THE MICROPALEONTOLOGY OF THE MIDDLE TRIASSIC TO UPPER MIOCENE SEDIMENTS OF SERAM, EASTERN INDONESIA

by

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SHAIBAN K. AL-SHAIBANI, DAVID J. CARTER and LOUISETTE AZNINETTI (1982)
Geological and Micropaleontological investigations in the Upper Triassic (Asinepe Limestone) of Seram, Outer Banda Arc, Indonesia (part 2). Revue de paleontologie, no. 3 (in press).

ILLUSTRATIONS

ABSTRACT

The geology of Seram may be described in terms of three principal stratigraphical structural elements (Figs. 10, 11, 12): (1) Para-autochthon (Australian facies), (2) Allochthon (Asian facies), and (3) Autochthon (Post-orogenic facies). Only the first two elements are dealt with here.

The Para-autochthon is interpreted as a subducted extension of northwest Australian Continental margin below the Asian Allochthon. Three stratigraphical divisions of Formation status comprise this element: (a) The Nief Beds (Late Jurassic - Late Miocene), (b) The Wakuku Beds (Early Triassic - Jurassic), and (c) The Saman Saman Limestone (Triassic). The Para-autochthon is highly deformed and imbricated.

The allochthonous element is composed of several different thrust sheets of igneous, metamorphic and sedimentary rocks and an olistostrome. These are interpreted as having been originally derived from the southeast Asian margin during the Cretaceous. The convincing stratigraphical support for the presence of major overthrust faulting in Seram is the close juxtaposition of rocks of the same age but different facies (FIG. 16 and 17). Only the Asinepe Limestone (Norian S.L.) is dealt with here.

A total of 203 samples from four stratigraphical units, namely, the Nief Beds, the Wakuku Beds and the

Asinepe Limestone were collected from seven traverses in Central and East Seram (FIG. 2-9). The samples were examined under the microscope as crushed residues and in thin section, mainly for Foraminiferal analysis.

A total of 178 species and subspecies of stratigraphically important foraminifera were identified; 159 planktonic Foraminifera from the Nief Beds (Table, 1, 3, 5), and 19 benthonic species from the Asinepe Limestone (Table 10). These are referred to 5 suborders, 5 superfamilies, 19 families, 15 subfamilies and 39 genera. In the chapter dealing with the systematic paleontology, a description and illustration of each species is given together with its abundance, distribution, faunal association, stratigraphical occurrence, and range. The microfossils (mainly benthonic Foraminifera) from the Upper Jurassic to Lower Cretaceous portion of the Nief Beds, the Saman Saman Limestone and the Wakuku Beds are not reliable age indicators and have been identified mostly to generic level (Table 7 & 9).

The planktonic Foraminifera of the Nief Beds indicate deposition during the Cretaceous, Paleocene, Eocene and Miocene periods in a deep bathyal (Slope & Rise) environment (Table 1, 3, 5). The presence of corroded Radiolaria in the Upper Jurassic to Lower Cretaceous portion of the Nief Beds indicate deposition close to the compensation depth for silica at about 4,000 meters.

The benthonic Foraminifera and other microfossils, and the siliciclastic nature of the sediments of the Wakuku Beds indicate deposition in low energy, moderately deep marine environments.

The fine grain-size of the sediments, and the planktonic microfossils (mainly Radiolaria) of the Saman Saman Limestone indicate deposition in very deep marine water beyond the shelf.

The Calcareous bioclastic nature of the Asinepe Limestone, its benthonic Foraminifera and other microfossils reveal deposition during the Norian S.L. in a warm, reefal to sublagoonal environment (Table 10).

ACKNOWELDGEMENTS

The author is deeply indebted to Mr. D.J. Carter of Imperial College for suggesting the project, providing the samples and maps, his general supervision and advice, and reading the Manuscript.

Particular thanks are also due to Dr. J.E. Whittaker of the British Museum (Natural History), London, and Professor L. Zanninetti of the Department of Geology, University of Geneva, Switzerland for their fruitful and valuable discussion on the Triassic Foraminifera from Seram.

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CHAPTER 1

INTRODUCTION

The Project

The project suggested by D.J. Carter, Geology Department, Imperial College, involves a description and a re-evaluation of the age of the fossil Foraminiferal faunas collected from the Island of Seram, eastern Indonesia, in 1975 by the London University Seram Expedition. Its project is to provide a reliable chronological framework into which the tectonic events in the island, which is of extreme structural complexity, may be fitted by subsequent workers.

Geographical Location of Seram

Seram is an east-west elongated island (400 km x 75 km), about 860 km north of Australia and 250 km west of New Guinea (FIG. 1). It is one of the islands which forms the eastern end of the Outer Banda Arc (eastern wing of the Indonesian Archipelago).

Previous Work

Detailed geological information relating to the geology of Seram is sparse. The earliest work was connected with the discovery of oil in the Bula area in 1860 and most of the details are in the unpublished

