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NUMMULITES BROACHENSIS CARTER, 1857 (FORAMINIFERIDA). NEW ILLUSTRATIONS AND INFORMATION ON A LITTLE KNOWN NUMMULITE

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ABSTRACT

Nummulites broadchensis Carter, 1857 is redescribed from material collected at Wasna in the Rajpipla Hills, Western India and presented by H.J. Carter himself in 1889 to the British Museum (Natural History). It is shown to be a valid species, and a Lectotype is designated. Its statigraphic position within the Middle Eocene (Upper Khirthar) of the region is discussed.

INTRODUCTION

In July 1889, H.J. Carter presented 12 slides and two pieces of rock to the British Museum (Natural History) containing specimens of larger foraminifera from the Rajpipila Hills, Western India (Fig. 1). Amongst these were 6 specimens labelled.... "*Nummulites broachensis* /Crtr/" ...(Pl. 1 — 8) register number P22266, which are from the type locality of this species (Carter 1857), mounted together with *Operculina* in Canada Balsam on a single slide. These specimens are illustrated here (Pl. 1 — 1-6, 8 and Fig. 2a, b. Fig. 3a) to supplement the series of rudimentary drawings (Pl. 1 — 7) which, in the absence of an original illustration, Carter made in 1861. These drawings are barely reconisable as nummulites and appear to have been subsequently overlooked,particularly as they are not reproduced in the Ellis and Messina Catalogue of Foraminifera (1941 *et seq*), to accompany the original description. Since it is unlikely that any further material was gathered for and examined by Carter (Blandford 1869, p. 199 (361)) from the type locality, this material, it is argued, is almost certainly syntypic and a Lectotype is designated herein (Pl. 1 — 5).

ORIGINAL INFORMATION (1857)

Carter (1857, p. 697) described the new species, *N. broachensis* as follows:- "Discoidal, thick, with margin acute. Surface smooth, presenting punctae arranged spirally without striae. Spire regular consisting of at least six whorls. Chambers longer than broad. Septa reflected, curved. Diameter 5/48th inch, thickness 2/48th inch." The age was cited as Eocene, from the Rajpipla (argillaceous) limestone. The type locality was given as Wasna in the Rajpipla Hills, near Broach, about 50 miles up the Nerbudda, India.

CARTER'S OWN ORIGINAL INFORMATION (1861)

Carter, in 1861, possibly realising that his original description and lack of illustration left something to be desired, redescribed the species and clarified cetain points (*op cit* ; p. 373), thus... "Chambers increase in diameter in the direction of the spire more than in the transverse direction towards the circumference [Pl 1 — 7e]. The number of turns of the spire,

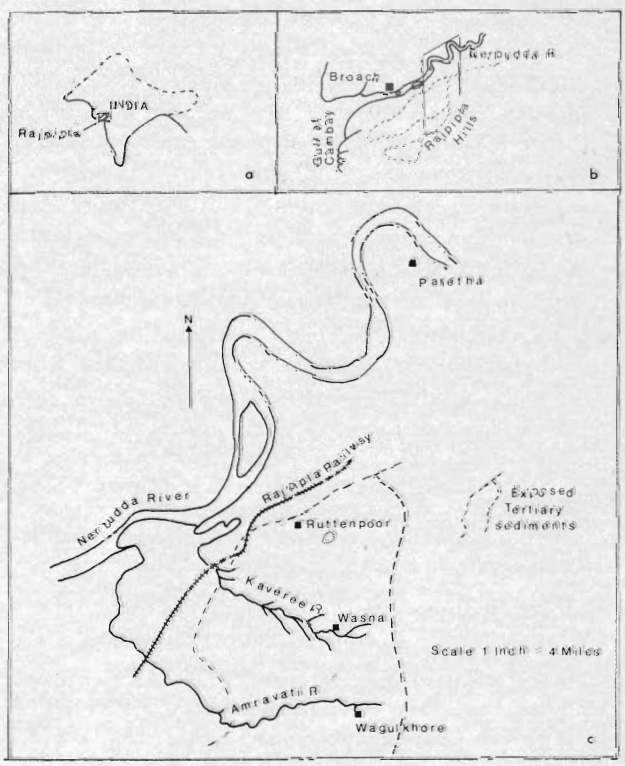

Fig 1. Sketch maps to show the Type locality of *Nummulites broachensis*
b. Modified from Blandford, 1869
c. Modified from Bose, 1908

