CRETACEOUS FORAMINIFERA OF UM SOHRYNGKEW RIVER SECTION, MEGHALAYA

JAGADISH PANDEY

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ABSTRACT

Twelve species of bentonic and thirty six species of planktonic foraminifera, restricted to the Cretaceous section of Mahadeo Formation, are described and figured from the Um Sohryngkew River section near village Therria (25° 11′ N : 91° 45′ E). The recorded assemblage is divisible into two distinct biozones which, together, are correlated with the Maastrichtian of Europe.

The rich planktonic assemblage includes several cosmopolitan species, but some local characteristics are also observed. These include absence of dicarinata Globotruncana, a second record of genus Guembelitriella after Santonian, a very rare occurrence of Planammina ex gr. buxtorfi which is believed to be extinct much before Maastrichtian and a rare record of Campanian form Globotruncana coarctata.

INTRODUCTION

In the southern part of Meghalaya, comprising of southerly areas of Shillong Plateau and its rapidly descending slopes near Bangladesh border, Cretaceous and Tertiary strata occur overlying a Pre-Cambrian granitic basement or, occasionally, the Sylhet Basalts (‘trap’) of presumably Jurassic age. One of the earliest explored segments of these strata occurs around Cherrapunji (25° 16′N : 91° 45′ E; Figure-1, insets 1, 3,)

Although the first account of the Cheera sedimentary succession was presented by Oldham (1858); it was Medlicott (1869) who introduced a formal classification for the sediments underlying the famous Sylhet Limestone of Tertiary age. He grouped the infra-Sylhet strata around Cherrapunji into the Mahadeo, Langpar and Cherra ‘bands’; and, on the megafaunal evidence compared the Mahadeo ‘band’ with the Cretaceous ‘Ariyalooor’ beds of Trichinopoly.

An account of Cretaceous foraminifer occurrence from the Mahadeo ‘band’ of Medlicott was given, for the first time, by Nagappa (1959; Mahadeo and Mahadek lithotopes are synonymous; Mahadeo, the current and Medlicott’s spelling of the locality, is adopted here). This was followed by enumeration of several planktonic foraminifera of Cretaceous age by this author (1974) from the Um Sohryngkew River section near village Therria (25° 11′N : 91° 45′E), about twelve kilometres south of Cherrapunji. It was also brought out in this report, that the Cretaceous/Tertiary boundary falls in the continuously marine section of the Mahadeo Formation—the terminal and initial events of the Cretaceous and Paleocene respectively, being the disappearance of Globotruncana-Heterohelix suite, and appearance of Turborotalia sabina assemblage.

The present paper figures and describes such species of foraminifera that are essentially restricted to the Creta-
Fig. 1. Cretaceous Foraminiferal ranges in the Um Sohryngkew River section.
The overlying Langpar Formation represents a second transgression and its boundary with the overlying Therria Formation of the Sylhet Group was placed at the appearance of first arkosic, whitish sandstones (with plant leaves). In the Therria area, Therria Formation is the obvious facies of Cherra Sandstone of Cherrapunjii and mapped as Cherra lithotope earlier by Ghosh (1940).

The Mahadeo Formation, wherein the Cretaceous/Tertiary boundary has been placed about ten metres below the Mahadeo-Langpar contact in the Therria area (Pandey 1978), exhibits the following succession in Um Sohryngkew River:

**Upper Member 21 m.** Light to dark gray and greenish gray silty shales; greenish gray, fine grained nodular, calcareous and noncalcareous sandstones.

**Lower Member 22 m.** Fine to medium grained, greenish gray graywackes and subgraywackes; brownish and greenish sandy shales. A 15 to 30 centimeter thick bed of ‘shell limestone’ at the base.

The Mahadeo Formation is well exposed between the Um Sohryngkew River and the path between Therria and Mahadeo (25°13’ N: 91° 45’E) villages. The Upper Member is clearly seen on the western bank of the river where it has been continuously sampled (Fig. 1, inset 4). The Lower Member is also exposed almost continuously a little to the west of the river.

**SAMPLING AND PROCESSING**

Sampling, for the purposes of microfaunal studies was carried out on the western bank of Um Sohryngkew River. The Lower Member was sampled about 15 to 30 metres to the west of the main channel and the Upper Member between 3 and 8 metres west of the stream.

The sampled lithology is invariably an argillaceous, medium to fine, greenish sandstone in the Lower Member. Similar, fine greenish sandstones as also greenish or gray shales were collected from the Upper Member for microfaunal investigation vide the traverse details and lithoculum (figure 1).

The collected samples were boiled with washing soda and washed over a 200 mesh sieve. The residue, when sorted under microscope, gave a moderate to rich yield of smaller foraminifera.

**GROSS ASSEMBLAGE AND PALEOECOLOGY**

Both agglutinated and calcareous foraminifers occur in the Mahadeo Formation. The arenaceous or agglutinated ones commence with the base, whereas the calcareous types typically appear at the base of the Upper Member. Thus the boundary between the two principal lithological subdivisions of the Mahadeo Formation is also an approximate boundary between the two ecologically distinct assemblages.

The foraminiferal assemblage occurring in the Lower Mahadeo being composed of simple arenaceous foraminiferal types connotes estuarine, lower salinity environments. On the contrary, the Upper Mahadeo assemblage, including not only arenaceous and calcareous bentonic types but also planktonic ones, reflects an open shelf, neritic environment when sea bottom could have deepened down to central or outer shelf.

**BIOZONATION**

The Mahadeo Formation, comprises of a single marine cycle. *Pari passu*, the foraminiferal succession of the lithotope is continuous and the boundary between the succession faunal zones tend to be gradational. The Cretaceous/Tertiary boundary, nevertheless, is abruptly defined in the planktonic foraminiferal scale, albeit only with minor changes in the bentonic assemblage.

The Cretaceous sediments of the Mahadeo Formation are easily biozoned into two: a lower *Dorothyia oxyconaea* Zone and an Upper *Globotruncana stuartiformis* Zone. The diagnostic planktonic foraminifera of the formation occur in the *G. stuartiformis* Zone, corresponding to the Upper Mahadeo. This assemblage seems typically Maastrichtian on overall considerations. However, for the purposes of correlation of the Mahadeo Formation it seems imperative to briefly invoke the more recently followed Cretaceous biozones of global significance, (Boll, 1966; Bandy, 1967; Van Hinte, 1969, and Postuma, 1971).

That the Cretaceous biozonation has reached a plateau beyond which it is difficult to increase biostratigraphic resolution in the planktonic foraminifera is emphasized by Masters (1977)). He has re-fortified the datum-plane concept in foraminiferal record, adversely commented upon by Blow (1970). However, as a primary basis of global biostratigraphic homotaxis, zones remain a living concept since they are, in essence, defined by prominent and valid datum planes in the evolution of foraminifera themselves. The following review, therefore, seeks a comparison of Late Cretaceous foraminifer Zones of the Um Sohryngkew River with some of the global planktonic zones.

**LATE CRETACEOUS-PALOEocene PLANKTONIC FORAMINIFERAL ZONES**

Following Bandy (1967), the Late Cretaceous is a period of the dominance of *Globotruncana*. The planktonic zones of this period are, accordingly, based mainly on the ranges of the *Globotruncana* species. The generalised planktonic foraminiferal zonation of this period has been discussed in detail by Boll (1966), Bandy (1967) and Van Hinte (1969). In Maghalaya, as noted above, only the highest Cretaceous sequence, corresponding to the upper range of *Globotruncana stuartiformis* Dalbiez develops. The
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species is typically associated with the Campanian-Maastrichtian sediments world over and the total range is classified into several zones.

A significant change in the *Globotruncana* assemblage within the Campanian-Maastrichtian *Globotruncana stuartiformis* range is the sudden appearance of a spinose form, *Globotruncana calcarata* Cushman. Its first appearance level marks the base of upper Campanian while its extinction is taken as the base of Maastrichtian (Table 1). During the Maastrichtian, appearance of *Globotruncana gansseri* Bolli from *G. rosetta* (Crasey) is a widely recorded event marking the base of *G. gansseri* Zone. Again a dis- carinate form, *Globotruncana mayaroensis* Bolli, appears within *G. gansseri* range zone and divides it into a lower *G. gansseri* Zone and an upper *G. mayaroensis* Zone in the zonal scheme of Bolli (1966).

*Globotruncana gansseri* range zone has been divided into three zones by Van Hinte (1969) considering the evolutionary changes in the uncarinate forms of *Globotruncana stuartiformis* group. *G. gansseri* Zone covers the interval between the first appearances of *G. gansseri* and *G. stuartii* (De Lapparent); *G. stuartii* zone is the interval from the first appearance of this species till the appearance of *G. contusa* (Cushman); and, *G. contusa* is the uppermost zone of Maastrichtian.

In the biozonation adopted by Postuma (1971) the framework remains essentially that of Bolli (1966) except for the substitution of *G. elevata* zone in place of *G. stuartii* s.l. Zone of Bolli (1966).

The generalised zonal schemes of *G. stuartiformis* range as suggested by Bolli (1966), Bandy (1967) and Van Hinte (1969a) are indicated in Table 1 along with the suggested correlation of the two zones of Therriac. Detailed discussion of the correlation between these two local zones and global zonation is discussed under the description of Zones in the subsequent paragraphs.

**DESCRIPTION OF CRETACEOUS ZONES**

*Dorothyia oxycona* Zone

**Nomenclature:** Named after the commonly occurring species.

**Description:** Type section in Um Sohryngkew River; lower and upper boundaries marked by the first appearances of the marker species and *Globotruncana stuartiformis* Dalbiez respectively; lower boundary marks an ecological change between nonmarine and estuarine sediments and the upper boundary a change from estuarine to holomarine.

The zone occurs between sample Nos. W-73 and W-2 (both inclusive); in type section thickness of the zone 28m; a moderately diverse suite of agglutinated benthonics occurs. These include:

- *Haplophragmoides glabra* Cushman and Waters
- *Spiroplectammina semiconplanata* (Carsey)
- *Dorothyia ozycona* (Reuss)
- *Gaudryina bronni* (Reuss)
- *G. rugosa d’Orbigny*

None of the above species, except *Dorothyia ozycona* survive this zone.

**Correlation:** On the evidence of the stratigraphic position this zone is tentatively correlated with *Globotruncana lapparenti tinosiana*—*G. gansseri* Zones of Bolli (1966) since
the overlying zone is homotaxial with G. mayaroenis and a part of G. gansseri Zone of Bolli (1966). G. lapparenti limeiana is the lower zone of Maastrichtian hence D. oxyoca Zone is placed in the Early Maastrichtian. 