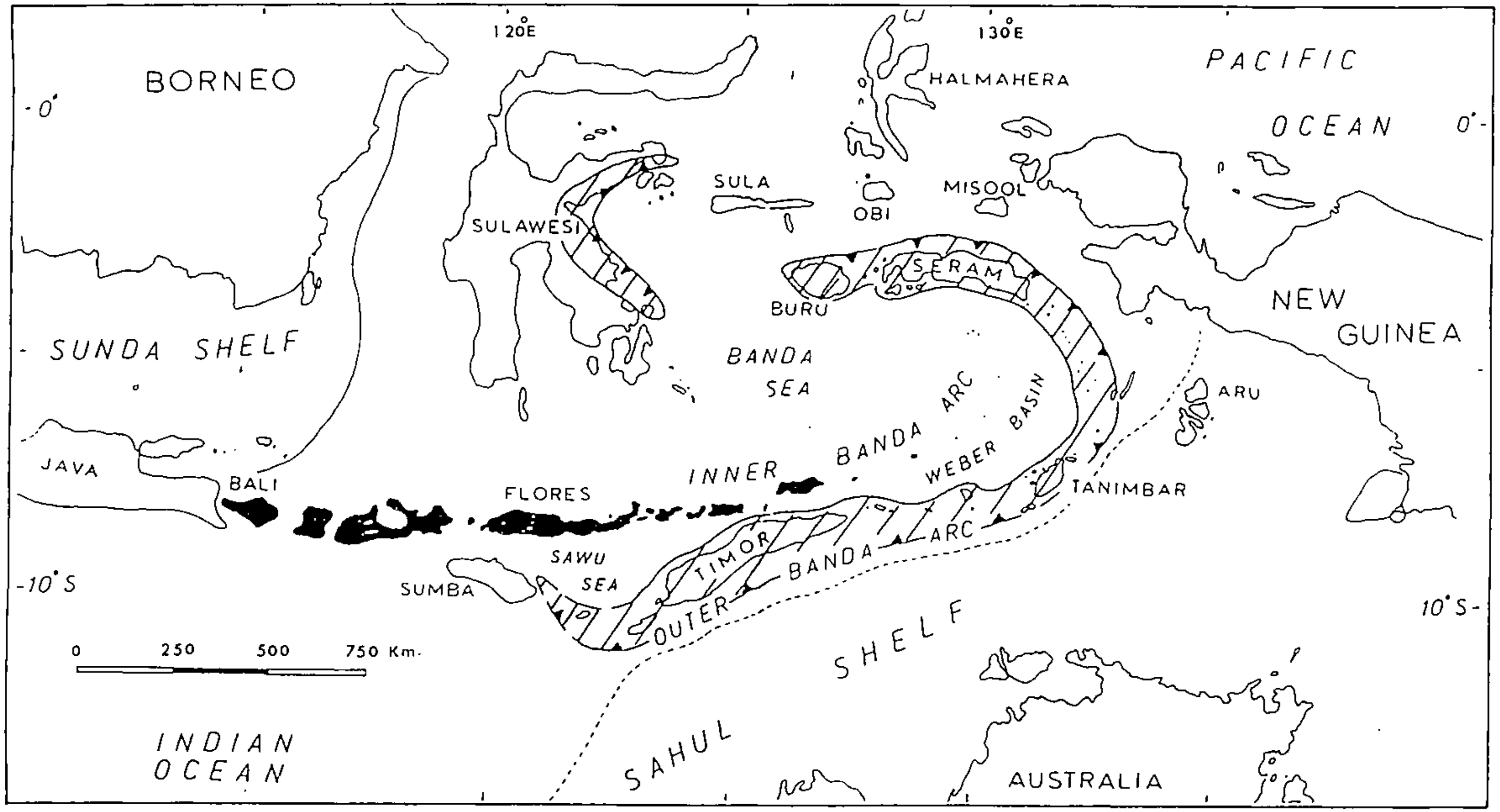


FIG. 1. Location map for Seram and the Banda Arcs, Eastern Indonesia. This map also shows the northern margin of the imbricated zone (A-zone) at the boundary of the imbricate zone with the gently deformed Australian craton and cover. The dotted line marks the edge of the Australian continental shelf. (After Audley-Charles et al., 1979).

■ Neogene Volcanic Arc ▨ Neogene Imbricate Zone ▲ A-Zone reports of Bataafsche Petroleum Maatschappij (B.P.M.). Oil was later discovered in the Bula area on the N. Coast.

The reports by Valk (1945), West Seram, Germeraad (1946), Central Seram, Sluis (1950), east Seram, Bemellen (1949, 1970, p. 72, 78-79, 442-450), Zillman and Paten (1975a, b) and the recent work by Audley-Charles, Carter, Barber, Norvick and Tjokrosapoetro (1979) are the main sources used in this study.

Other published works dealing with the plate tectonics of the eastern Indonesian Archipelago (The Inner and Outer Banda Arcs and the Moluccas), have touched directly or indirectly on the geology of Seram. These publications are more numerous and utilise a variety of models. They include the work of Audley-Charles (1968, 1981), Audley-Charles and Carter (1972, 1978), Audley-Charles, Carter and Barber (1975), Audley-Charles, Carter and Milson (1972); Barber, Audley-Charles and Carter (1977), Carter, Audley-Charles and Barber (1976), Crostella and Powell (1976), Crostella (1977), Gribi (1973, 1974), Hamilton (1973, 1974), Powell and Mills (1975, In Crostella, 1977), Veevers, Jones and Talent (1971) and other papers. The interpretations by some of these workers of the general framework of tectonism in the Banda Arc have changed with the emergence of new evidence. However, many earlier hypotheses have been confirmed including the postulated overthrusting away from the Banda Sea onto Australian subducted basement and the Late Tertiary, anticlockwise rotation of the eastern part of this arc due to the pressure effect of the south westerly moving pacific plate. Some of these publications give a detailed account of the geology of Timor which is in many aspects a mirror image of that of Seram.

A complete historical review of the geological investigation of Seram prior to (1945-1950) has been given by Valk (1945), Germeraad (1946) and Sluis (1950): Schneider (1951) first reported the presence of phyllites in western Seram.

Rosenberg (1860) indicated the occurrence of oil in the region of Bula Bay.

Martin (1897) recorded Quaternary and Neogene deposits from Wahai in north central Seram. He observed Triassic, Cretaceous and Eocene rocks along a traverse from near Pasanea in the north to the Bay of Elpapoetih in the south. Mica Schist and Amphibolite were recorded by Martin (op. cit.) from South of the Loemoete mountains. He also named the Wallace mountains, and studied the coastal regions of Piru Bay, West Seram.

Schroeder Van der Kolk (1899-1902) studied part of the material collected by Martin (1897). He recognized the "Cordierite Province" in West Seram, and described granite without cordierite from central Seram.

Verbeek (1900) reported many types of rocks from east Seram including Mesozoics, serpentine, Lepidocyclina-Limestone and young, elevated coral reefs. He studied the cause of the earthquake of September 30, 1899, and traced faults to the north and south of the Wallace mountains.

Verbeek (1908) gave an outline of the geology of the Molucca. He recognized a fault through Hoamoal in Western Seram.

Wanner (1907) worked on some Triassic fossils from Bula Bay, and indicated the possible occurrence of alpine structure in east Seram.

Deninger (1914, 1918) gave a morphologic sketch map of Seram. He recognized gneiss and schist as the lowest part of a sequence followed above by a graywacke-flysch facies and a coralligenous limestone. He also recognized the presence of Inoceramus-Radiolarian marls.

Rutten and Hotz (1918-1920) outlined the geology of Seram, and collected a large number of samples from the eastern central and western part during their "Seram Expedition".

Brouwer (1919) indicated the possibility of the presence of a large overthrust in the chasm of the Nief river.

Zwierzycki (1925) mentioned the presence of flysch and "fatu-like" limestones in Seram.

Many papers dealing with the paleontology of the material collected by Wanner (1907), Verbeek (1908), Brouwer (1919) and Rutten and Hotz (1918-1920) were published during the period from 1908-1950. These papers dealt with the Triassic Radiolaria (Hinde, 1908); Oligocene and Pliocene Corals (Dollfuss, 1908); Hydrozoa

(Gerth, 1910); Miocene or Pliocene Corals (Grosch, 1910); Pliocene Mollusca and Foraminifera (Fischer, 1921, 1927); Upper Triassic Brachiopoda, Lamellibranchiata and Gastropoda of Central Seram (Krumbeck, 1923); Triassic Dasycladaceae (Pia, 1923); Triassic Ammonites (Welter, 1923); Young Tertiary Corals (Umbgrove, 1924), Young Tertiary Foraminifera (Koch, 1925); Triassic Corals (Wanner, 1928); Jurassic Mollusca (Wandel, 1936); Upper Triassic Corals and Calcispongia (Wilckens, 1937); Upper Jurassic Foraminifera (Wanner, 1940); Upper Triassic, Jurassic and Pliocene-Pleistocene Foraminifera of West Seram (Valk, 1945, Chapter in a published report on West Seram); Upper Cretaceous to Recent Foraminifera, mostly of the benthonic habit, and Young Neogene to Recent Ostracoda of central Seram (Germeraad, 1946, chapter in a published report on central Seram), and Cretaceous - Tertiary Foraminifera of east Seram (Sluis, 1950, included in the stratigraphy of east Seram). Comments on the relevant taxa recorded by these authors (notably by Valk (1945), Germeraad (1946) and Sluis (1950)) are given under the chapters dealing either with stratigraphy or the systematic paleontology as approrpriate. However, most of the Foraminifera recorded are benthonic and not important from the stratigraphic point of view, and many of the samples on which this early work was based were collected from loose float in the rivers or from blocks from an olistostrome.

It is worthwhile to mention that *Stomiosphaera* Wanner, 1940 and *Cadosina* Wanner, 1940 were included by this author in the Foraminifera. These two genera are regarded now as "problematica". However, the two forms seem to be restricted to Upper Jurassic - Lower Cretaceous rocks.