altogether 6 (six)... There is a slight appearance of septal lines"... He illustrated it on Plate 15, figures 3a, b, d, e (not c). They are reproduced here as Pl. 1 —7a, b, d, e.

NEW INFORMATION & LECTOTYPE CHOSEN

Following the discovery of these six specimens in the Micropalaeontology and Palynology Section, Department of Palaeontology, British Museum (Natural History), a Lectotype is designated (Pl. 1 — 5, Fig. 2a, b, f). The Lectotype (B.M.(N.H.) numberr P52280 ex slide P22266), best shows the features mentioned by Carter (1857 & 1861) and illustrated by him in 1861 (reproduced here Pl. 1 — 7). The final few chambers prominently retain clear alar prolongations. The polar pustule is prominent. Trabeculae are present. Diameter 2.45mm, thickness 1.15mm.

External appearance of the Species

The type specimens are bown. The ornament, in larger specimens, is colourless, and stands out against the brown backgroud (Pl. 1 — 5). A central, more or less well developed pustule is present on both poles (Pl. 1 — 4b, 5). The underlying position of the marginal cord (marginal cord trace, see Adams 1988) is prominently marked by interrupted, slightly raised calcite bars and discrete knobs. The thickened radial indications of the underlying septae (septal traces, see Adams 1988) are normally a weak and irregular feature. In the smallest specimen considered to be conspecific (Pl. 1 — 3), where the marginal cord trace is not prominent and septal traces easily seen, the specimen appears radiate. Other specimens show prominent alar prolongations towards the poles only in the final part of the last developed whorl. Traversing the laminae of the last formed whorl are vertical thickenings (trabeculae; derived from the Latin Trabecula, a little joist) arranged not onlly at right angles to the suture but randomly over the chamber (Fig. 2f).

Dimensions

Diameter ranges between 1.85 and 2.55 mm. Thickness 0.66 mm and 1.25 mm.

Number of chambers

One specimen in the collection has at some time been rubbed down to an off-centre median section with the megalospheric proloculus not fully opened (Pl 1 — 6a), this, converted to a median section provided some information (Pl. 1 — 6b), as follows:

Number of Chambers per whorl

1st	2nd	3rd
5	9	10

The number of chambers in the last whorl of the smallest specimen is 22 but the number of whorls is not known. In the largest specimen, the number of chambers and the number of whorls are not determinable.

Internal appearance of the megalospheric form

Chamber dimensions at-

end of first whorl	end of fifth whorl	
0.08 mm	0.25 mm	radial
0.17 mm	0.44 mm	height

Marginal cord thickness at-

end of first whorl	end of fifth whorl
0.05 mm	0.08 mm

The spire is close coiled (Pl. 1 — 6a, b), The test wall very finely perforate. The thickenings representing the trabeculae are prominent and almost uniform in thickness throughout the wall. Marginal cord contains branching canals. The pustules forming the marginal cord trace often contain a canal arising from the marginal cord. A small specimen (Pl. 1 — 4), sectioned transversely clearly shows the polar pustules and the canal system (Pl. 1 — 4a). Two megalospheric proloculi measured internally, have dimensions 0.07 x 0.06 mm and 0.1 x 0.08 mm. The microspheric form of this species has not yet been recognised.

