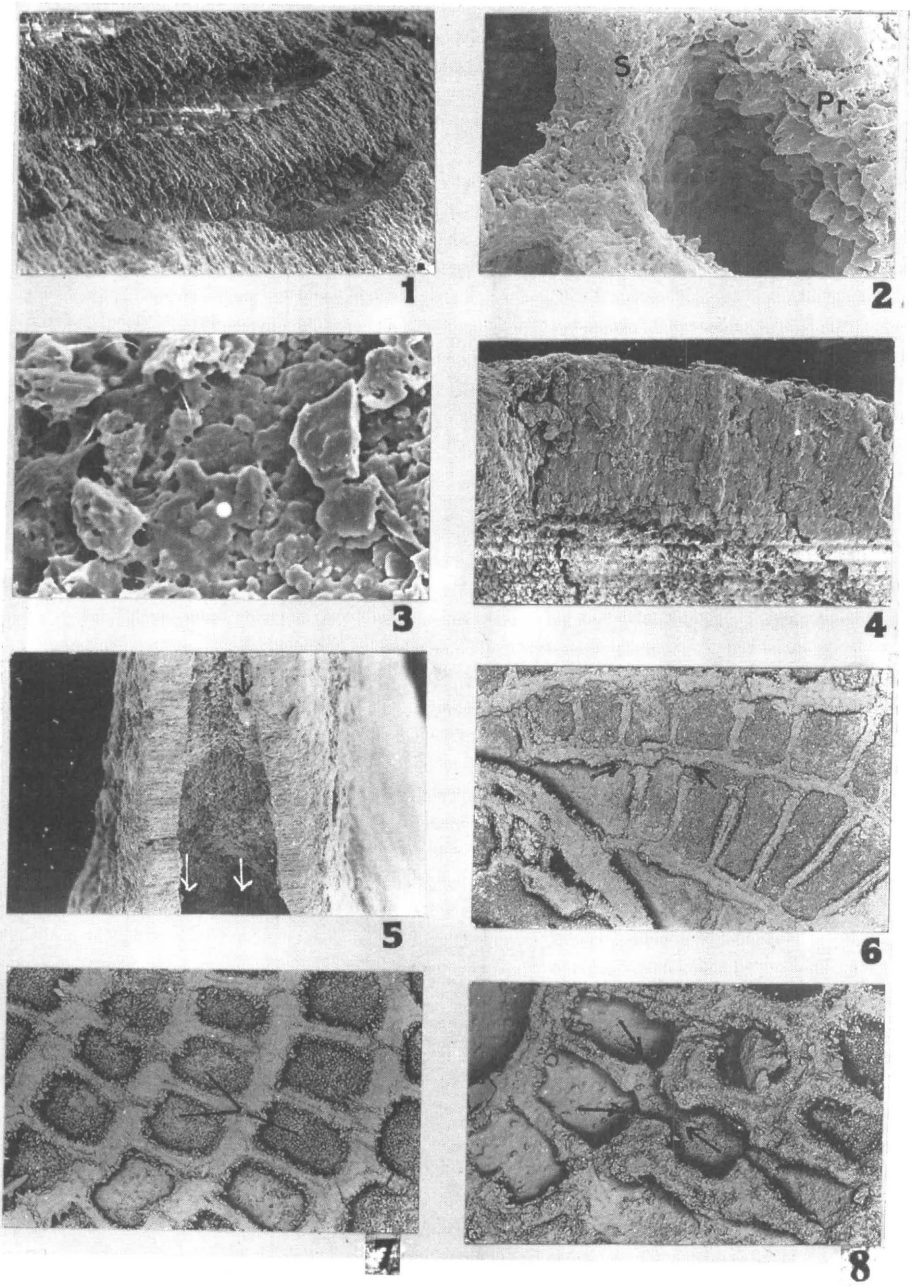

Plate.1. 1. Wall microstructure of *spiroclypeus* showing stacking of prismatic crystals normal to the test. (X 800). 2. An equatorial section of *Spiroclypeus* showing preferential orientation of crystals in septa (S). (X 1400). 3. An enlarged view of septal wall (of fig.2) showing equant and randomly oriented crystals. (X 8500). 4. Keel (K) in *Operculina* made up of large crystals, arranged without any preferred orientation. (X 650). 5. Aperture in *Operculina*, having two arched opening at the base of apertural face (apertural part darkened in picture). (X 220) 6. Tangential stolons in *Spiroclypeus*. (X 190). 7. Y-shaped radial stolons in *Heterostegina*. (X 170). 8. Y-shaped radial stolons in Spiroclypeus (X 350)