Other palaeontological papers include those on Tertiary Crinoidea from east and central Seram (Sieverts, 1933) and the Jurassic and Triassic Miospores and Phytoplankton assemblages of east Seram (Price, 1976).

The presence of Rhaetian, Norian and Carnian limestone in Central Seram was indicated by Krumbeck (1923), Wanner (1928, 1931) and Wilckens (1937). Krumbeck (op. cit.) record a limestone with Halobidae. Wilckens (op. cit.) pointed out that the faunas are alpino-Triassic and the limestone is of shallow water origin related in facies and habit to the fatu-limestones of Timor. These limestones are equivalent to the Saman-Saman and Asinepe limestones of Audley-Charles et al. (1979). Wanner (1931) also recorded the presence of "Upper Cretaceous" rocks with *Globotruncana*, *Guembelina* and *Globorotalia* in Central Seram.

Using the sample collections and the diary of the "Seram Expedition" by Rutten and Hotz (1918-1920) and other publications, important reports have been published on the geology of western Seram (Valk, 1945), Central Seram (Germeraad, 1946) and eastern Seram (Sluis, 1950). (The stratigraphic units recognized by the above authors and their relationship to the units suggested by Audley-Charles et al. (1979) are given in the chapter dealing with the geology and stratigraphy of Seram). The work of Bemmelen (1949, 1970, p. 72, 78, 442-450) dealing with the geology of Seram is primarily based on these reports.

The paper by Audley-Charles, Carter, Barber, Norvick and Tjokrosapoetro (1979), is a major revision of the published stratigraphy, structure and tectonic history of Seram. According to this work Seram can be divided into four principal stratigraphical-structural elements. These from the base to top;

1. Metamorphic Continental basement complex.
2. An entirely marine Early Triassic-Upper Miocene imbricate succession regarded as para-autochthonous (Australian facies). Three informal divisions of Formation status were suggested:
    a. The Nief Beds (Late Jur. - Late Miocene).
    b. The Saman-Saman Limestone (Triassic).
    c. The Wakuk Beds (Early Triassic - Jurassic).
3. An allochthon composed of several different thrust sheets and an Olistostrome. These are regarded as an Asian in origin. They include:
    a. The Asinepe Limestone (Up. Triassic).
    b. Kaibobo Complex (probably Triassic in part).
    c. Tehoru Formation (possibly Paleozoic in part).
    d. Kobipoto Complex (possibly Pre-Cambrian in part).
    e. The Salas Block Clay (a Neogene Olistostrome).
    f. The Serpentinites and igneous rocks of West Seram.
4. A Pliocene-Pleistocene post-orogenic autochthon.

Zillman and Paten (1975a, b) mainly concentrated on the petroleum prospects of the Pliocene-Pleistocene sediments of the Bula and Wahai basins. They formally described the Fufa Formation (Pleistocene) and the Wahai Beds (Pliocene-Pleistocene). According to them, the term "Fufa Formation" was used initially by the Bataafsche Petroleum Maatschappij to refer to the whole of the Pliocene-Pleistocene sequence. They gave a brief summary of the oil exploration in this island carried out by the various oil companies since 1897 including the Bataafsche Petroleum Maatschappij.

Gribbi (1973, 1974) discussed the general framework of the tectonic elements in the Moluccas. He related the origin of the oil producing Pliocene-Pleistocene basins in northern Seram to the S-shaped fossil subduction zone extending from Timor, through Seram, Buru and Sulawesi.

Sample Collections

The present investigation is based on a faunal analysis (mainly of planktonic and benthonic Foraminifera) of 203 samples collected by M.G. Audley-Charles (Queen Mary College), D.J. Carter (Imperial College) and M.S. Norvick (B.P. Development Ltd.) in the course of their work on reconnaisance geologic field traverses (FIG. 2) in Seram during the end of August and September, 1975. These samples were provided by D.J. Carter (Supervisor). This work is part of a larger project carried out by an expedition which consisted of Dr. M.G. Audley-Charles, Dr. A.J. Barber (Chelsea College), Mr. D.J. Carter, Dr. J.S. Milsom (Queen Mary College), Dr. M.S. Norvick and members from the Indonesian Geological Survey. This expedition was sponsored by the Indonesian Geological Survey and financed by the Natural Environment Research Council and BP Development Ltd. with the co-operation of the A.A.R. Ltd. in Bula, Seram. The work of this expedition led to major revisions of the published stratigraphy, structure and tectonic history and the production of a geological sketch map (Audley-Charles et al., 1979).

Because of the complex tectonics in Central and eastern Seram, the presence of imbricated thrust faults, deformations, landslides and shear zones, few of the samples treated here were obtained from long continuous stratigraphical sequences. Consequently, some of these samples contain tectonically mixed Foraminifera of different ages. A few of the samples are of loose floats.

Microscopic examination revealed that these samples are referable to the Miocene (52 samples); Eocene (7 samples); Paleocene (12 samples); Cretaceous (34 samples); Lower Cretaceous - Upper Jurassic (36 samples) and the Triassic - Early Jurassic (62 samples) (see Tables 1, 3, 5, 7, 9, 10).

The samples were collected from seven geologic traverses between Lat. $2^{\circ}45'S \rightarrow 3^{\circ}20'S$ and Long. $129^{\circ}E-130^{\circ}30'E$ (FIG. 2). Three traverses were from central Seram (FIGS. 3 - 5), sampled by M.G. Audley-Charles and M.S. Norvick, and four traverses were from the north