*Globotruncanca stuartiformis* Zone

**Nomenclature** : Named after the commonly occurring species.

**Description** : Type section in Um Schryngkew River; marked by the observed range of *G. stuartiformis*; conformably underlain and overlain by *Dorothyia oxyoca* and *Turborotalia sabina* Zones respectively; the lower limit an ecological boundary between euryhaline and stenohaline waters; zone confined between sample Nos. W-3 and W-7, (both inclusive); maximum thickness considered to be 12 m; characterised by a rich suite of planktonic and smaller benthonic foraminifera which includes following species:

**Planktonic**

_Guembelitria cretacea* Cushman

_Guembelitriella postcretacea* Pandey sp. nov

_Heterohelix naveroensis* Loeblich

_H. glabran* Cushman, *H. globulosa* Ehrenberg

_H. precarcogae* Pandey, n. sp.

_H. striata* Ehrenberg, *H. plumeriae* Loetterle

*_H. elegans* Rzehak

_Gablerina cuvillieri* Kikoine, *G. acuta* De Klasz

_Pseudougebelinella exolata* (Cushman)

_P. punctulata* Cushman, *P. palpebra* Bronnimann & Brown

_Planoglobulina frunctiosa* (Egger)

_Planoglobulina acerulinoidea* (Egger)

_Planomalina buxtorfi* (Gandolfi)

_Globigerinelloides asperus* (Ehrenberg)

_G. massinae* (Bronnimann), *G. subcarinata* (Bronnimann)

_Schackoina* sp. cf. *S. molinensis* Reichel

_Hedbergella monmouthensis* (Olssøn)

_Globotruncanella havanensis* (Voorvijk)

_Globotruncanella* sp.

_G. subbetaloida* (Gandolfi)

_G. circummodifer* (Finlay), *G. coarctata* (Bolli)

_Globotruncanca rosetta* (Carsey)

_G. stuartii* (De Lapparent)

_G. stuartiformis, G. elevata* (Brotzen)

_Rugoglobigerina macrocephala* Bronnimann

_R. ornata* Bronnimann, *R. rugosa* (Plummer)

_R. scoti* Bronnimann, *R. pilula* Belford

_R. rotundata* Bronnimann

**Benthonic**

_Bathyphison alexanderi* Cushman, *Reophax texana* Cushman

_Haplophragmoides kirki* Wickenden, *Ammobaculites expansus* Plummer

_Navarella joaquinii* Ciry and Rat

_Spiriroplectammina lalickeri* Albirton & Phleger

_Tritaxia trilatera* Cushman, *Dorothyia oxyoca* (Reuss)

_D. hokkaidoana* Takayanagi, *Nodosaria affinis* Reuss

_Dentalina megapolitana* Reuss, *D. basiplanata* Cushman

_Frondicarina* cf. *F. arichiaca* D’Orbigny

_Lagenac uccicostata* Reuss, *L. hipida* Reuss

_Lenticulina jonesi* Sandidge, *L. rumoiensis* Takayanagi

_L. matsumotoi* Takayanagi, *Marginulina texasensis* Cushman

_M. bullata* Reuss, *Marginulopis decorata* (Reuss)

_Pseudonodosaria manifesta* (Reuss)

_Saracenaria triangulalis* D’Orbigny, *Brizalina incrassata* (Reuss)

_B. crosa* (Cushman), *Brizalina* sp., *Bulimina kikakpoaehis* Cole

_Nodosarella jarvisi* (Cushman), *Coryphostoma plaita* (Carsey)

_C. clavata* (Cushman)

_Anomalinoidea subba* (Cushman & Bermudez)

_Gyroidina girardana* (Reuss)

_Heterolepa allenii* (Brotzen)

All the planktonic species of the zone are restricted to it. In addition the following benthonic do not survive this zone:

_Haplophragmoides kirki, Navarella joaquinii

_Brizalina incrassata, B. crosa

_Coryphostoma plaita, C. clavata, Dorothyia oxyoca

_Tritaxis trilatera

The appearance of *Guembelitria cretacea* in the upper part of this zone suggests that the zone may be suitably classified into a lower and an upper subzone. These are being named as *Globotruncanca rosetta* and *G. cretacea* Subzones respectively. The former being a partial range zone and the latter a true range zone. Among planktonic foraminifera *Planomalina buxtorfi* is restricted to the G. rosetta Subzone and *Guembelitriella postcretacea, Rugoglobigerina rotundata* and *R. scoti* are restricted to the G. cretacea Subzone. No significant faunal change is observed between the two subzones.

**Correlation** : Occurrence of *Globotruncanca stuartii* through out the zone, a species commonly restricted to the G. gansseri and G. mayaroenis zones of Bolli (1966), suggests that the G. stuartiformis Zone is not older than G. gansseri Zone of Bolli. *G. mayaroenis* Bolli is absent in Meghalaya, Occurrence of *R. scoti* and *R. rotundata*, however, is sufficient evidence to suggest that upper part of G. stuartiformis may be correlated with *Globotruncanca mayaroenis* Zone. As evidenced by the planktonic fauna, this zone covers G. mayaroenis as also a part of G. gansseri Zone.

**TAXONOMY**

As noted earlier, the present paper covers only the species which are restricted to Cretaceous and the forms common to Cretaceous and Paleocene are included in another paper (Pandey, 1978). The taxonomic arrange-
ment of Genera and superficarian taxa in the following pages follows (Loeblich and Tappan, 1964) with slight deviations in some cases. Thus Genus Heterohelix Ehrenberg includes all the biserial types with simple terminal aperture irrespective of chamber shape and ornamentation. The polyserial forms of subfamily Heterohelicinae are referred to Planoglobulina Cushman when devoid of a nonseptate cavity, and Globulina Kikoiné when this cavity is present.

In family Globotruncanidae, Globotruncanella Reiss, considered synonymous with Globotruncanina by Loeblich and Tappan (1964), has been retained.

ILLUSTRATIONS

Figures of the planktonic and bentonic foraminifera, in plates 1 to 6 were made by the author from the photographs of specimens. Outlines were traced from photographs on a drawing paper and subsequently the drawings were shaded. Magnifications have been calculated to the nearest multiple of 5 and could vary by ±2 when it is more than 35X.

DEPOSITORY

Figured and enlisted specimens of foraminifera in the present work are deposited in the Palaeontology Laboratory, Oil & Natural Gas Commission, Baroda.

SYSTEMATIC DESCRIPTION

Family Lituolidae De Blainville, 1825
Subfamily Haplophragmoidinae Myanč, 1952
Genus Haplophragmoides Cushman, 1910
Haplophragmoides glabra Cushman and Waters
(Pl. I—1-2)
Haplophragmoides glabra Cushman and Waters, 1921, p. 83.

Figured Specimen: Figured specimen BF 429 is from sample W-7.
Remarks: The diameter of the forms varies from 0.28 mm to 0.50 mm. Forms are 0.1 to 0.2 mm thick.
Occurrence: H. glabra is frequent in common in Dorothia oxyconoid Zone of Um Sohryngkew River section.

Haplophragmoides kirki Wickenden
(Pl. I—3-4)
Haplophragmoides kirki Wickenden, 1932, p. 85.

Figured specimen: Figured specimen BF 430 is from sample W-6.
Remarks: Diameter and thickness of the figured specimen are 0.45 mm and 0.28 mm respectively.
Occurrence: H. kirki occurs rarely in the G. stuartiformis Zone of Um Sohryngkew River section.

Genus Cribrostomoides Cushman, 1910
Cribrostomoides trinitatis Cushman and Jarvis
(Pl. I—5-6)
Cribrostomoides trinitatis Cushman and Jarvis, 1928, p. 91.

Figured Specimen: Figured specimen BF 431 is from sample W-7.
Remarks: Largest diameter of the forms from the Mahadeo Formation is 0.54 mm and thickness 0.48 mm.
Occurrence: C. trinitatis is rather rare in Um Sohryngkew River and occurs in the upper part of G. stuartiformis Zone.

Subfamily Lituolinae De Blainville, 1825
Genus Navarella Ciry and Rat, 1951
Navarella joquinii Ciry and Rat
(Pl. I—7-9)
Navarella joquinii Ciry and Rat, 1951, p. 76 (fide Ellis and Messina, 1940 et. seq.)

Figured specimen: Figured specimen BF 432 is from sample W-4.
Remarks: Specimens referred to N. joquinii are upto 4.0 mm long, 2.2 mm broad and 1.1 mm thick.
Occurrence: The species is restricted to the Maastrichtian of the Um Sohryngkew River. Profuse occurrence of the species is seen in a thin band within G. stuartiformis Zone of the Mahadeo Formation wherefrom sample W-4 has been collected.

Genus Triplasia Reuss, 1854
Triplasia cushmani (Alexander and Smith)
(Pl. I—20-21)
Frankenia cushmani Alexander and Smith, 1932, p. 309.

Figured Specimen: Figured specimen BF 433 is from sample W-26.
Remarks: The Triplasia population in Um Sohryngkew River section compares well with T. cushmani (Alexander and Smith) both in appearance and size. T. cushmani seems to be closely related to Triplasia taylorensis, originally described as Frankenia taylorensis by Cushman and Waters (1929). It is hardly distinguishable from the latter but for its smaller size. The studied forms of T. cushmani are up to 0.75 mm in length and 0.38 mm in thickness.
Occurrence: In Um Sohryngkew River section, T. cushmani is impersistently recorded in large numbers from T. pseudobuloides s.1. and G. pusilla Zones of Mahadeo and Langpar Formations. The Meghalayan occurrence is younger than the American occurrence of the species which is typically Cretaceous (Cushman, 1946).

Family Textulariidae Ehrenberg, 1838
Subfamily Spiroplectamminae Cushman, 1927
Genus Spiroplectamina Cushman, 1927
Spiroplectammina semicomplanata (Casey)

(Pl. I—16-17)

Textularia semicomplanata Casey, 1926, p. 25.

Figured Specimen: Figured specimen BF 434 is from sample W-67.

Remarks: Specimens are up to 0.81 mm long, 0.55 mm broad and 0.28 mm thick.

Occurrence: S. semicomplanata is commonly recorded in the lower part of the Mahadeo Formation and extend from base of the formation till the base of G. Stuartiformis Zone.

Family: Ataxophragmiidae Schwager, 1877
Subfamily: Verneuilinace Cushman, 1911
Genus: Gaudryina d'Orbigny, 1839
Gaudryina bronni (Reuss)

(Pl. I—10-11)

Verneuilina bronni Reuss, 1845, p. 38 (vide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 435 is from sample W-67.

Remarks: Length, breadth and thickness of the forms from the Mahadeo Formation are 0.54 mm-1.00 mm, 0.30 mm-0.80 mm and 0.45 mm-0.55 mm respectively.

Occurrence: In Um Sohringkew River G. bronni occurs commonly in the Dorothia oxycona Zone.