THE TYPE LOCALITY

Carter (1861, p. 373) clarified his original information (1857) on the type locality by writing "These are the specimens...so richly infiltrated with red or yellow oxide of iron"...that came from...."Wasna, a little village in Rajpipla, about 15 miles E.S.E. of Broach and about five miles south of Ruttenpoor"...His original statement (1857) that this locality was "fifty miles up the Nurbudda on the north side"...was a mistake on his part. The material was given to him by Major Fulljames who (see references in Rao 1941) spent some time in this area. Blandford (1869, p. 119 (361)) was unable to locate the limestone, said to be a thin band, in this area and suggests that the material could have come come from "Wagulkhore or in its neighbourhood". The spelling of place names is also a problem. In Fig. 1, I have used the place names as

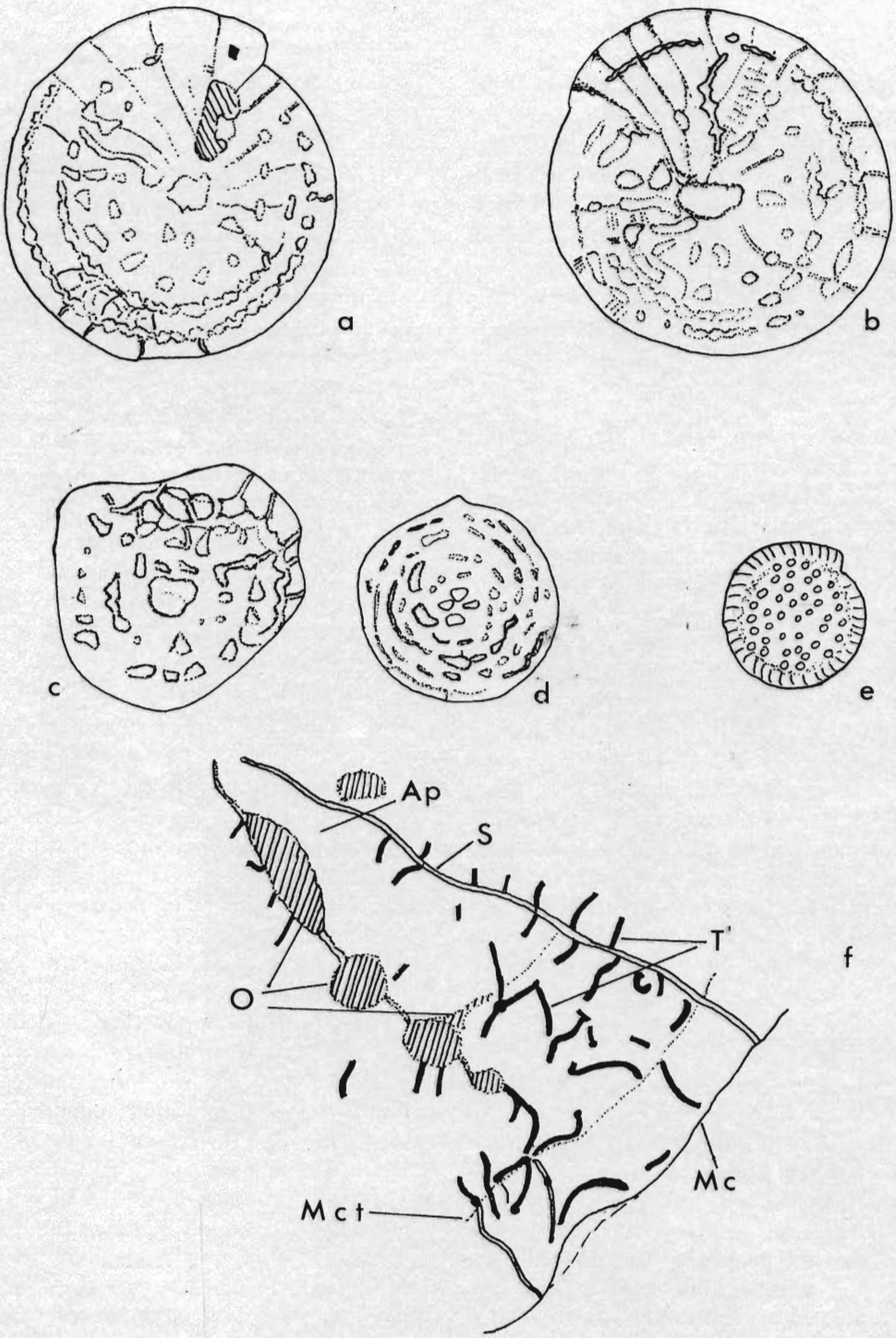

Fig. 2. External views:-

Figs. a,b. *Nummulites broachensis* Carter Lectotype x 20

a. view of specimen mounted in Canada balsam.

b. reverse side, view in air.

c. *Nummulites ptuchiani* Kacharava. Based on Kracheninnikov and Ptuchian's pl. 7, fig. 4 x 10 From Armenia.

d. *Nummulites fabianii* (Prever). Megalospheric form from Grancona, Italy. Based on Roveda, figure 78. x 1.

e. *Nummulits vredenburgi* Prever 9 in Vredenburg, 1908). Based on pl.8, fig. 9a (*Nummulites douvillei* Vredenburg, 1906). x 5 Western India (Kachchh).

f. *Nummulites broachensis* Carter. Based on the Lectotype. Detail of a small portion in the last whorl of the test, showing:-

Ap. alar prolongation of a chamber, Mc. marginal cord, Mct. marginal cord trace, O. granules marking the septal and marginal cord traces, T. trabeculae.

spelt by Carter (1857, 1861) and Blandford (1869). The river Oomrwtee (Blandford 1869) is probably the river Amravati (Bose 1908, pl. 5). The village Wagulkhore is probably Vagalkhod (Bose 1908, pl. 5) and Wasna is probably Vásna (Bose 1908, pl. 5) at approximately 22° 19'N 73° 16'E. The mines at Ruttenpoor are apelt Ratanpur by Bose (1908, pl. 5). All these place names appear to correspond to the distances and directions given by Carter 1861 and Blandford 1869.