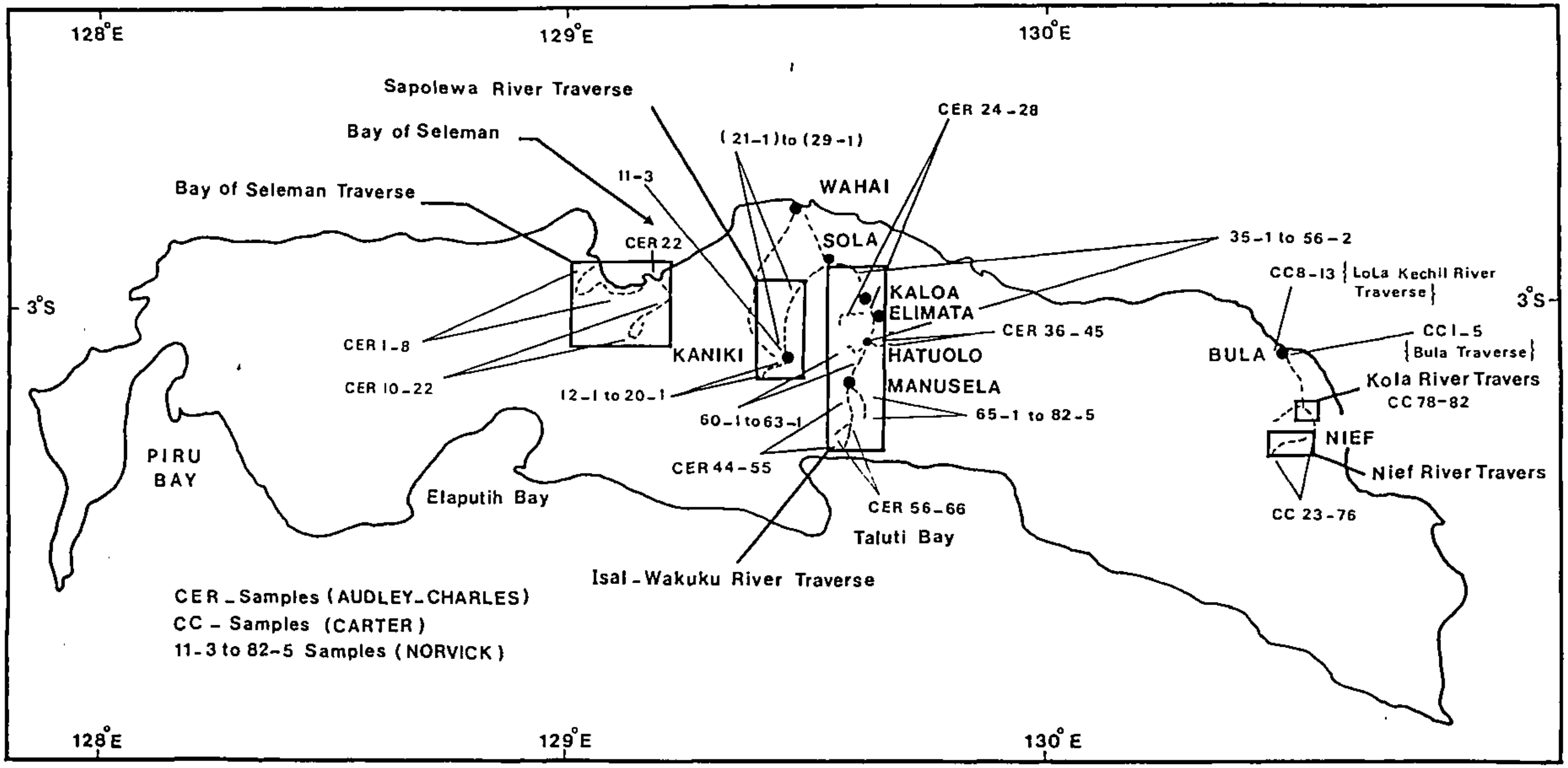


FIG. 2. Location map of sample traverses in Seram. (After Audley-Charles et al., 1979). Bay of Seleman Traverse CER.1 -CER. 22 Sapolewa River Traverse (12-1) to (29-1) Isal-Wakuku River Traverse (35-1) to (82-5) and CER.24 to CER.66 Bula Traverse C.C.1-5 Lola Kechil River Traverse C.C.8-13 Nief River Traverse C.C.23-76 Kola River Traverse C.C.78-82.

east part of Seram (FIGS. 6-9), sampled by D.J. Carter. The Bula, Lola Kechil and Kola River traverses were traced from D.J. Carter's field notes while the rest are from 1/100,000 sample location maps of central and east Seram provided by D.J. Carter.

1- Bay of Seleman Traverse (FIG. 3)
   Co-ordinate Limit: between Lat. $2^{\circ}27'$S - $3^{\circ}1'$S and $129^{\circ}1'$E - $129^{\circ}11'$E, central Seram. The name is taken from the Bay of Seleman. The Samples (CER. 1-22) were collected by M.G. Audley-Charles.

2- Sapolewa River Traverse (FIG. 4)
   Co-ordinate Limit: between Lat. $3^{\circ}1'$S - $3^{\circ}9'$S and Long. $129^{\circ}26'$E - $129^{\circ}28'$E, central Seram. The name is taken from the river Sapolewa (= Wai Sapolewa). The samples (12-1 to 29-1) were collected by M.S. Norvick.

3- Isal-Wakuku River Traverse (FIG. 5)
   Co-ordinate Limit: between Lat. $3^{\circ}2'30''$ S - $3^{\circ}16'$ S and Long. $129^{\circ}32'30''$E - $129^{\circ}39'$E, central Seram. The name is taken from the rivers Isal and Wakuku (= Wai Isal and Wai Wakuku). The samples (35-1 to 82-5) and (CER. 24 - CER. 66) were collected by M.S. Norvick and M.G. Audley-Charles respectively.

4- Bula Traverse (FIG. 6)
   This small traverse is along the road leading to the exploration office in Bula. The name is taken from Bula in the north east of Seram. The samples (C.C. 1-7) were collected by D.J. Carter.

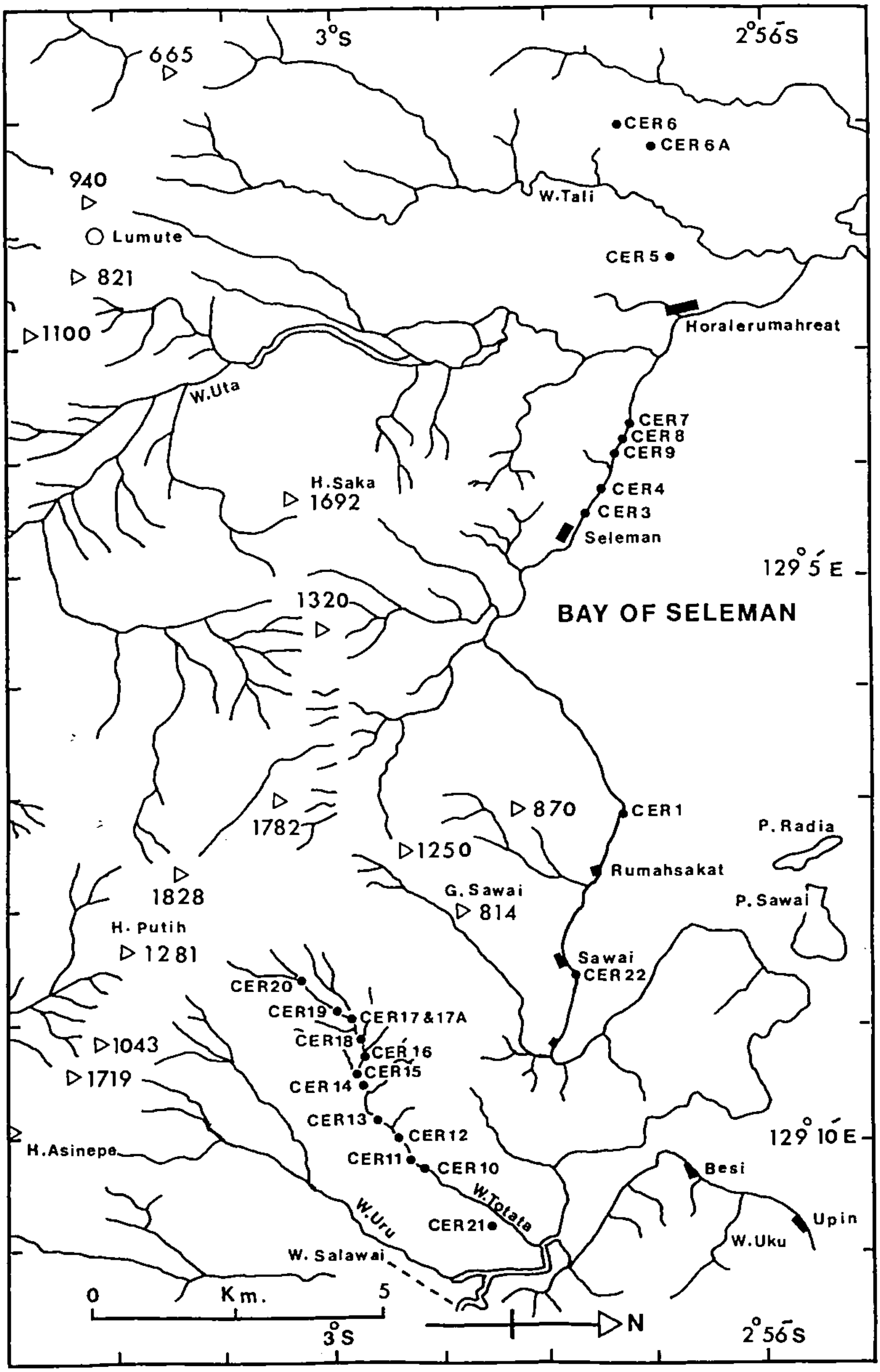


FIG. 3. Bay of Seleman Traverse. Samples CER. 1-CER. 22. W.=Wai=River. G=Gunung=Mountain. △ Height in metres.