Genus: Tritaxia Reuss, 1860
Tritaxia trilatara (Cushman)

(Pl. I—14-15)

Clausolina trilatara Cushman, 1926, p. 588.

Figured specimen: Figured specimen BF 436 belongs to sample W-7.

Remarks: Length and breadth of the specimens are up to 1.60 mm and 0.62 mm respectively.

Occurrence: T. trilatara is common in the G. Stuartiformis Zone of the Mahadeo Formation.

Dorothia oxycona (Reuss)

(Pl. I—18-19)

Gaudryina oxycona Reuss, 1860, p. 229 (vide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 437 is from sample W-7.

Remarks: Meghalayan forms are up to 0.85 mm long 0.50 mm diameter.

Occurrence: In Um Sohringkew River D. oxycona is common in the marine Cretaceous sequence; its frequency varies from common to rare in different samples

Genus: Eggerella Cushman, 1923

Eggerella sp.

(Pl. I—12-13)

Figured specimen: Figured specimen BF 438 is from sample W-7.

Remarks: A rarely occurring form of Eggerella in the Mahadeo Formation is characterised by medium size, indistinct early spire, penultimate whorl with four chambers and three appressed globular chambers with slightly depressed sutures in the last whorl. Wall is rather rough and non-calcareous. Comparison of this form with species of Eggella is difficult due to paucity of well preserved material.

Forms referable to this species are up to 0.72 mm long and 0.48 mm broad.

Occurrence: The species occurs rarely in the upper part of G. Stuartiformis Zone of Um Sohringkew River section.

Family: Nodosariidae Ehrenberg, 1838
Subfamily: Nodosariace Ehrenberg, 1838
Genus: Pseudonodosaria Boogart 1949
Pseudonodosaria manifesta (Reuss)

(Pl. II—1-2)

Glandulina manifesta Reuss, 1851, p. 22 (vide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 439 is from sample W-7.

Remarks: Specimens from the Mahadeo Formation are 0.45 mm-0.55 mm long and 0.15-0.23 mm thick.

Occurrence: This species occurs in the upper part of G. Stuartiformis Zone where it is recorded infrequently.

Family: Bolivinidae Cushman, 1927
Genus: Brizolina Costa, 1856
Brizolina cretosa (Cushman)

(Pl. II—3-4)

Bolivina cretosa Cushman, 1936, p. 49.

Figured specimen: Figured specimen BF 440 is from sample W-7.

Remarks: Form figured as B. incrassata Reuss, by Rasheed and Govindan (1968), from Vridhachalam Cretaceous of Coromandel Coast is more compressed than B. incrassata and may possibly be referred to this species.

Forms from the Mahadeo Formation are up to 0.45 mm long, 0.20 mm broad and 0.10 mm thick.

Occurrence: B. cretosa is typically associated with the Campanian-Maastrichtian lithotopes of Coromandel Coast (Rasheed and Govindan, 1968) and occurs commonly in the G. Stuartiformis Zone of the Mahadeo Formation.

Brizolina incrassata (Reuss)

(Pl. II—5)

Bolivina incrassata Reuss, 1851, p. (vide Ellis and Messina, 1940 et seq.)
Figured specimen: Figured specimen BF 441 belongs to sample W-7.

Remarks: Length, breadth and thickness of the specimens are up to 0.45 mm, 0.25 mm and 0.13 mm respectively.

Occurrence: The species is restricted to Cretaceous section of Meghalaya and reported from the Mahadeo Formation by Nagapa (1959). B. incrassata is of common occurrence in G. stuartiformis Zone of Um Sohryngkew River section.

Family: Heterohelicidae Cushman, 1927
Subfamily: Guembelitriinae Montanaro
Genus: Guembelitria Cushman, 1933
Guembelitria cretacea Cushman (Plate II—7)

Guembelitria cretacea Cushman, 1933, p. 37.

Figured specimen: Figured specimen BF 442 is from sample W-7.

Remarks: Forms from the Mahadeo Formation are 0.16 mm-0.22 mm long and 0.12 mm-0.17 mm thick. Variation in the height to the thickness ratio of the spire is from 1 : 1 to 2 : 1. There is little morphologic distinction between G. cretacea and G. harrisii Tappan (1940) but these two forms appear to constitute chronologically distinct populations.

Occurrence: In Meghalaya, G. cretacea occurs in the upper part of G. stuartiformis Zone, corresponding to Globotruncana mayaroensis Zone of Bolli (1966).

Genus: Guembelitria Tappan, 1940
Guembelitriella postcretacea Pandey, sp. nov. (PI.-II—8-14)

Figured specimen: Figured specimen (holotype) BF 443 and figured paratype BF 444 are from sample W-7.

Description: Test small, early stage triserial in many forms, others triseriation obliterated. Early part of the test constituted by closely appressed globular chambers arranged in three or four series; later part of the test made up of an irregular cluster of chambers which grow in the distal part of the test; some of these chambers attach themselves to one of the sides of triserial test and spread till the proximal part of the initial test. The test has either a racemose appearance spreading gradually base upwards or an appearance of a two-layered cluster of globular chambers—the first layer of triserial stage and second layer of proliferation stage (Cf. plate II—8-10 and 11-14 respectively). Forms in which triseriation is completely obliterated, test is an irregular cluster of globular chambers. Surface of chambers is smooth and sutures are distinct and deep. Primary aperture in the triserial stage is a narrow opening at the inner margin of the last formed chamber; small sutural apertures, mostly at trijunction of chambers, are also seen. A few of these secondary apertures are covered by a very small bulla-like plates. The holotype is 0.21 mm long, 0.15 mm broad and 0.15 mm thick.

Remarks: The recorded species is referred to genus Guembelitriella Tappan which is so far known to be represented only by a single species G. graysonensis Tappan (1940) of Early-Middle Cretaceous. This is second occurrence of the genus. G. postcretacea is transitional and derived from G. cretacea is unrelated to G. graysonensis which is derived from Guembelitria harrisii Tappan. Trivial nomenclature has been chosen to denote the intimate relationship between Guembelitriella postcretacea and Guembelitria cretacea. The two species occur together and also show some cases of intergradation.

Length, breadth and thickness of the observed population are up to 0.25 mm, 0.20 mm and 0.15 mm respectively.

Occurrence: This species is restricted to and occurs abundantly in upper part of G. stuartiformis Zone.

Subfamily: Heterohelicinae Cushman, 1927
Genus: Heterohelix Ehrenberg, 1844

Remarks: Heterohelix of current usage is either completely biserial or possesses a small spire (Montanaro Gallitelli, 1957; Brown, 1969; Stenetad, 1969). El-Naggar (1971 a) regards Pseudotextularia Rzezak, Plano-globulina Cushman and Racemigemmellina Montanaro Gallitelli as junior synonyms of this genus.

Pseudotextularia as redefined by Montanaro Gallitelli (1957) and adopted by Loeblich and Tappan (1964) is biserial throughout. Others like Berggren (1962), Bandy (1967), Brown (1969) include in this genus biserial populations like Pseudotextularia elegans (Rzezak) and polyserial types like 'Guembelina fructiosa' Egger. The latter species is the genotype of Racemigemmellina but regarded as a species of genus Pseudotextularia (Nagappa, 1959; Berggren, 1962), subspecies of P. elegans (Bandy, 1967) and as a variant of P. elegans (Nagappa, 1959; Brown, 1969). Scanning electron microscope studies by Pessagno and Brown (1969) suggest distinctive and specialised wall structure in 'G. fructiosa' as compared to the biserial population of Pseudotextularia deformis (Kikoine) illustrated by Pessagno (1969b). P. deformis has been considered as a junior synonym of P. elegans by Montanaro Gallitelli (1957, p. 139). Accordingly, P. elegans and related biserial forms could not be included in the group of polyserial forms like 'G. fructiosa'.

P. elegans and related species closely resemble a typical Heterohelix, e.g., H. globulosa or H. striata, except in chamber geometry. In a typical Heterohelix, chambers are generally inflated and globular to reniform (Montanaro Gallitelli, 1957, p. 137). In Pseudotextularia (sensu
Montanaro Gallitelli, 1957) later chambers are strongly compressed laterally and broad initial aperture becomes linear in ‘most appressed form’. This development is opposite of ‘lateral flattening’ seen in Heterohelix glabrans (Cushman) in which chambers flatten rapidly and aperture is reduced to a narrow slit extending up face.

Neither H. glabrana nor P. elegans could be accommodated within Heterohelix if the chamber geometry, in place of apertural characteristics are considered for generic classification. However, emphasis on chamber shape seems to carry the splitting of otherwise homogeneous group too far. Accordingly, both the trends—‘compression’ and ‘flattening’ of later chambers—could be placed as specific variations within a genus. Thus, El-Naggar (1971 a) appears to be well justified in considering Pseudotextularia a junior synonym of Heterohelix.

Polyserisation and multiple apertures are distinctive generic characters shown neither by Heterohelix navarroensis Loeblich, the genotype of Heterohelix, nor by any of its related species. Racemiuguemelina, Planoglobulina and Ventilabrella Cushman, all characterised by proliferation of chambers in the later part of the test, are not considered as junior synonyms of Heterohelix by this writer, contrary to the opinion of El-Naggar (1971 a).

Heterohelix elegans (Rzhakh) (Pl. III—9-10)

Cunoeolina elegans Rzhakh, 1891, p. 3 (fide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 445 is from sample W-7.

Remarks: Cushman (1946) figured three forms of Heterohelix elegans plexus with moderate to strong striae and referred them to H. plummerae. In these forms the costae are much stronger than H. plummerae of original description (Loetterle, 1937). Montanaro Gallitelli (1957) referred one of these forms to H. elegans (=Pseudotextularia elegans). Similar material has also been figured by Nagappa (1959) as H. plummerae (=P. plummerae). Brown (1969) designated a new species—Heterohelix cushmani (Brown), originally described as Pseudotextularia cushmani Brown—based on the figures of Cushman (1946). His distinction of this species is based on intermediate striaions in this species as compared to finely striated H. plummerae and coarsely striated H. elegans. In all other characters, this species is similar to H. elegans. Although the striae of H. cushmani, as figured by Cushman (1946) may be termed as moderately strong, Gallitelli’s (1957) drawing of one of these same forms shows coarse striation. The writer is, therefore, not inclined to separate H. elegans from H. cushmani and hence H. cushmani is treated here as a junior synonym of H. elegans. Forms figured as Pseudotextularia plummerae (Loetterle) by Nagappa (1959) are typical population of H. elegans from the Mahadeo Formation of Meghalaya and are included here.

The length, breadth and thickness of the studied specimens are up to 0.40 mm, 0.30 mm and 0.35 mm respectively.