DISCUSSION

Nummulites broachensis was treated by Carter 1861 as a *punctulatae*, following d'Archiac and Haime (1853, p.73). The characters of this group have been clarified by Morley Davies (1971, p.58) and covers globose species with large and abundant granules. On the surface, the canaliculate granules arising from the marginal cord, marking the spiral ridge are most noticable where they are crossed by the thickened septal traces of the next whorl and, in some specimens, this is visibly suggestive of a "pseudoreticulum" as defined by Roveda (1970, p 238). The species *broachensis* was erected by Carter in 1857 at the end of a period when many Indian species were being described (d' Archiac and Haime 1853). It surely follows that in a region, so fully investigated as Western India that this species must have been collected again and given the name of some well known junior species. Using the Lectotype and paralectotypes, comparison is here made with forms similar in appearance and age.

COMPARISON WITH OTHER SPECIES

Nummulites hormoensis Nuttall and Brighton, 1931

The Lectotype and paralectotypes preserved in the C. Barrington Brown collection in the Sedgwick Museum, Cambridge (Roveda 1970, p.299) have been examined. The species is less globose, the reticulum is better developed and the median section shows the chambers to be more equidimensional and the transverse section, shows pillars which are continually growing. An interpretation of the median section based on their type figure, pl.3, fig.7 is given as Fig.3b for comparison.

Nummulites vredenburgi Prever (in Vredenburg 1908).

Rao (1941, p.6) suggested that *N. broachensis* is its megalospheric form. This seems most unlikely since examination of the *N. vredenburgi* type figures shows considerable differences in the median chamber shape (Fig.3e is based on Vredenburg, 1906, pl.8, fig.12a); it also lacks a "pseudoreticulum" (Fig.2e is based on Vredenburg 1906, pl.8, fig.9a).