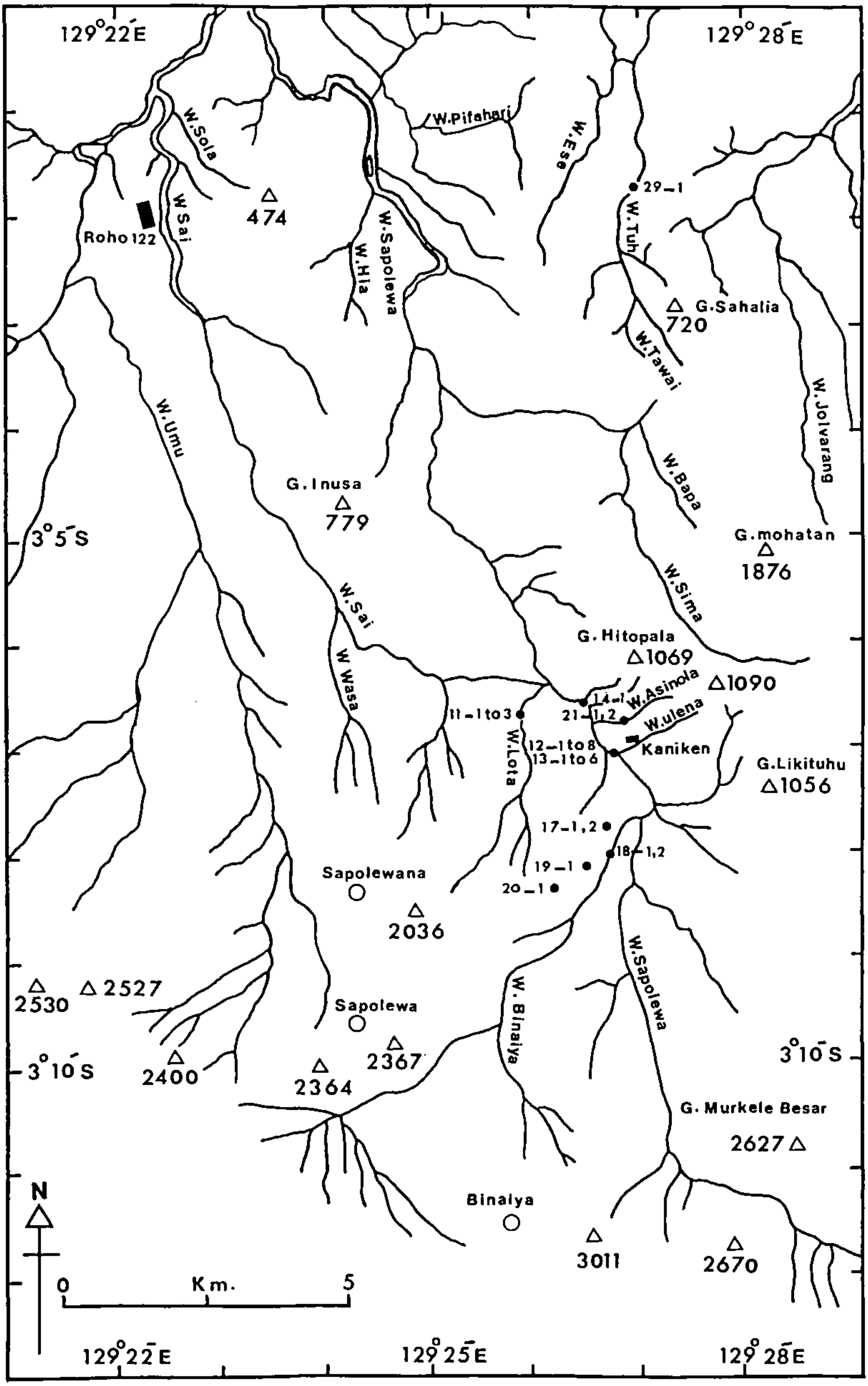


FIG. 4. Sapolewa River Traverse. Samples (12-1) to (29-1).
W=Wai=River. G=Gunung=Mountain. △ Height in metres.

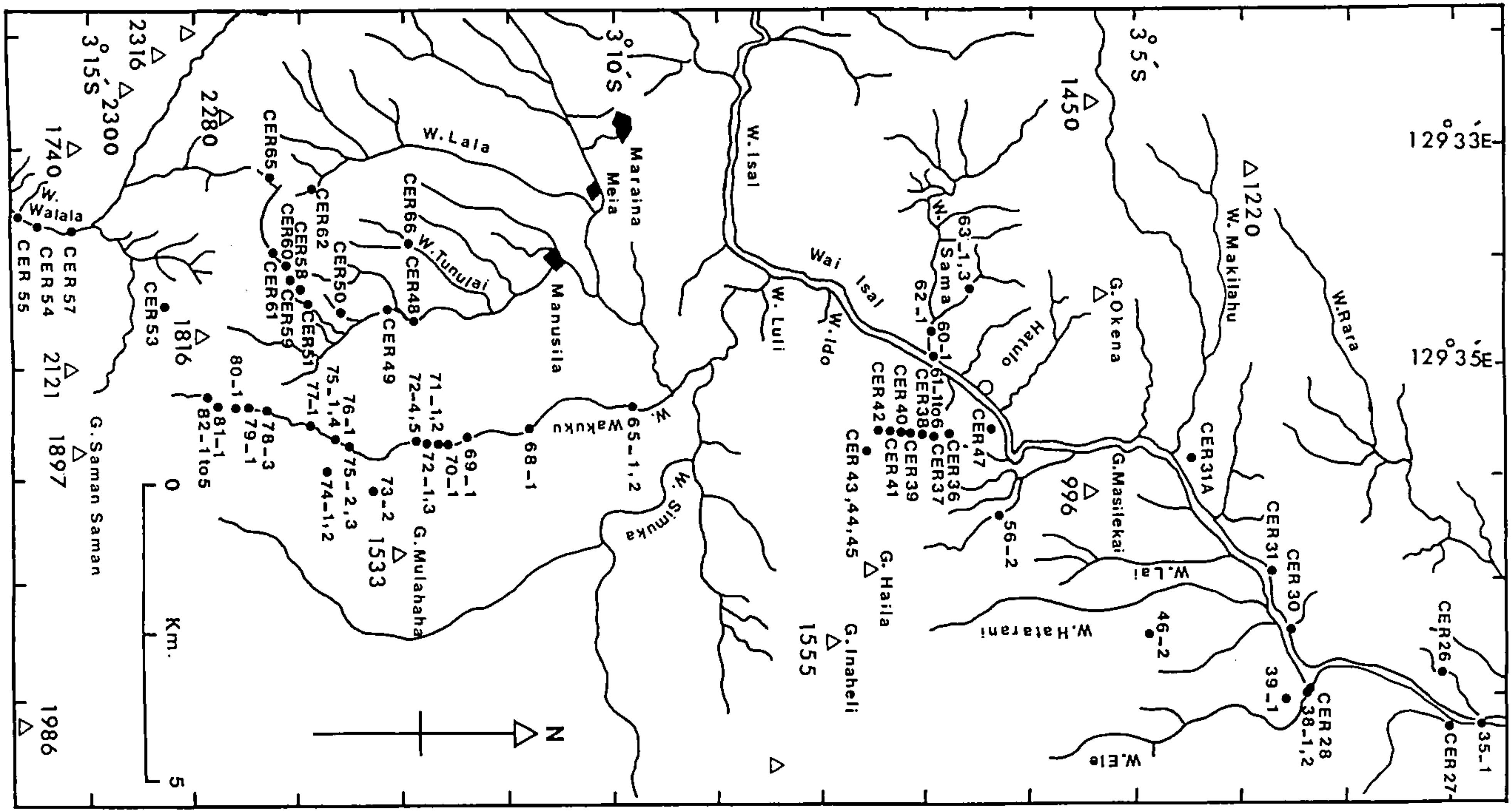


FIG. 5. Isal-Wakuku River Traverse. Samples (35-1) to (82-5) and CER. 24 to CER. 66. W=Wai=River G=Gunung=Mountain

△ Height in metres.