Occurrence: This species was reported from the Mahadeo Formation of Um Sohryngkew River by Nagappa (1959) as Pseudotextularia plummerae. H. elegans is confined to G. stuartiformis Zone of Um Sohryngkew River and is of common occurrence.

Heterohelix glabrans (Cushman) (Pl. IV—5-6)

Guemelina glabrana Cushman 1938, p. 15.

Figured specimen: Figured specimen BF 446 is from sample W-7.

Remarks: Specimens from Um Sohryngkew River are up to 0.32 mm long, 0.25 mm broad and 0.10 mm thick.

Occurrence: In Um Sohryngkew River H. glabrans is restricted to upper part of G. stuartiformis Zone. It is associated with the Globotruncana mayaroensis assemblage of Coromandel Coast (Govindan, 1972).

Heterohelix globulosa (Ehrenberg) (Pl. II—17-18)

Textularia globulosa Ehrenberg 1840, p. 135.

(fide Ellis and Messina, 1940 et seq.)


Figured specimen: Figured specimen BF 447 is from sample W-7.

Remarks: Nagappa (1959) has figured two forms of ‘Guemelina globulosa’ from the Langpar Formation of the Khasi Hills. These are very similar to Chiloguemelina morssei (Kline) occurring abundantly in the Langpar. Nagappa’s specimen, being from the Paleocene Langpar Formation, are not H. globulosa and should be referred to C. morssei.

Forms from Um Sohryngkew River are up to 0.28 mm long, 0.21 mm broad and 0.15 mm thick.

Occurrence: H. globulosa is a common Cretaceous species in the Indian subcontinent. Govindan (1972) has reported the species from Campanian-Maastrichtian strata of Coromandel Coast and Pandey and Rao (1976) figured it from the Campanian-Maastrichtian sediments of Andaman Islands. It is of common occurrence in the G. stuartiformis Zone of the Um Sohryngkew River Section.

Heterohelix navarroensis Loeblich (Pl. II—15-16; Pl. IV—1-2)

Spiroplectea americana Ehrenberg, 1844, p. 75 (fide Ellis and Messina, 1940 et seq.)

Heterohelix navarroensis Loeblich, 1931, p. 107.

Figured specimen: Figured specimens BF 448 and BF 449 are from sample W-7.

Remarks: This species, documented originally from the Late Cretaceous Chalk of North-eastern Mississippi, has been considered under two names—Heterohelix americana (Ehrenberg) and Heterohelix navarroensis: Loeblich. Loeblich and Tappan (1964, p. 654) considered H. navarroensis a junior synonym, Brown (1969) remarks “but because H. (Spiroplecta) americana (Ehrenberg, 1844) is a junior secondary homonym of H. (Textillaria) americana (Ehrenberg, 1843) the existing available name H. navarroensis may be retained as the correct name for the species”.

Masters (1977), however, considers a non-reporting or non-discussion about Textillaria americana Ehrenberg, a senior homonym of H. (Spiroplecta) americana (Ehrenberg) during the last fifty years, as a weighty argument to recognize it as a nomen oblitum. Hence, H. americana is a valid senior synonym of H. navarroensis. However, once the anomaly is discovered, the concept of nomen oblitum becomes slender and, accordingly, in the present work H. navarroensis is being retained. The species is remarkably similar to Heterohelix globulosa (Ehrenberg). Distinguishing features of this species include slightly compressed chambers, smaller rate of flaring in the test and inclined intercameral sutures as compared to more globular chambers, rapidly flaring test and horizontal sutures in H. globulosa. Vertical striae are more prominent in this species as compared to H. globulosa.

The studied forms are up to 0.28 mm long, 0.18 mm broad and 0.18 mm thick.

Occurrence: In Um Sohrungkew valley H. navarroensis occurs sporadically in G. stuartformis Zone.

Heterohelix pseudocarsoniae Pandey, sp. nov.

(Pl. III—6-8)

Ventrilabrella carsoniae Plummer, 1931, (part), p. 178, p. 9, figs. 7, 9 (not fig. 8)
Ventrilabrella carsoniae Plummer: Cushman, 1946, (Part), p. 112, pl. 48, figs. 1-3 (not figs. 4-5).
Pseudotextillaria carsoniae (Plummer): Brown, 1969, (part), p. 54, pl. 4, fig. 8, text-figs. 11-12 (not pl. 4, fig. 9).

Figured specimen: Figured specimen BF 452 is from sample W-7.

Description: Test small to medium sized, biserial throughout, constituted by about six pairs of subglobular chambers, increasing gradually in size as added, last chamber slightly smaller than penultimate and shifted towards the middle, distinct depressed sutures, surface ornamented with moderately strong vertical striae; primary aperture a large, low to high arch at the base of the final chamber on its inner margin; about 25% forms possess secondary aperture—a small arcuate opening at the outer margin of the final chamber. Both microspheric and megaspheric types occur within this population.

Remarks: Vertical striae in this species are similar to Heterohelix striata (Ehrenberg) and H. elegans. The species differs from H. striata owing to its stronger striae and deflection of the last chamber to the middle; and, from H. elegans by its comparatively feeble ornamentation, absence of lateral compression in the late chambers and low arch-shaped aperture in contrast to much compressed chambers and slit-like aperture in H. elegans. Presence of an auxiliary aperture in the last chamber, at least in 25% forms, is also its distinctive character. Such an aperture is not seen in H. elegans and H. striata. Plummer (1931) included in the Ventrilabrella carsoniae both biserial and polyserial forms. But Cushman (1946, p. 112) remarked “large part of the specimens do not progress beyond Guembelina stage but in any large series a certain number of megaspheric forms show ventilabrelloid chambers”. These megaspheric, polyserial planglobuline forms, including the holotype of Ventrilabrella carsoniae Plummer (1931, pl. 9, fig. 8) and referred specimens of Cushman (1946, p. 48, figs. 4-5), appear to be the megaspheric generation of Planoglobulina acerulinioides (Egger) and may be referred to P. acerulinioides. Accordingly, Ventrilabrella carsoniae Plummer, as defined by its holotype, is treated as a junior synonym of P. acerulinioides (Egger) and biserial forms included by Plummer (1931), Cushman (1946) and Brown (1969).
under ‘Ventilabrella carseyae’ or ‘Pseudotextularia carseyae’ are regarded as an undesignated species. It is being named as H. pseudocarseyae with holotype of the species represented by plate 9, figure 7 of Plummer (1931). The trivial nomenclature pseudocarseyae is coined to denote the relationship of these biserial forms with the polyserial forms of Planoglobulina carseyae (Plummer) which is regarded as conspecific with P. acerulinitoides (Egger) by this writer. A biserial form, figured by Cushman (1946, pl. 47, fig. 14) as Planoglobulina acerulinitoides (Egger), however, is included in this species.

Forms referred to this species, from Um Sohryngkew River, are up to 0.37 mm long, 0.26 mm broad and 0.17 mm thick.

Occurrence: As suggested by Cushman (1946) this species is a typical Navarroan (Maastrichtian) heterohelicoid. Pessagno (1969a) has shown its occurrence in G. gansseri—G. mayaroensis Zones. Brown (1969) extended its lower limit in Campanian. In Um Sohryngkew River H. pseudocarseyae is common in the lower and rare in the upper part of G. stuartiformis Zone.

Heterohelix striata (Ehrenberg)

Pl. IV—3-4

Textularia striata Ehrenberg 1840, p. 135 (fide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 453 is from sample W-3.

Remarks: In the Mahadeo material the surface ornamentation of striae is gradational between H. globulosa and H. striata supporting the observation of Berggren (1962) who contends that the two species appear to be end members of a gradational morphologic series.

The forms referred to H. striata are up to 0.31 mm long, 0.25 mm broad and 0.18 mm thick.

Occurrence: H. striata occurs commonly in the G. stuartiformis Zone of Um Sohryngkew River.

Genus Planoglobulina Cushman, 1927

Remarks: Rzehak (1891) included in his Cancolilla elegans—the type species of his genus Pseudotextularia Rzehak (1896)—completely biserial as also such biserial forms which developed chamber proliferation in the distal part of the test. These polyserial forms were figured as Pseudotextularia varians by Rzehak (1895, p. 217, figs. 1-3). As discussed by Montanaro Gallitelli (1957) P. varians is an invalid synonym of ‘Pseudotextularia elegans’ (Rzehak). The biserial population of ‘P. elegans’ has been discussed under Heterohelix in the proceeding text.

Populations with initial biserial stage and later chamber proliferation were first validly named by Egger (1895, 1899). He designated (1895, p. 217) Guembelina acerulinitoides Egger for the flabellate types lacking a conical appearance and suggested nomenclature Guembelina fructcosa Egger (1899, p. 35) for forms possessing initial biserial stage followed by chamber proliferation resulting into a conical shape. Three generic names were suggested to classify these proliferated heteroheliocoids which are characterised by an ornamentation of vertical costae and striae and absence of a non-camerate apical cavity. These were: Planoglobulina Cushman (1927), Ventilabrella Cushman (1928) and Racemiquelgelina Montanaro Gallitelli (1957). Montanaro Gallitelli (1957) has vividly clarified how Planoglobulina is a valid senior synonym of Ventilabrella in view of the Cushman’s initial (1928) and later (1946) treatment of Ventilabrella. In Racemiguemelina, as per the original description (Montanaro Gallitelli, 1957, p. 142), the crown of the chamberlets produces a nearly circular outline in apertural view and the test is conical with typical “proportion of breadth to thickness 1 : 1”. Planoglobulina is characterised by “a more or less abundant proliferation of globular chambers, which spread out in the plane of biserality, giving a flabelliform shape to the test” (Montanaro Gallitelli, 1957, p. 141). In the material figured by her (1957, pl. 32, figs. 14a-15b) as ‘Racemiguemelina fructiosa’ Egger minimum to maximum diameter ratio of the crown is 1 : 1 and 1 : 1.3. In the forms attributed to ‘Pseudotextularia (Racemiguemelina) fructiosa’ (Egger) by Berggren (1962) this ratio is 1 : 1-6. In the latter case, test has a definite flabelliform appearance. Intermediate types between these populations occur in Meghalaya and are also figured by Govindan (1972). Similar gradation may also be inferred from figures of Cushman (1946, pl. 47). This gradation from nearly conical to thick flabelliform shape is gradual and demonstrates that circular crown of Racemiguemelina grades into flabelliform test of Planoglobulina. Planoglobulina acerulinitoides (Egger) and Racemiguemelina fructiosa (Egger) have been considered as conspecific by Brown (1969). The two species, however, seem to be distinguishable not only by their general test morphology and chamber geometry but also by specialised wall structure in the latter (Pessagno and Brown, 1969). The generic separation between the two species appears to be carrying the ‘taxonomic splitting’ too far. Planoglobulina Cushman being the earliest generic name for ‘acerulinitoides-fructiosa’ group has been adopted by the author. As suggested by Brown (1969) and El-Naggar (1971a), who consider Planoglobulina as synonyms of Pseudotextularia and Heterohelix respectively, Ventilabrella Cushman is a valid genus. Ventilabrella has been appropriately recognised as a junior synonym of Planoglobulina by Montanaro Gallitelli (1957). The heterohelicoid genus Gablerina Kikone, initially biserial but showing chamber proliferation in the later stage, is distinguished from Planoglobulina due to its wide non-camerate space between the two divergent series of chambers (Plate III—17) and absence of proliferation in the test excepting the apical area.
Planoglobula acervulina (Egger)  
(Pl. III—11-12)
Guembelina acervulina (fide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 454 is from sample W-7.
Remarks: The thick flabelliform test is easily distinguished from conical forms of Planoglobula fructicosa (Egger). Ratio between thickness and breadth in the observed material is more than 1:1.5 but less than 1:2. In the same range also falls the specimen referred by Berggren (1962, pl. 6, fig. 6) to 'P. fructicosa'. Cushman (1946, pl. 47) figured a biserial and a quadrisserial conical form under P. acervulina. The former is referred to Heterohelix pseudocarceae and the latter to P. fructicosa. The material figured as Platystophyla brazensis (Martin) by Masters (1977, pl. 4, figs. 3-4) is probably a variant of P. acervulina.