Nummulites ptukhiani Kacharava, 1969.

The megalospheric form of this species has been illustrated from Armenia by Kracheninnikov and Ptuchian (1986). (The latter is the author in whose honour the species was named in 1969). All chambers in the median section tend to be equidimensional (Fig.3c is based on an interpretation of their pl.7, fig.2). There is no illustration of a transverse section. The polar pillar is present. (Fig.2c is based on an interpretation of their pl.7, fig.4).

Nummulites fabianii (Prever), 1905.

The megalospheric generation of *N. fabianii* has been neotypified by Roveda and specimens from Grancona have been illustrated (1970, p.286, figs.83-85). Internally the median section is very similar to *broachensis* (Fig.2d is based on his fig.83) but externally it lacks the concentrated polar pillar (Fig,2d is based on his fig.83) and large granules, it may have more of a reticulum than a "pseudoreticulum".

Nummulites broachensis is clearly a distinct species and should be used as an intermediary between forms with equidimensional equatorial chambers (*N. ptukhiani*) and those with equatorial chambers similar to *N. fabianii* but which retain the central polar pustule and "pseudoreticulum".

The discovery of *Nummulites broachensis* in Carter's collection in the British Museum (Natural History) is of twofold importance. Firstly, it relates the species name to extant specimens whose presence was known in Western India but not confirmed by Nuttall (1926, p.926). Subsequently it was recorded as a name by Puri 1954 in his list of larger Tertiary Indian Foraminifera, and of, necessity, ignored by Roveda in his major revision of the reticulate nummulites (1970). Secondly, it shows that it belongs to the "Phylum de *Nummulites fabianii*" (Schaub 1981 : 124) but its relationship to other members of this group needs further clarification, beyond the scope of this paper.

STRATIGRAPHIC AGE OF *N. BROACHENSIS*

Carter recorded additional genera and species accompanying this new species, namely *Nummulites ramondi* Defrance, *Orbitoides dispansa* Sowerby and *Operculina*, which are deposited in this Museum (Register numbers P22253-22265). The *Orbitoides* is