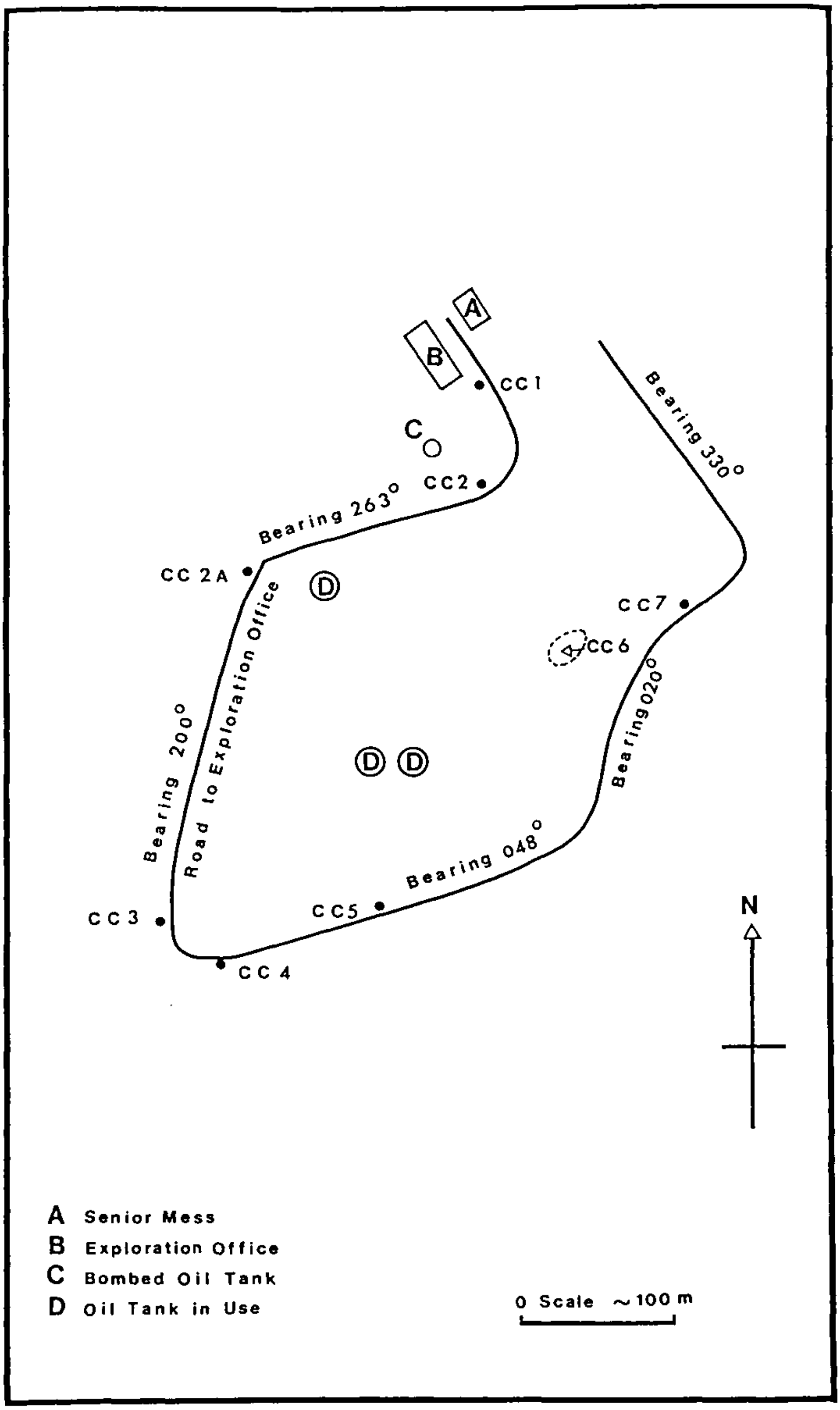


FIG. 6. Sketch map of Bula Traverse. Samples C.C.1-7.