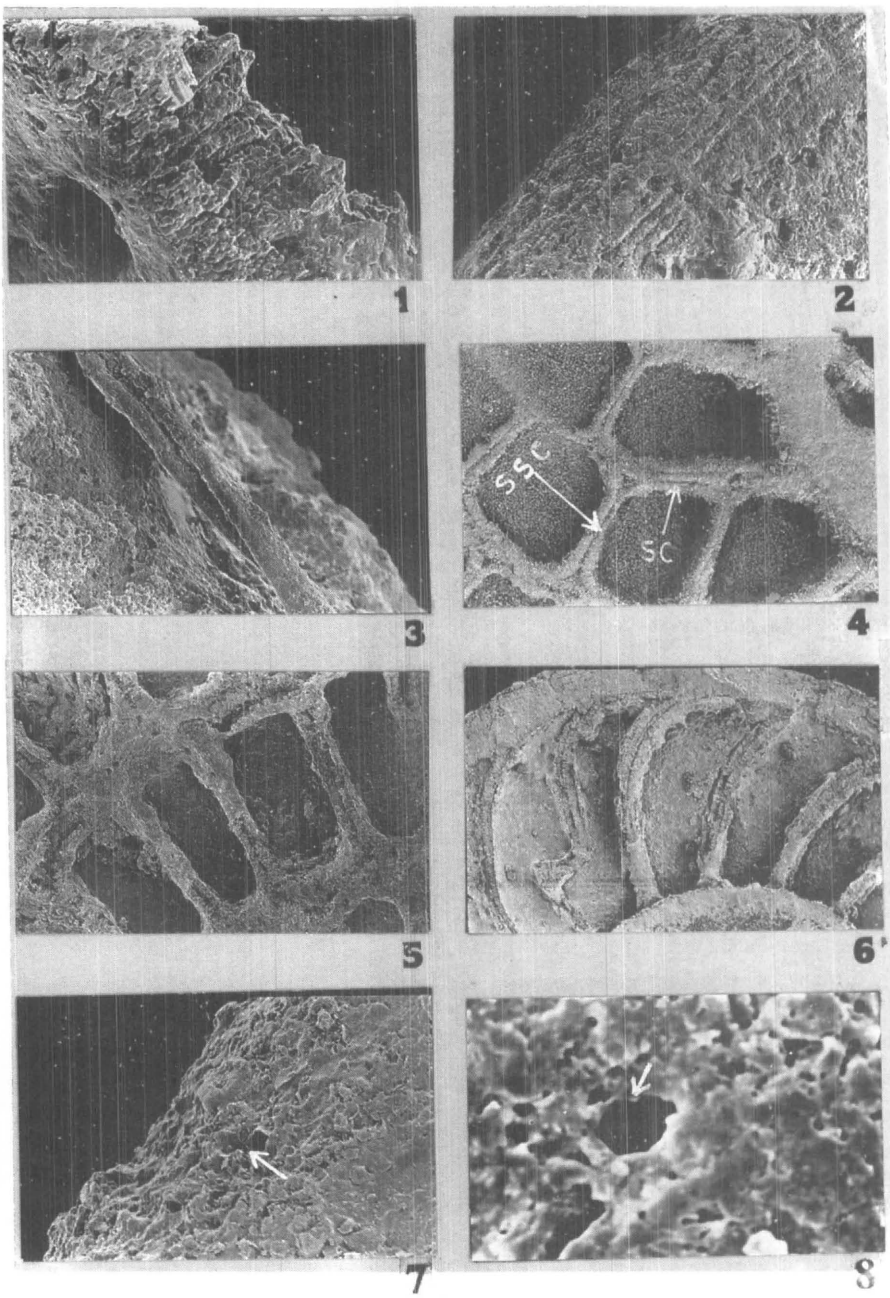

Plate.2.1. Stolons in the protoconchal wall of *Spiroclypeus*, connected with an equatorial chamber. (X 1900). 2. Marginal cord in *Operculina*. (X 400). 3. Marginal canal in *Spiroclypeus*. (X 1200). 4. Secondary Septal Canal (SSC) joining Septal Canal (SC) in *Heterostegina*. Two canals in each septum are observed. (X 300). 5. Septal canals and secondary septal canals in *Spiroclypeus*. (X 370). 6. Two to three canals in each septum of *Operculina* (X 140). 7. Opening on peripheral part of *Heterostegina* marking the communication of marginal canal with exterior. (X 1500). 8. Sutural opening in *Operculina*, marking the communication of septal canal with the exterior. (X 10,000)

In brief, *Heterostegina*, *Operculina* and *Spiroclypeus* have preferentially oriented prismatic crystals in the wall and randomly oriented polygonal crystals in the septa. Both, *Heterostegina* and *Spiroclypeus*, have Y-shaped radial stolons. *Operculina* has marginal and septal canal while Heterostegina and *Spiroclypeus* have, in addition, secondary septal canals.

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(Received : 23 September, 1993: Revised form accepted : 28 April, 1994)