Forms from Um Sohryngkew River are up to 0.51 mm long, 0.45 mm broad and 0.24 mm thick.
Occurrence: P. acervulina is of common occurrence in Um Sohryngkew River and occurs throughout G. stuartiformis Zone.

Planoglobula fructicosa (Egger)  
(Pl. III—13-14)
Pseudotextularia varians Rzehak, 1925, p. 217, figs. 2-3 (not fig. 1) (fide Ellis and Messina, 1940 et seq.)
Guembelina fructicosa Egger, 1899, p. 35 (fide edem.)

Figured specimen: Figured specimen BF 455 is from sample W-3.
Remarks: Forms from the Mahadeo Formation are up to 0.35 mm long and 0.25 mm in diameter.
Occurrence: In Meghalaya the species has been reported by Nagappa (1959) earlier. It is of frequent occurrence in the G. stuartiformis Zone.

Genus Gublerina Kikoine, 1948
Gublerina acuta De Klasz  
(Pl. III—18-19)
Gublerina acuta De Klasz, 1953, p. 246.

Figured specimen: Figured specimen BF 456 is from sample W-7.
Remarks: This species has been distinguished from G. cuwillierii Kikoine due to lack of chamber proliferation in the apical part of its test. It grades into referred G. cuwillierii in the Um Sohryngkew assemblage.
Forms of this species are up to 0.41 mm long, 0.33 mm broad and 0.10 mm thick.
Occurrence: Gublerina acuta occurs in G. stuartiformis Zone of Um Sohryngkew River.

Gublerina cuwillierii Kikoine  
(Pl. III—15-17)

Figured specimens: Figured specimens BF 457 and BF 458 are from sample W-7.
Remarks: Montanaro Gallitelli (1957), after studying the topotype material of this species and holotype and paratypes of 'Ventilabrella ornatisima' Cushman and Church, concluded that G. cuwillierii is an invalid synonym of G. ornatisima (Cushman Church). Her view, accepted by Loeblich and Tappan (1964) and Bandy (1967) has not been incorporated by Brown (1969), Dupeuble (1969) and El-Naggar (1971a). This species is probably conspecific with G. ornatisima as already suggested by Montanaro Gallitelli (1957).

Specimens from Um Sohryngkew River are up to 0.48 mm long, 0.40 mm broad and 0.08 mm thick.
Occurrence: G. cuwillierii occurs commonly in the G. stuartiformis Zone of River Um Sohryngkew.

Genus Pseudoguembelina Bronnmann and Brown, 1953
Pseudoguembelina costulata (Cushman)  
(Pl. III—4-5)
Guembelina costulata Cushman, 1938, p. 16

Figured specimen: Figured specimen BF 459 is from sample W-3.
Remarks: Length, breadth and thickness of the forms from Um Sohryngkew River are up to 0.30 mm, 0.16 mm and 0.08 mm respectively.
Occurrence: P. costulata occurs infrequently in G. stuartiformis Zone of Um Sohryngkew River section.

Pseudoguembelina punctulata (Cushman)  
(Pl. III—1-3)
Guembelina punctulata Cushman, 1938, p. 13.

Figured specimen: Figured specimen BF 460 is from sample W-3.
Remarks: P. punctulata is distinguished from P. costulata (Cushman) by its thicker test, globular chambers, nearly uniform breadth in greater part of the test and feeble ornamentation. P. costulata as figured by Govindan (1972), possesses globular chambers and feeble ornamentation. His form could better be placed in this species.
Forms from Um Sohryngkew River are up to 0.33 mm long, 0.23 mm broad and 0.15 mm thick.
Occurrence: P. punctulata is infrequent in the G. stuartiformis Zone of Um Sohryngkew River.

Family Planomaliniidae Bolli, Loeblich and Tappan, 1957
Genus *Planomalina* Loeblich and Tappan, 1946

*Planomalina* cf. *P. buxtorfi* (Gandolfi)

(Pl. V—1-2)

*Planomalina* buxtorfi Gandolfi, 1942, p. 103.

**Figured specimen**: Figured specimen BF 461 is from sample W-3.

**Remarks**: A solitary form of *Planomalina*, recorded from the upper Mahadeo, is characterised by planispiral, biumbilicate, slightly evolute test, slightly lobulate equatorial and keeled axial periphery, nine and half chambers in the last whorl, and an equatorial aperture extending from one umbilicus to another with umbilical portions of successive apertures left as secondary apertures. This form is very similar to *Planomalina buxtorfi* (Gandolfi) to which it is tentatively compared. Rare occurrence of this species, commonly occurring in Albain to Cenomanian sediments of world (Bolli, Loeblich and Tappan, 1957; Bandy, 1967; Postuma, 1971; Barr, 1972), in the Meghalayan Maastrichtian is rather curious. It may either be a homomorphic development simulating *P. buxtorfi*, or most probably, the last stratigraphic record of *P. buxtorfi* which became exceedingly rare after Cenomanian.

The form measures 0.31 mm in diameter and 0.11 in thickness.

**Occurrence**: *P. buxtorfi* has been commonly reported from Albain Cenomanian sediments from different parts of world including Pakistan in Indian subcontinent (Dorren, 1974). Solitary form of Um Sohryngkew River section falls in the lower part of *G. sutartiformis Zone*.

Genus *Globigerinelloides* Cushman and Tendam, 1948.

*Globigerinelloides asperus* (Ehrenberg)

(Pl. V—3-4)

*Phanerostomum asperum* Ehrenberg, 1854, pl. 30, fig. 26; pl. 32 figs. 24, 42 (fide Ellis and Messina, 1940 et seq.)

**Figured specimen**: Figured specimen BF 462 is from sample W-7.

**Remarks**: Variation in this species is best illustrated by Dain (1953). The species, with typically five to seven gradually increasing chambers, appears to be conspecific with *Globigerina voluta* White (1928). *Globoturricula (Rugoglobigerina) bedelli* Gandolfi and *G. (R) subbedelli* Gandolfi have been considered as junior synonyms of *Globigerinelloides messinae* (Bromimann) by Berggren (1962). He, however, seems to include all planispiral planktonic forms ex gr. *G. asperus*, from the Scandinavian Maastrichtian, in his *G. messinae*. Bandy (1967, p. 12) has drawn attention towards four to four and half chambers in the last whorl of *G. messinae*. This concept, followed by the author, excludes *Globigerinelloides* populations with typically five to seven gradually increasing chambers of last whorl from *G. messinae*. *Globigerinelloides asperus* (Ehrenberg) is earliest name for these forms figured subsequently from the Late Cretaceous of different parts of world under different names (White, 1928; Gandolfi, 1955; Hofker, 1956). Five to seven chambered forms of *G. messinae*, as figured by Berggren (1962), and Govindan (1972), may also be included under *G. asperus*.

Aperture, in this species, as pointed out by Dain (1953) and Berggren (1962), shows variation in the range of perfect equatorial to bifid equatorial; and the latter is sometimes followed by ‘*Biglobigerinella*’ stage (Berggren, 1962). Although bifid equatorial aperture is common in *G. asperus* of Mahadeo Formation, ‘*Biglobigerinella*’ stage is not encountered.

The diameter of the studied forms is up to 0.35 mm and thickness up to 0.16 mm.

**Occurrence**: In Meghalaya *G. asperus* is common in the upper part of *G. sutartiformis Zone* and rare in the lower part.

*Globigerinelloides messinae* (Bromimann)

(Pl. V—7-8)

*Globigerinelloides messinae messinae* Bromimann, 1952, p. 42.

**Figured specimen**: Figured specimen BF 463 is from sample W-7.

**Remarks**: As suggested by Bandy (1967), *G. messinae* is derived from *G. asperus* by reduction of chambers in the last whorl. Some of the Berggren’s (1962) illustrations are referable to this species but greater part of Scandinavian material may be referred to *G. asperus*.

In the studied forms the diameter is up to 0.25 mm and thickness up to 0.15 mm.

**Occurrence**: In Um Sohryngkew River Section, *G. messinae* is restricted to the upper part of *G. sutartiformis Zone*.

*Globigerinelloides subcarinatus* (Bromimann)

(Pl. V—5-6)

*Globigerinella messinae subcarinata* Bromimann, 1952, p. 44.

**Figured specimen**: Figured specimen BF 465 is from sample W-5.

**Remarks**: The studied forms are up to 0.35 mm in diameter and up to 0.12 mm in thickness.

**Occurrence**: In Meghalaya, *G. subcarinatus* occurs sporadically in the *G. sutartiformis Zone*.

Family Rotaliporidae Sigal, 1958

Subfamily Hedbergellinae Loeblich and Tappan, 1961

Genus *Hedbergella* Bromimann and Brown, 1958
Hedbergella monmouthensis (Olsson)
(Pl. V—9-11)

Globorotalia monmouthensis Olsson, 1960, p. 47.

Figured specimen: Figured specimen BF 464 is from sample W-7.

Remarks: Bandy (1967, p. 10) has suggested the occurrence of dimorphic population in Hedbergella planispira (Tappan). He observed in the study of American material that Hedbergella holmdelensis (Olsson) and Hedbergella monmouthensis (Olsson) “are difficult to separate from megalospheric forms of H. planispira sensu stricto” and “specimens of H. planispira from the Middle Cretaceous include forms amazingly similar” to the two species of Olsson. Barr (1972) has also pointed out towards similarity of H. holmdelensis and H. planispira, although he is not certain “whether these two species are closely related or homeomorphic”. Bandy’s arguments, however, suggest the conspecific nature of three populations: megalospheric generation of H. planispira, H. holmdelensis and H. monmouthensis. The last being the earliest name for this group has been adopted by the author.