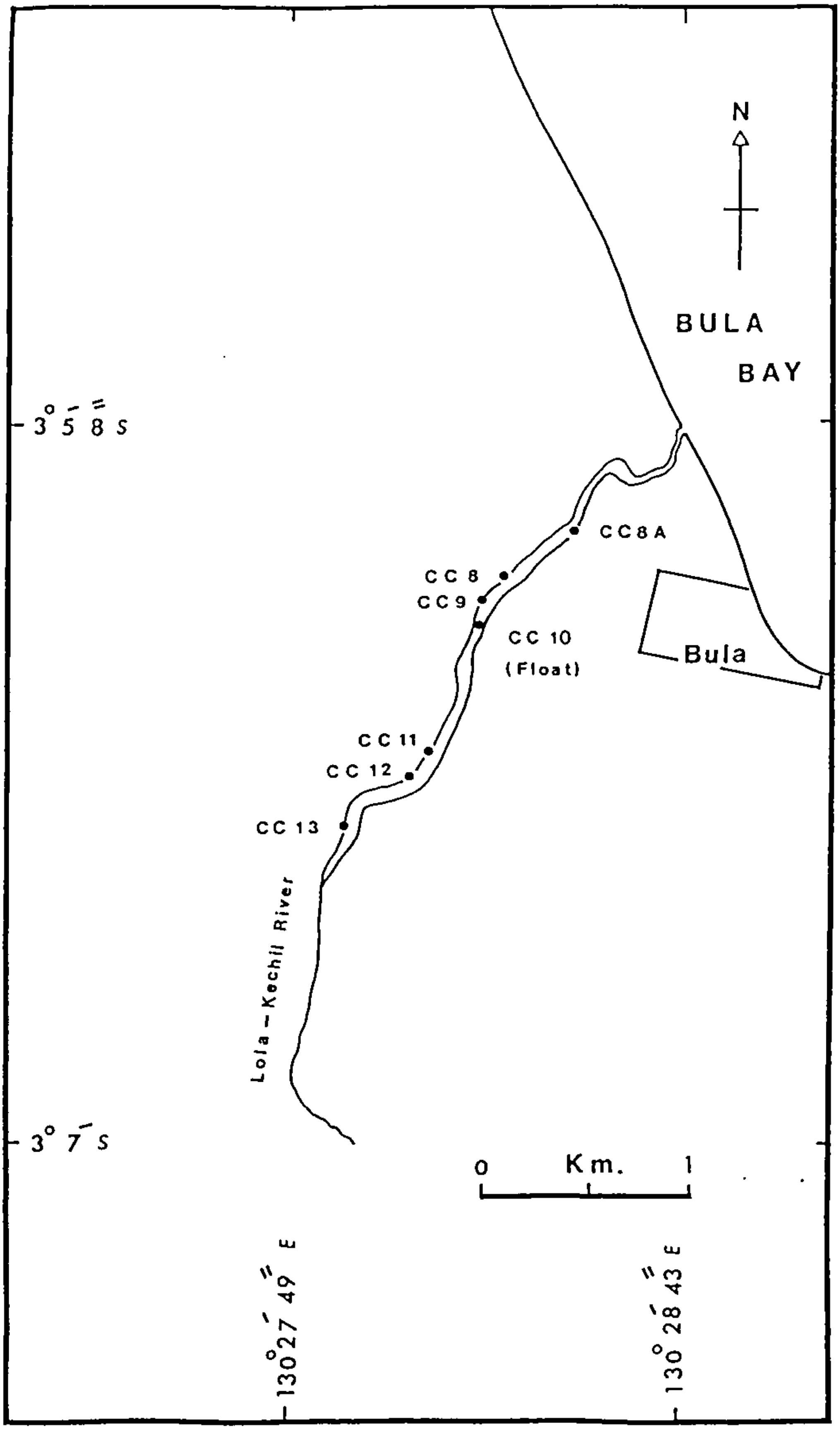


FIG. 7. Lola Kechil River Traverse. Samples C.C. 8-C.C. 13.

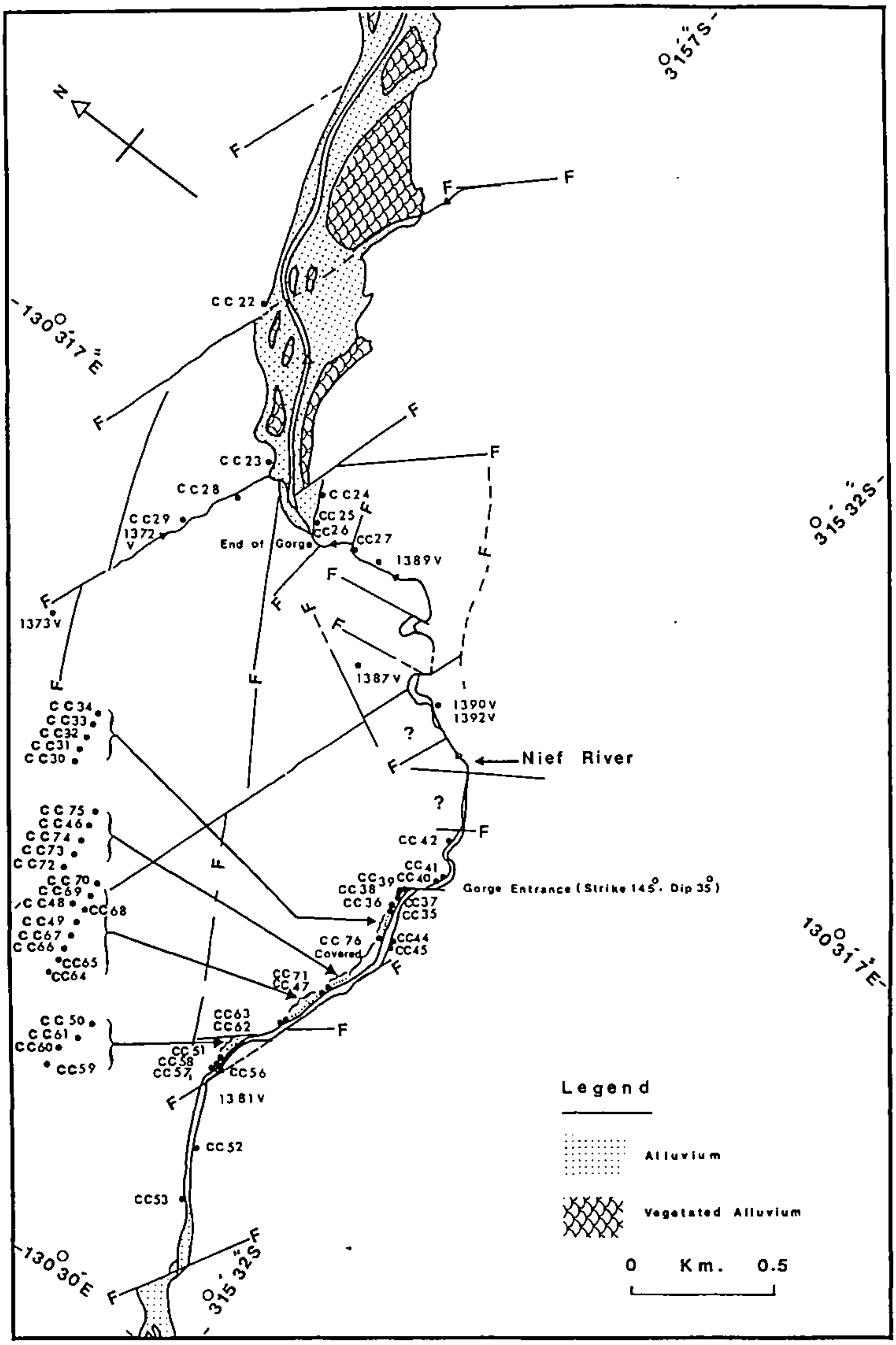


FIG. 8. Nief River Traverse. Samples C.C.23-C.C.76.