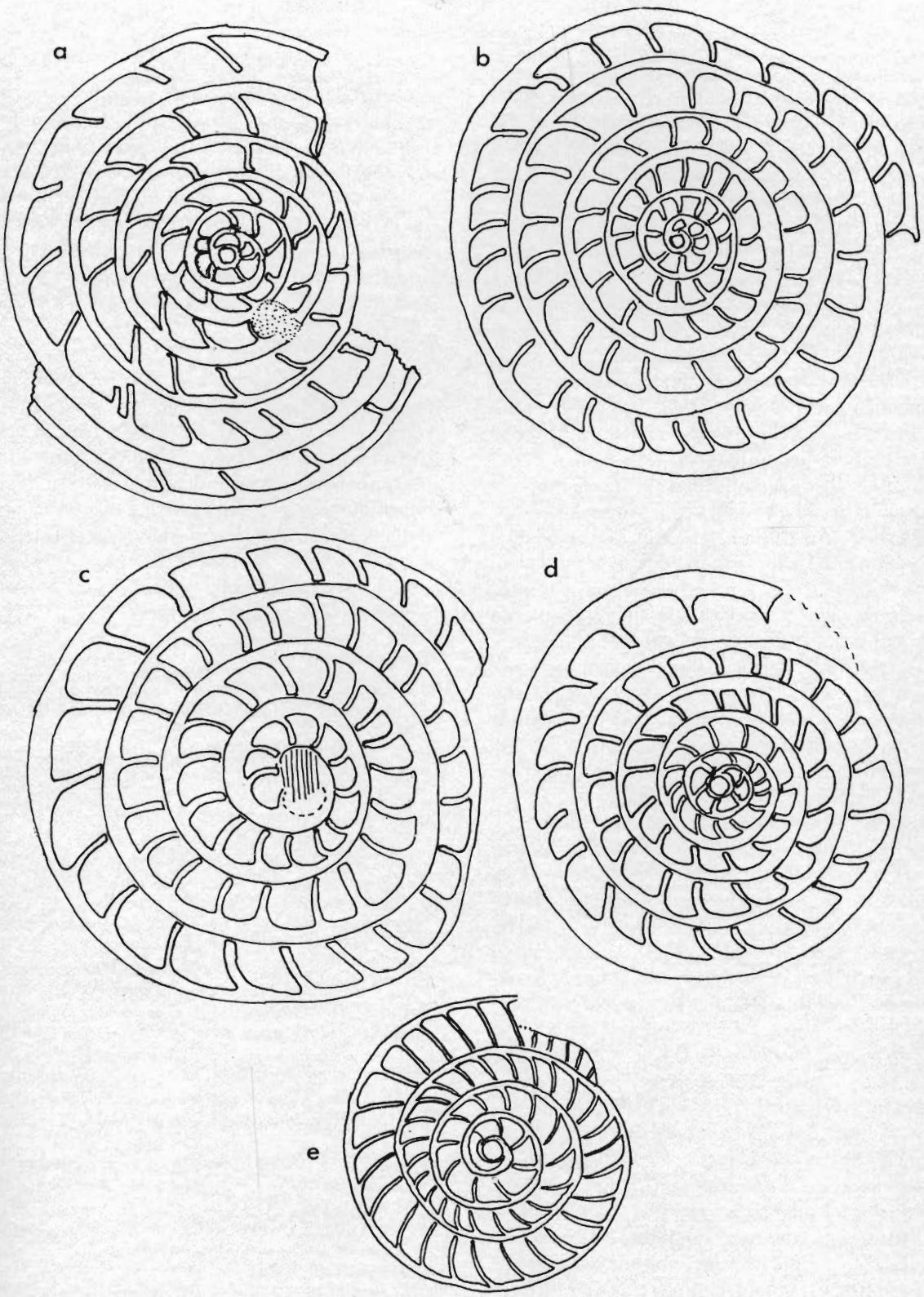

Fig. 3. Sketches of median sections drawn to show the median chamber shapes of:

Figures a. *Nummulites broachensis* Carter. Based on thin section Pl. 1-6b approximately x 30

b. *Nummulites hormoensis* Nuttall and Brighton. Based on their type figure pl.3, fig. 7. approximately x 25 From somaliland.

c. *Nummulites ptukhiani* Kacharava. Based on Kracheninnikov and Ptuchian pl.7, fig. 2. approximately x 22 From Armenia.

d. *Nummulites fabianii* (Prever). Based on Roveda figure 83. x 2 From Grancona, Italy.

e. *Nummulites vredenburgi* (Prever) (in Vredenburg, 1908). Based on pl.8, fig.12a (*Nummulites douvillei* Vredenburg, 1906). x 2 Western India (Kachchh).

clearly a discocyclinid and some of the operculines are trabeculate. Rao, 1941 gives a summary of the geological and palaeontological investigations carried out in the Broach area, but re-examination of Carter's material in this Museum has failed to find any *Pellatispira*. The fact that Rao, 1941 does not find *N. broachensis* associated with *Discocyclina* but finds *Discocyclina* and *Pellatispira* together remains a problem so far unsolved. It seems possible that the genera said to occur together by Carter could, in fact, be from more than one horizon at the same locality, and since Major Fulljames was himself given the material which he passed on to Carter (1861 p.373), this is a plausible explanation. The absence of *Pellatispira* could place the occurrence of *N. broachensis within the "Nummulites/Discocyclina* subfacies of Raju *et al.* 1970, suggesting Zone P 14 (*Truncorotaloides rohri*) or the very top of the Middle Eocene, within Ta3 age. Properly documented palaenotological evidence in support of a precise age for this horizon in Western India is still lacking (Samanta pers. comm.), but it is likely that the age of the sediments in this area, especially the "Rajpipla argillaceous limestone" which was found not only at Wasna but also at Tarkeshwar by Rogers (see Rao, 1941), is Upper Khirthar (Middle Eocene, P 12-14) and being older than the late Eocene (Tb) *Pellatispira* bed may indicate a *Truncorotaloides rohri* age of P 14 (very top of the Middle Eocene within Ta3).