The diameter and thickness of the studied forms are up to 0.35 mm and 0.14 mm respectively.

Occurrence: In Um Sohringkew River Section, H. monmouthensis occurs commonly in the G. stuartiformis Zone.

Genus Globotruncanella Reiss, 1957

Remarks: Reiss (1957) established genus Globotruncanella based on ‘Globotruncanina cincta’ Bolli. This species, now regarded as synonymous with ‘Globotruncanina havaensis’ Voorwijk (Berggren, 1962; Loeblich and Tappan, 1964; Douglas, 1969b), is intimately related to ‘Rugoglobigerina glaessneri’ Gandolfi and ‘Globotruncanella petaloidea’ Gandolfi. Although Loeblich and Tappan (1964) retained ‘G. havaensis’ in Globotruncanina and considered Globotruncanella a synonym of Globotruncanina, the extraumbilical umbilical aperture in this species prompted others (Berggren, 1962; Bandy, 1967; Postuma, 1971) to refer it to Praeglobotruncanina Bermudez (1952). The latter genus, however, lacks the weekly developed apertural flaps or tegula which are seen in well preserved ‘G. havaensis’. In this aspect G. havaensis group seems parallel to Globotruncanina and Rugoglobigerina. Genus Globotruncanella has been adopted by the author due to unsatisfactory assignment of ‘G. havaensis’—‘G. glaessneri’ group either in Globotruncanina or in Praeglobotruncanina.

As adopted here, Globotruncanella lacks well-formed true keel except in terminal forms, umbilical aperture and prominent rugosities on surface—typical characters of Globotruncanina and Rugoglobigerina and, possess feebly developed tegulla covering extraumbilica-umbilical aperture. Feebly developed tegulla, whenever broken away, give the forms of this genus a typical Praeglobotruncanina appearance. Five species have been ascribed to Globotruncanella in the Um Sohringkew assemblage. These have been grouped as under:

1. High trochospiral, pseudeocarina prominent. (a) Chambers little to moderately compressed and petaloid: G. havaensis (= G. citae = G. petaloidea).
   (b) Chambers much compressed and highly petaloid: G. subpetaloidea.

2. Low trochospiral, pseudeocarina feeble or absent.
   (a) Chambers compressed G. coarctata.
   (b) Chambers subglobular to slightly compressed G. circummodifer.

3. High trochospiral, pseudeocarina absent. Globotruncanella sp. circummodifer (Finlay)

Globigerina circummodifer Finlay, 1940, p. 469.

(fide Ellis and Messoria, 1940 et seq.)
Globotruncanina (Rugoglobigerina) glaessneri glaessneri Gandolfi, 1955, p. 50.
Rugoglobigerina jersensis Olsson 1960, p. 49.

Figured specimen: Figured specimen BF 468 is from sample W-7.

Remarks: This population is intimately related to and possibly derived from Globotruncanella inornata (Bolli), originally described as Globotruncanina inornata by Bolli (1957), which is distinguished by its carinate appearance, curved dorsal sutures, less petaloid chambers and wide umbilicus. The holotype of ‘G. (R.) glaessneri glaessneri’ Gandolfi (1955, pl. 3, fig. 11) is characterised by five chambers in the final whorl, spire lower than the dorsal profile of the last whorl, straight dorsal sutures, smooth test and ‘umbilical aperture or apertures with fine lips’.

In these characters it is distinct from spiroconvex ‘G. (R.) glaessneri subglaessneri’ Gandolfi which has been considered by the author synonymous with G. havaensis. ‘G. (R.) glaessneri glaessneri’ seems to be conspecific with G. circummodifer. Four and half chambered form designated as Rugoglobigerina jersensis by Olsson (1960) also seems to be synonymous with this species. G. petaloidea (Gandolfi), as figured by Govindan (1972), is a very low trochospiral form referable to this species. Population figured as Rugoglobigerina glaessneri (Gandolfi) by El-Naggar (1971b, pl. 15, figs. 1, 4) from Egypt appears to be R. arucae El-Naggar and unrelated to G. circummodifer.
The Meghalayan forms of the species are up to 0.42 mm in diameter and 0.16 mm in thickness. 

Occurrence: In Um Sohringkew River G. circumnodifer occurs sporadically in the G. stuartiformis Zone.

Globotruncana coarctata (Bolli)  
(Pl. IV—7-9)


Figured specimen: Figured specimen BF 469 is from sample W-7.

Remarks: As pointed out by Bolli (1957, p. 55), distinctive features of this species, from G. havanaensis, are its low trochospiral test and five gradually increasing chambers in the last whorl as compared to generally high trochospiral test with rapidly increasing four chambers in the last whorl of G. havanaensis.

The figured specimen is 0.30 mm in diameter and 0.13 mm in thickness.

Occurrence: G. coarctata has been described and figured by Bolli (1957) from the Campanian sequence of Trinidad corresponding to G. stuarti s. l. Zone (Bolli, 1966). G. coarctata is of rare occurrence in the upper part of G. stuartiformis Zone. Apparently this is a somewhat younger occurrence of the species.

Globotruncana havanaensis (Voorwijk)  
(Pl. V—12-17)


Globorotalia pachia Keller 1946, p. 99, (Fide Ellis and Messina, 1940 et seq.)

Globotruncana coarctata Bolli, 1951, p. 197

Globotruncana (Rugoglobigerina) petaloidea petaloidea Gandolfi, 1955, p. 52.

Figured specimen: Figured specimen BF 470 and BF 471 are from sample W-7.

Remarks: Globotruncana havanaensis (Voorwijk) as described originally by Voorwijk (1937, p. 195) is characterised by high trochospiral test and compressed chambers. In the generalised drawing of the holotype compression is not well seen and the form looks very similar to the original drawing of 'Globotruncana (Globotruncana) petaloidea petaloidea' Gandolfi (1955, pl. 3, fig. 13). Globotruncana coarctata (Bolli), figured by Gandolfi (1955) as Globotruncana citae, shows same degree of difference from 'G. petaloidea' as from, 'G. havanaensis'. A good deal of variation is observed in the pseudocarinate high trochospiral Globotruncana population of Mahadeo Formation which are characterised by four to five subglobular to much compressed, gradually increasing petaloide chambers. The forms at globular end are very similar to specimen figured as Globotruncana (Rugoglobigerina) glaesneri subglaesneri by Gandolfi (1955, pl. 3, fig. 9) and compressed forms compare well with the 'Globotruncana citae' Bolli (1951, pl. 35, fig. 4). In light of the gradation observed in the Mahadeo material, this author is inclined to include in Globotruncana havanaensis all populations referred to 'G. (R.) glaesneri subglaesneri' Gandolfi, 'G. (R.) petaloidea petaloidea Gandolfi and 'C. citae' Bolli in the original designation, and subsequently described by various workers from different parts of world. 'Globorotalia pachia' Keller of original designation and subsequent description (Subbotina, 1953) is also a junior synonym of this species.

The Meghalayan forms are up to 0.31 mm in diameter and 0.14 mm high.

Occurrence: In Meghalaya, G. havanaensis occurs commonly in the G. stuartiformis Zone.

Globotruncana subpetaloidea (Gandolfi)  
(Pl. V—18-20)

Globotruncana (Rugoglobigerina) petaloidea subpetaloidea Gandolfi, 1955, p. 52.

Figured specimen: Figured specimen BF 472 is from sample W-7.

Remarks: Gandolfi (1955) pointed out towards two of the main features of this species—lobed periphery and drawout chambers. He related these features to Plumerita hankeivinoides (Brommann). The form illustrated by him in text-figure 8 is low trochospire and much similar to G. coarctata except its extremely lobulate periphery and drawout last two chambers. Its ancestral stock, therefore, seems to be a Globotruncana and not Plumerita hankeivinoides as suggested by Gandolfi (1955). This species seems to have been derived, as suggested by Bandy (1967), from Globotruncana havanaensis.

Forms studied are up to 0.37 mm in diameter and 0.14 mm thick.

Occurrence: The species has been originally described from the Late Campanian—Early Maastrichtian sequence of Colon Shale of northeastern Colombia. G. subpetaloidea is restricted to upper part of G. stuartiformis Zone in Um Sohringkew River.

Globotruncana sp.  
(Pl. IV—13-17)


Figured specimen: Figured specimens BF 466 and BF 467 are from sample W-7.

Description: Test of small to medium size, high trochospiral; equatorial periphery rounded, entire to slightly lobulate, axial periphery rounded; all chambers visible on spiral side, numbering about twelve to fourteen, arranged in a high trochospire of about three whorls, four chambers in the last whorl; spiral sutures distinct, slightly depressed, intercameral sutures gently curved outwards and backwards; four semiglobular chambers seen on the
ventral side; ventral sutures depressed, deep, slightly curved; umbilicus rather wide, deep; aperture umbilical-extra-umbilical bordered by a distinct lip and covered by feeble tegilla; surface smooth in the Um Sohryngkew material except small areas of slight rugosity. Dimensions of the studied material: Diameter up to 0.25 mm; thickness up to 0.21 mm.

Remarks: Globotruncanaella sp. looks somewhat similar to Rugoglobigerina rotundata Bronnimann due to its high trochospiral coiling. However, it is distinguished from R. rotundata by its smaller size, nearly smooth to feebly rugose test, extraumbilical extensions of umbilical aperture and weakly developed tagilla.

Berggren (1962) figured a small high trochospiral form, rarely occurring in the upper Maastrichtian of Scandinavia, as Rugoglobigerina cf. rotundata Bronnimann and considered it as a juvenile form of R. rotundata. It, however, differs from R. rotundata by its smaller size and "apparent lack of meridional ornament". Its surface rugosity, as may be made out from figures of Berggren (1962, pl. 13, fig. 2), is similar to but lesser than the Scandinavian specimens of G. havanensis figured by Berggren (1962, pl. 7, fig. 1), suggesting its close relationship with genus Globotruncana. A very similar high trochospiral form has also been figured by El-Naggar (1971b) as Rugoglobigerina (Archeoglobigerina) sp. from Egyptian Maastrichtian. The Meghalayan population is invariably smooth although some forms show slight rugosity in some parts of the test. In lack of sufficient material for further studies no new name is suggested here for this species.

Forms are up to 0.25 mm in diameter and 0.21 mm in thickness.

Occurrence: This widely distributed but uncommon species is restricted to Maastrichtian in Europe and North Africa, it seems (cf. Berggren, 1962; El-Naggar, 1971b). In Um Sohryngkew River Section it occurs sporadically in the upper part of G. stuartiformis Zone.

Family: Globotruncanidae Brotzen, 1942
Genus: Globotruncanana Cushman, 1927

Remarks: Globotruncanana is represented in the Cretaceous sequence of Um Sohryngkew River by unincarinate forms constituting G. rosetta—G. stuart group. Dalbiez (1955, p. 63) stressed the need for a complete revision of this group in view of confusion in the diagnoses of species and their conflicting ranges. Inconsistency in the identification, range and morphological characters of these populations could not be solved even in two decades after Dalbiez's remarks. The causal factors, here, are: first “these species are closely related and often there are intermediate forms making a typological approach to identification difficult” (Barr, 1972, p. 24); and, second “there are factual and philosophical differences in species concept” (Van Hinte, 1969, p. 258). A unanimous agreement on these species is rather difficult and criteria laid down by one worker for one species of this group often overlap on the second species of the other worker. The following tentative basis has been adopted for classifying G. rosetta—G. stuart group in Meghalaya.

1. Equatorial periphery
   (a) Ventral chambers much lobate; dorsal sutures curved; chambers of last whorl petaloïd.
   (b) Ventral chambers elevated around umbilicus, depressed towards the sutures and periphery; keel mostly smooth; G. rosetta.

2. Equatorial periphery entire; rounded or angular; dorsal sutures of the last whorl straight; keel beaded.
   (a) Chambers on the spiral side of last whorl tri-angular: G. stuartiformis.
   (b) Chambers on the spiral side of last whorl trapezoidal: G. stuarti.

Globotruncanana elevata (Brotzen)
(Pl. VI—4-6)

Rotaia elevata Brotzen, 1934, p. 66 (fide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 473 is from sample W-7.

Remarks: In the synonymy of Globotruncanana elevata, author has included unincarinate un-equally biconvex forms with a distinctly lobed periphery and five to seven chambers in the last whorl which show limbate intercameral sutures and petaloïd chambers on the dorsal side. Their nearness to G. stuarti is obvious and Subbotina (1953), Berggren (1962) and Govindan (1972) preferred to include some of the morphotypes in G. stuarti. Cushman (1946) included some unincarinate globotruncanids, e.g., G. rosetta in his Globotruncanana arca (Cushman). One of his figured specimens of G. arca from Anona Chalk (Campanian) of Gulf Coastal Region may be referred to this species. Dupueble (1969) has figured some forms of this species under G. falsostuarti Sigal. G. falsostuarti is characterised by double keels, fusing in the middle part of each chamber as pointed out by Postuma (1971), hence figured specimens of Dupueble could be referred to G. elevata.

Meghalayan specimens are up to 0.52 mm in diameter and 0.27 mm in thickness.

Occurrence: In Um Sohryngkew River it occurs commonly throughout G. stuartiformis Zone.
Globotruncana rosetta (Carsey)
(Pl. V—21-23)

Globigerina rosetta Carsey, 1926, p. 44.

Figured specimen: Figured specimen BF 474 is from sample W-7.

Remarks: Transitional forms between G. rosetta and G. gansseri Bolli (1951) occur in Meghalaya but G. gansseri (forma typica) is absent. The specimen illustrated by Govindan (1972, pl. 5, figs. 20-22) as G. gansseri is transitional between G. rosetta and G. gansseri; and, better retained in G. rosetta. G. rosetta (Carsey) of Rao, Mungain and Sastry (1968) is a spiroconvex form with nearly flat ventral side and horse-shoe shaped ventral sutures. It could better be placed as Globotruncana fomicata Plummer (1931).

Forms of this species are up to 0.52 mm in diameter and 0.18 mm in thickness.

Occurrence: In Um Sohryngkew River G. rosetta occurs sporadically in the G. stuartiformis Zone.

Globotruncana stuarti (De Lapparent)
(Pl. IV—17-20)

Rosalina stuarti De Lapparent, 1918, p. 11, (fide Ellis and Messina, 1940 et seq.)

Figured specimen: Figured specimen BF 475 is from sample W-7.

Remarks: Forms figured by Nagappa (1959) as G. stuarti, from the Mahadeo Formation, possess triangular chambers and are best referred to G. stuartiformis.

Specimens from Mahadeo Formation are up to 0.55 mm in diameter and 0.27 mm in thickness.

Occurrence: Nagappa (1959) has placed the occurrence of this species in the Meghalayan Cretaceous. However this species is reported from the basal part of Langpar Formation by Govindan (1972, p. 77). This report, appears erroneous since the species is restricted to G. stuartiformis Zone of Mahadeo Formation. The species occurs commonly throughout G. stuartiformis Zone.

Globotruncana stuartiformis (Dalbeye)
(Pl. V—1-3)

Globotruncana (Globotruncana) elevata stuartiformis Dalbeye, 1955, p. 169.

Figured specimen: Figured specimen BF 476 is from sample W-7.

Remarks: Diameter of the recorded specimens is up to 0.54 mm and their thickness up to 0.25 mm.

Occurrence: In Meghalaya G. stuartiformis is of common occurrence in the upper member of the Mahadeo Formation. From here it was figured as G. stuarti by Nagappa (1969). Disappearance level of the species marks top of the Cretaceous in Um Sohryngkew River.

Genus Rugoglobigerina Bronnimann, 1952

Rugoglobigerina macrocephala Bronnimann
(Pl. IV—21-23)


Figured specimen: Figured specimen BF 477 is from sample W-7.

Remarks: Main distinction of this species from R. ornata is its consistent smaller size. Small forms of R. rugosa group, designated as R. arvae by El-Naggar (1971b), show good gradation with R. macrocephala and figured with in many cases (cf. Berggren, 1962, pl. 12, fig. 5; El-Naggar, 1971b, pl. 14, figs. 2, 4 12-14; Govindan, 1972, pl. 3, figs. 19-21). The author prefers to restrict R. macrocephala for four to four and half chambered smaller Rugoglobigerina showing rapidly increasing chambers in last whorl. Others, exhibiting somewhat regular increase in the chambers of last whorl, like R. rugosa, and possibly the dimorphs of R. rugosa may be placed within R. arvae El-Naggar (1971b).

Forms from Um Sohryngkew River are up to 0.23 mm in diameter and 0.15 mm in thickness.

Occurrence: R. macrocephala is a characteristic Maas- trichtian species (Bandy, 1967; Berggren, 1962; El-Naggar, 1971b). It occurs in G. stuartiformis Zone of Um Sohryngkew River.

Rugoglobigerina ornata Bronnimann
(Pl. VI—7-9)

Rugoglobigerina macrocephala ornata Bronnimann, 1952, p. 27.

Figured specimen: Figured specimen BF 478 is from sample W-5.

Remarks: R. ornata was recognised as subspecific population by Bronnimann (1952), distinct species by Gandolfi (1953) and El-Naggar (1971), and, synonymous with R. macrocephala by Berggren (1962). Its consistent large size and strongly developed ornamentation distinguish it from typical R. macrocephala hence it has been recognised as a distinct species in the Mahadeo material. R. macrocephala and R. ornata, however, seem to be A and B forms, respectively, of a single dimorphic population.

Diameter of the studied forms up to 0.39 mm and thickness up to 0.27 mm.

Occurrence: R. ornata occurs frequently in the G. stuartiformis Zone of the Therria area.

Rugoglobigerina pilula Belford
(Pl. VI—10-12)

Rugoglobigerina pilula Belford, 1960, p. 92.

Figured specimen: Figured specimen BF 479 is from sample W-7.

Remarks: In its characters this species is close to R. pennyi Bronnimann, from which it is distinguished by
its smaller size, fewer chambers in the last whorl and smaller umbilicus.

*R. pilula* measure up to 0.30 mm in diameter and 0.12 mm in thickness.

**Occurrence:** The sporadic Meghalayan occurrence of *R. pilula* is from Late Maastrichtian *G. stuartiformis* Zone of Therria area.

*Ruggoglobigerina rotundata* **BRONNIANN**

*(Pl. VI—16-18)*

*Ruggoglobigerina rugosa* rotundata Bronnmann, 1952, p. 34.

**Figured specimen:** Figured specimen BF 480 is from sample W-7.

**Remarks:** Although rare in occurrence, *R. rotundata* Bronnmann is a readily distinguished species in Um Sohryngkew assemblage because of its high spiroconvex test, moderate to large size, five chambers in the last whorl of which last is smaller than the penultimate one, and, a deep umbilicus. Some of the large high spired forms figured by Subbotina (1953) as *Rotundina ordinaria* may be referred to this species. Berggren (1962) has figured a small spiroconvex *'Ruggoglobigerina'* rarely occurring in the White Chalk (upper Maastrichtian) of Denmark and considered it to be juvenile form of *R. rotundata*. It has been now referred to *Globotruncana* sp. by the author. Dupuebel (1969) has figured a high trochospiral *Ruggoglobigerina* from upper Maastrichtian of Western Aquitaine and referred it to *R. rugosa*. This form is more appropriately placed as *R. rotundata*.

In the studied forms diameter is upto 0.38 mm and thickness up to 0.28 mm.

**Occurrence:** In Um Sohryngkew River Section *R. rotundata* occurs sporadically in the upper part of *G. stuartiformis* Zone.

*Ruggoglobigerina rugosa* **(PLUMMER)**

*(Pl. VI—13-15)*


**Figured specimen:** Figured specimen BF 481 is from sample W-5.

**Remarks:** In the *R. rugosa* from Um Sohryngkew River, dorsal side of the last-whorl is lightly convex due to inflation of chambers and extends above the spire. This character is displayed not only by the type figures of Plummer (1926) but also by the specimens figured by Bolli, Loeblich and Tappan (1957) and a number of illustrations provided by El-Naggar (1971b). Two forms illustrated by El-Naggar *(loc. cit., pl. 1, fig. 3 ; pl. 3, fig. 2)* are quite small and could be referred to *R. arcuae* El-Naggar. Berggren (1962) suggested that *R. ordinaria* (Subbotina), designated initially as *Rotundina ordinaria*, by Subbotina (1953), is partly a junior synonym of *R. rugosa*. This view has not been supported by Bandy (1967) who holds *R. ordinaria* to be a distinct species. Characteristic difference between *R. rugosa* *(forma typica)* and *R. ordinaria* lies in the height of the spire. In *R. rugosa* the spire is either in level with or lower than the dorsal side of the last-whorl. In *R. ordinaria*, excluding some of the very high trochospiral forms referable to *R. rotundata* Bronnmann, spire is invariably above the last-whorl. The same feature is shown by the Scandinavian population of *"R. rugosa"* figured by Berggren (1962) and doubtfully referred to *R. rugosa* by El-Naggar (1971b). The author recognizing *R. ordinaria* as distinct from *R. rugosa*, prefers to refer such forms to *R. ordinaria*.