The phylogenesis and biostratigraphic significance of the whole group of species closely related to *Nummulites broachensis* in the Surat-Broach area, has been studied by Guha and Pandey (1972) and by Pandey and Dwarikanath (1976). They have noted that *N. broachensis* is so closely related to *N. ptukhiani* (sensu Schaub 1981) that they could be considered as synonymous; if this taxonomy were to be used, then the senior name for the species would be *N. broachensis* Carter,1857, with its junior synonym *N. ptukhiani* Kacharava, 1969, but, as noted above, the morphology of the latter needs to be re-studied even though that of the former is now established.

Pandey and his collaborators (opera cit.) have regarded the stratigraphic range of *Nummulites broachensis* (of its supposed synonym, *N. ptukhiani*) to be from Late Middle Eocene to basal Late Eocene; in the Tapti River part and Cambay Basin, they have found it associated with *Pellatispira* in the *N. fabianii* Zone (both *Pellatispira* and *N. fabianii* (Prever) are confined to the Late Eocene, "Tb" of the Indo-Pacific Area according to Adams, 1970, fig.2). This gives the same stratigraphic range for *N. broachensis* as that noted above. The prominent pustulation and "pseudoreticulum" (sensu Schaub) of the ancestral forms has developed into a true reticulum of the Late Eocene species (which later evolves into the more complex reticulum of the Oligocene *N. fichteli*). The ancestral *N. broachensis*- form appears to survive, for a short interval, with the descendant *N. fabianii*-form, in the earliest Late Eocene.

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EXPLANATION OF PLATE

PLATE I

Nummulites broachensis Carter

1,2 & 5. Specimens showing the prominent polar pustule and thickening over the external trace of the marginal cord (spiral ridge). The radial thickenings over the septae become clearer in larger specimens (see Fig. 5). All X 20 Fig. 5 is the Lectotype. P52280.

3. Smallest specimen. This shows the radial septal traces.

4. Specimen with abraded radial septae overlying the previous spiral sheet of the earlier whorl where the spiral and radial thickenings are showing.