Studied forms from Um Sohryngkew River are up to 0.37 mm in diameter and 0.22 mm in thickness.

**Occurrence:** The species occurs frequently in *Globotruncana stuartiformis* Zone of Um Sohryngkew River.

*Ruggoglobigerina scotti* **(BRONNIANN)**

*(Pl. VI—19-21)*

*Trinitella scotti* Bronnmann, 1952, p. 57.

**Figured specimen:** Figured specimen BF 482 is from sample W-7.

**Remarks:** The medium-sized low trochospiral Meghalayan form possessing flat dorsal side, slightly lobulate equatorial periphery, about fourteen chambers arranged in two and half whors, five to five and half gradually increasing chambers in last whorl, and with a pseudocarin in last few chambers are included here. El-Naggar (1971b) has figured a good number of *Ruggoglobigerina* characterised by flat dorsal side, five and a half to six chambers in the last-whorl and angular periphery in the last one or two chambers. These have been named by him as *Ruggoglobigerina* bronnmanni. Some of these (e.g. pl. 12, fig. 2) are very similar to the American forms of *R. scotti* figured by Bolli, Loeblich and Tappan (1957) from the Navarro Formation and Tunisian specimen illustrated by Postuma (1971). El-Naggar (1971b) observed that *R. bronnmanni* shows a certain degree of similarity to *R. scotti*, although it is much larger in size and lacks the compressed and keeled later chambers. Bolli, Loeblich and Tappan (1957) noted the absence of keel in the latter species. Accordingly *R. bronnmanni* is treated as a junior synonym of *R. scotti*.

Original designation of genus *Trinitella* Bronnmann (1952) with *T. scotti* as type species, was based on globigerine chambers and angled periphery of this species, giving it an appearance between *Ruggoglobigerina* and *Globotruncana*. Although placed under *Ruggoglobigerina* by Bolli, Loeblich and Tappan (1957), *Trinitella* has been adopted by Loeblich and Tappan (1964b) as a valid genus. El-Naggar (1971b, p. 484) suggested that forms with angled periphery merge imperceptibly into the
Cretaceous Foraminifera of Um Sohringkew River Section

Typical Rugoglobigerine population; hence, Trinitella should be placed in Rugoglobigerina as its junior synonym. Accordingly, the species has been included in the Rugoglobigerina here.

The Meghalayan forms are up to 0.32 mm in diameter and 0.17 mm in thickness.

**Occurrence**: The present record appears to be first Indian occurrence because the species is noted for its absence in the Coromandel Coast (Govindan, 1972, p. 165). In Um Sohringkew River it is restricted to higher horizons of Globotruncanana stuartiformis Zone where it occurs rather commonly.

**Family** Loxostomidae Loeblich and Tappan, 1964.

**Genus** Coryphostoma Loeblich and Tappan, 1962.

*Coryphostoma plaita* (Casey)

*(Pl. II—6)*

*Bolivina plaita* Casey, 1926, p. 26

**Figured specimen**: Figured specimen BF 483 is from sample W-3.

**Remarks**: Studies forms are up to 0.50 mm long, 0.17 mm broad and 0.10 mm thick.

**Occurrence**: This species is restricted to *G. stuartiformis* Zone in Um Sohringkew River.

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**References**


Ghosh, A. M. N. 1940. The stratigraphical position of *Cherria* Sand-


EXPLANATION OF PLATES

PLATE I

1-2 Haplophragmoides glabra Cushman and Waters
Specimen BF 429, x75
1, Side view ; 2, peripheral view.

3-4 Haplophragmoides kirkii Wickenden
Specimen BF 430, x75
3, Side view ; 4, peripheral view.

5-6 Orbostyntoides trinitatensis Cushman
Specimen BF 431, x65
5, Side view ; 6, peripheral view.

7-9 Navellina joosquinii Giry and Rat
Specimen BF 432, x20
7, spiral view ; 8, umbilical view ; 9, apertural view.
10-11 Gaudryna bronni (Reuss)
Specimen BF 435, x 40
10, side view; 11, apertural view.

12-13 Eggertella sp.
Specimen BF 438, x 80
12, side view; 13, apertural view.

14-15 Trinitatrilatera (Cushman)
Specimen BF 436, x 35
14, side view; 15, apertural view.

16-17 Spiroplectammina semiconplanata (Carsey)
Specimen BF 434, x 75
16, side view; edge view.

18-19 Dorothia oxycon (Reuss)
Specimen BF 437, x 65
18, side view; 19, apertural view.

20-21 Triplusia cushmani (Alexander and Smith)
Specimen BF 433 x 70
20, side view; 21, apertural view.

Plate II

1-2 Pseudopodotamia manifesta (Reuss)
Specimen BF 439, x 80
1, side view; 2, apertural view.

3-4 Brizalina treiosa (Cushman)
Specimen BF 440, x 140
3, side view; 4, apertural view.

5 Brizalina incrassata (Reuss)
Specimen BF 441, x 110
Side view.

6 Coryphostoma plaita (Carsey)
Specimen BF 483
Side view.

7 Guembelitria cretacea Cushman
Specimen BF 442, x 220
Side view.

8-14 Guembelitriella postcretacea Pandey sp. nov.

8-10 Paratype BF 444, x 200
8, spiral view; 9, side view; 10, apertural view.
11-14 Holotype BF 443, x 190
11-15, side views; 14, apertural view.

15-16 Heterohelix navarroensis Loeblich
Specimen BF 448, x 200
15, side view; 1,6 edge view.

17-18 Heterohelix globulosa (Ehrenberg)
Specimen BF 447, x 200
19, side view; 20, edge view.

19-22 Heterohelix plummerae (Loetterle)
19-20 Specimen BF 450, x 160
19, side view; 20, edge view.

21-22 Specimen BF 451, x 100
21, side view; 22, edge view.

Plate III

1-3 Pseudoguembelia punctulata (Cushman)
Specimen BF 460, x 130
1, side view; 2, edge view; 3, apertural view.

4-5 Pseudoguembelia costulata (Cushman)
Specimen BF 459, x 150
4, side view; 5, edge view.

6-7 Heterohelix pseudocaryae Pandey n. sp.
Specimen BF 452, x 115
6, side view; 7, apertural view; 8, edge view.
9-10 *Heteronelix elegans* (Rzehak)
Specimen BF 445, ×105
9, side view; 10, edge view.

11-12 *Planoglobulina acrutilinoides* (Egger)
Specimen BF 454, ×100
11, side view; 12, apertural view.
13, side view; 14, apertural view.

13-14 *Planoglobulina fructicosa* (Egger)
Specimen BF 455, ×115
13, side view; 14, apertural view.

15-17 *Gublerina cavillieri* Kikoine
15-16; Specimen BF 457, ×100
15 side view; 16, apical view.
17: Specimen BF 458, under transmitted light, ×100

18-19 *Gublerina acuta* de Klasz
Specimen BF 456, ×105.
18, side view; 19, apical view.

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**Plate IV**

1-2 *Heterohelix navarroensis* Loeblich
Specimen BF 449, ×140
1, side view; 2, edge view.

3-4 *Heterohelix striata* (Ehrenberg)
Specimen BF 453, ×170
3, side view; 4, edge view.

5-6 *Heterohelix glabrata* (Cushman)
Specimen BF 446, ×150
5, side view; 6, edge view.

7-9 *Globotruncana scoriacea* (Bolli)
Specimen BF 469, ×150
7, aporal view; 8, umbilical view; 9, peripheral view.

10-12 *Globotruncana circonvoluer* (Finlay)
Specimen BF 468, ×105
10 spiral view; 11, umbilical view; 12, peripheral view.

13-17 *Globotruncana* sp.
13-15 Specimen BF 466, ×150
13, spiral view; 14, umbilical view; 15, peripheral view.
16-17 Specimen BF 567, ×155
16, umbilical view; 17, peripheral view.

18-20 *Globotruncana stuarti* (de Lapparent)
Specimen BF 475, ×75
18, spiral view; 19, umbilical view; 20, peripheral view.

21-23 *Rugoglobigerina macrocephala* Bronnimann
Specimen BF 447 ×120
21, spiral view; 22, apertural view; 23, peripheral view.

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**Plate V**

1-2 *Plankomalina cf. baxteri* (Gandolfi)
Specimen BF 461, ×100
1, side view; 2, peripheral view.

3-4 *Globigerinelloides asperus* (Ehrenberg)
Specimen BF 462, ×100
3, side view; 4, peripheral view.

5-6 *Globigerinelloides subcarinatus* (Bonnimann)
Specimen BF 464, ×115
5, side view; 6, peripheral view.

7-8 *Globigerinelloides messeinae* (Bonnimann)
Specimen BF 463, ×100
7, side view; 8, peripheral view.

9-11 *Hedbergella monmouthensis* (Olsson)
Specimen BF 465, ×80
9, spiral view; 10, umbilical view; 11, peripheral view.
12-17 *Globotruncana katanensis* (Voorwijk)
12-14: Specimen BF 470, ×105
12, spiral view; 13, umbilical view; 14, peripheral view.
15-17: Specimen BF 471, ×110
15, spiral view; 16, umbilical view; 17, peripheral view.

18-20 *Globotruncana subpetaloidea* (Gandolfi)
Specimen BF 472, ×125
18, spiral view; 19, umbilical view; 20, peripheral view.

21-23 *Globotruncana rigida* (Carsey)
Specimen BF 474, ×125
21, spiral view; 22, umbilical view; 23, peripheral view.

**PLATE VI**

1-3 *Globotruncana stuartiformis* Dalbix
Specimen BF 476, ×110
1, spiral view; 2, umbilical view; 3, peripheral view.

4-6 *Globotruncana elevata* (Brotzen)
Specimen BF 473, ×125
4, spiral view; 5, umbilical view; 6, peripheral view.

7-9 *Rugoglobigerina ornata* Bronnimann
Specimen BF 478, ×120
7, spiral view; 8, umbilical view; 9, peripheral view.

10-12 *Rugoglobigerina pilula* Belfour
Specimen BF 479, ×110
10, spiral view; 11, umbilical view; 12, peripheral view.

13-15 *Rugoglobigerina rugosa* (Plummer)
Specimen BF 481, ×115
13-15: Specimen BF 480, ×115
17, spiral view; 14, umbilical view; 15, peripheral view.

16-18 *Rugoglobigerina rotundata* Bronnimann
Specimen BF 480, ×135
16, spiral view; 17, umbilical view; 18, peripheral view.

19-21 *Rugoglobigerina scotti* (Bromann)
Specimen BF 482, ×180
19, spiral view; 20, umbilical view; 21, peripheral view.