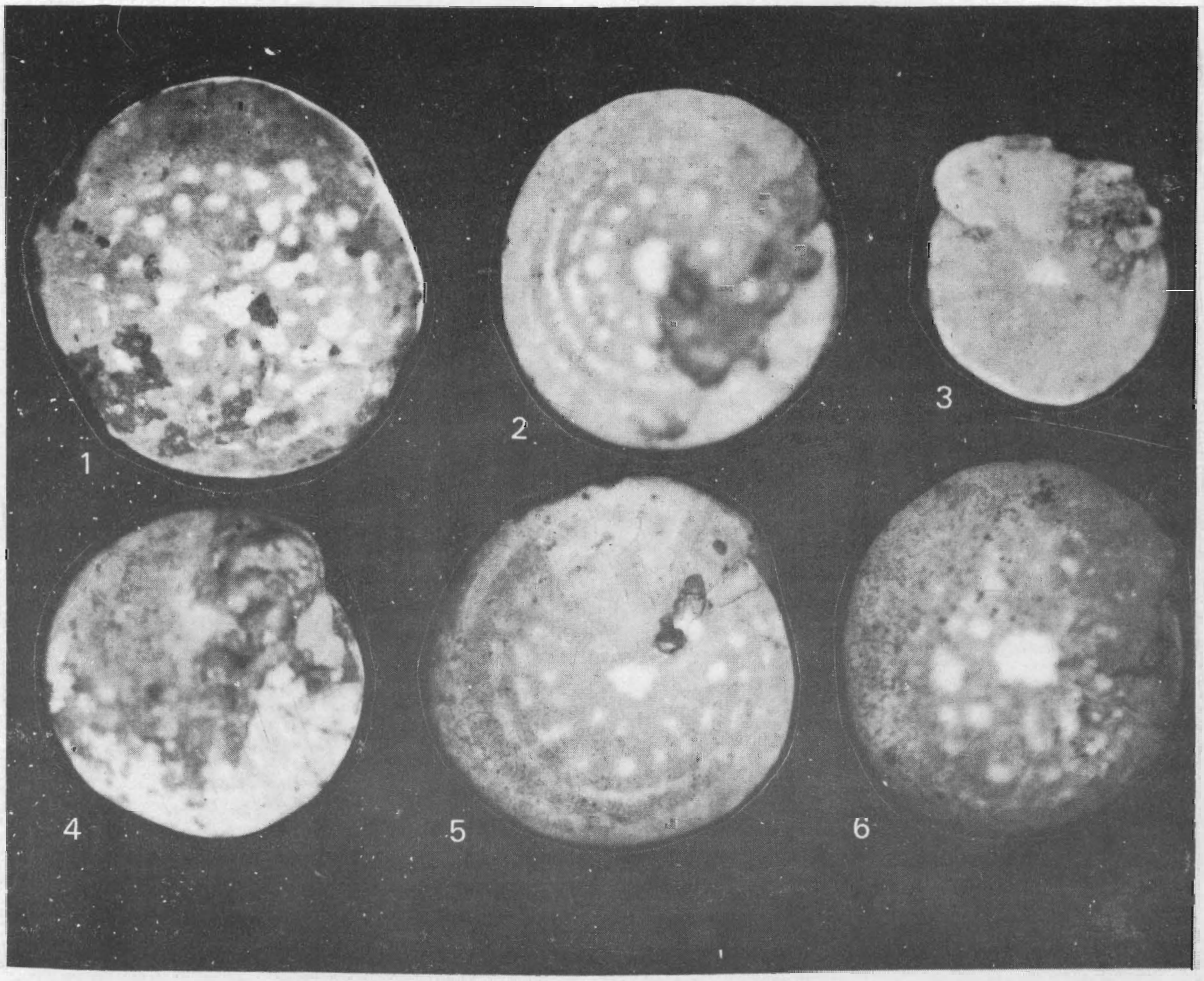
6. Reverse side of Fig. 6a.

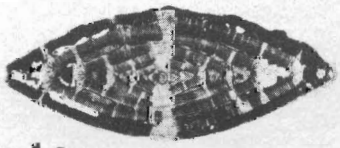
6a. Off centre, half median section showing the gradual increase in chamber height.

6b. Completed median thin section. All x 20.

7. *Nummulites broachensis* Carter. A reproduction of figure 3, plate 15 of Carter 1861. The figure explanations are Carter's own taken from his p.465.
   a. Marginal view. Natural size.
   b. Spire and chambers. Magnified.
   d. Flat surface. Magnified.
   e. Specimen of the largest chambers. Magnified.

8. Carter's original slide before the removal of the specimens for examination. The slide bears the British Museum (Natural History) register number P 22266. Natural size.





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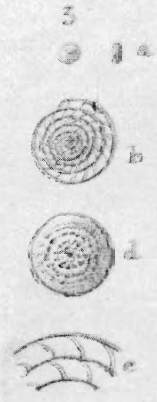
6 b



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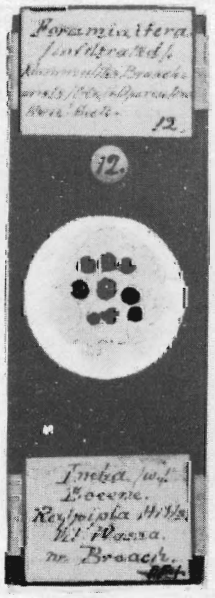

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6 a