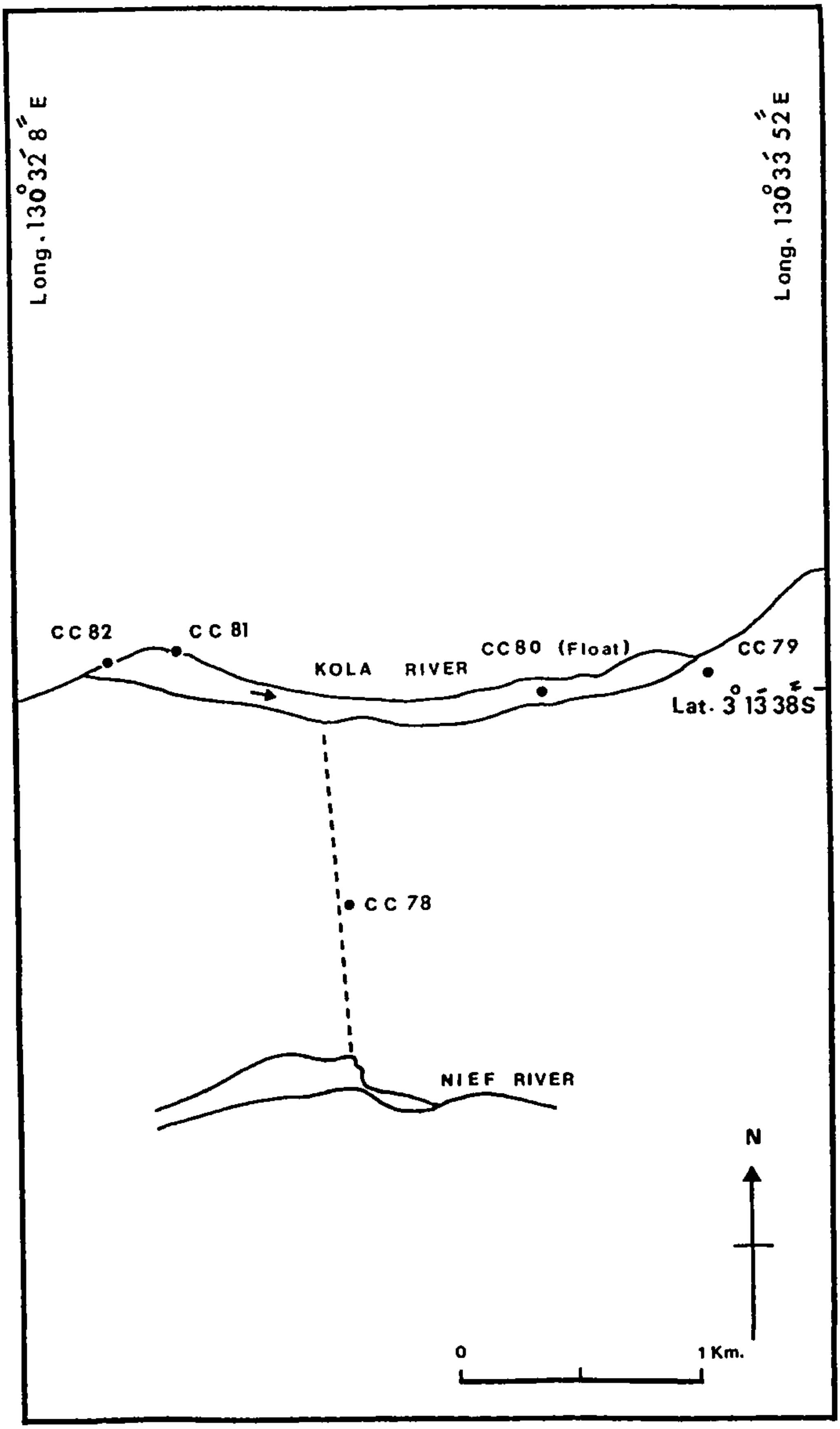


FIG. 9. Kola River Traverse. Samples C.C.78-C.C.82.

5- Lola Kechil River Traverse (FIG. 7)
Co-ordinate Limit: between Lat. $3^{o}5'8''S - 3^{o}6'30''S$ and Long. $130^{o}27'49''E - 130^{o}28'43''E$, north east Seram. The name is taken from the Lola Kechil river (= Wai Lola Kechil). The samples (C.C.8A-C.C.13) were collected by D.J. Carter.

6- Nief River Traverse (FIG. 8)
Co-ordinate Limit: between Lat. $3^{o}15'S - 3^{o}15'32''S$ and Long. $130^{o}30'E - 130^{o}31'7''E$, north east Seram. The name is taken from the Nief river (= Wai Nief). The samples (C.C. 23 - C.C. 76) were collected by D.J. Carter.

7- Kola River Traverse (FIG. 9)
Co-ordinate Limit: along Lat. $3^{o}13'38''E$ and between long. $130^{o}32'8''E - 130^{o}33'52''E$, north east Seram. The name is taken from the Kola river (= Wai Kola). The samples (C.C. 78 - C.C. 82) were collected by D.J. Carter.

Sample Processing and Method of Study

203 samples were processed for microscopic examination; 95 yielding washed residues and 108 thin sections.

	Washed Residues	Thin Sections
Miocene	38	14
Eocene	5	2
Paleocene	6	6
Cretaceous	1	33
Lower Cret. - Upper Jur.	20	16
Triass. - Lower Jur.	25	37

The 95 samples which were disaggregated consisted of soft marl, red shale, mudstone, micaceous sandstone and siltstone. Almost all the siliciclast samples were from the Wakuku Beds.

These samples were first broken down into small fragments in a mortar, then dried in an oven at 80° C for eight hours, and finally subjected to standard white spirit treatment. After boiling with sodium carbonate the disintegrated sample was washed through a clean 120 mesh (B.S.M.) sieve. The residues after drying were fractioned through 30, 60, 90 and 120 mesh sieves and stored in labelled corked glass tubes pending examination.

The Foraminifera in each sample were picked out with a fine brush under a stereoscopic microscope, and mounted on a 64-cell micro-slides.

All the slides were deposited in the Research Collection of the Micropaleontological Laboratory, Department of Geology, Imperial College.

The procedure for the preparation of thin sections is well known and not dealt with here. Thin sections were prepared from rocks too hard to be satisfactorily disaggregated.

Many oriented thin sections of planktonic foraminifera were made for comparison, study of the internal structure and identification. The technique used to make an oriented thin section was fully described by Pokorny (1963, p. 30) and Allman et al. (1972, pp. 40-46).

A count of the specimens in each sample was made to permit estimation of species abundances. The notation used to indicate relative abundance is as follows:

1 specimen per sample	Very Rare (V.R.)
2-5 specimens	Rare (R.)
6-10 specimens	Common (C.)
11-25 specimens	Frequent (F.)
More than 25 specimens	Very Frequent (V.F.).

The species distribution and abundances for each sample have been tabulated in order of age (see Table 1, 3, 5, 7, 9, 10).

Photography and Method of Presentation

The technique used to photograph solid specimens is different from that used for thin sections.

The matrix free specimens were photographed using the Scanning Electronic Microscope (S.E.M.).

Selected well preserved specimens showing the optimum morphologic features were chosen for each stratigraphically important species. These were washed in deionized water, dried and mounted on standard 13 mm. S.E.M. aluminium adhesive coated stubs in the required orientation. The specimen was coated with gold using a Polaron E 5000 Diode Sputter Coater. The stub and the coated specimen then placed in the S.E.M. and each specimen was photographed in the emissive mode.

The thin section specimens were photographed in transmitted plane polarized light with a Zeiss Photomicroscope III.

In the thesis, the photographs of specimens have been arranged as nearly as possible in the same order as the relevant species in the chapter dealing with the systematic paleontology. They are grouped into 27 plates and each plate contains a maximum of 15 photographs. All the photographs are approximately the same size and hence the size of each specimen is inversely proportional to the magnification. The exact size of each specimen is given in the systematic description of the relevant species.

CHAPTER 2

TECTONIC EVOLUTION AND REGIONAL GEOLOGY OF SERAM

Tectonic Evolution of Seram

The structural and tectonic setting of Seram and the other islands of the Outer Banda Arc are complex and much basic work remains to be done before the geology of Seram is fully understood. The complications can be unravelled only by renewed fieldwork and research. The scarcity of recent published papers, the limited number of observations and samples from some parts of Seram, the limitation of drilling to the oil producing Pliocene-Pleistocene basins, the highly deformed, crushed, imbricated, faulted and thrust condition of the rocks, the absence of long continuous stratigraphical sequences, the multi-orogenic phases and their effects on the structural assessment, the difficulty of making reliable measurements in such rugged terrain and the difficulty of access to its interior, added significantly to the difficulties of geological work. There is little ground between the various geologists and geophysicists concerning the interpretation of the geology and reconstruction of the tectonic history of Seram and other islands of the Banda Arc.

The tectonic complexity of this region relates to its critical location between four lithospheric plates moving in different directions to give the region counter-clockwise rotation (Gribi, 1973, 1974; Hamilton, 1973; Zillman and Paten, 1975a, b; Carter et al., 1976). The plates involved include the Pacific Plate on the northeast, expanding to the southwest (or west-northwestward according to Heirtzler et al. (1968) and Hamilton (1973)); the Indian Plate to the southwest, moving to the northeast; the Australian Continental Crustal Plate to the south, drifting northward and the southeasterly movement of the detached part of southeast Asian Margin (FIG. 1). According to Hamilton (op. cit.), this region is characterized by a constantly changing array of platelets, subduction zones, transform faults, migrating arcs and oroclines. He indicated that the present active seismisity, volcanism and tectonism in the Indonesian region are the products of the motions between these plates.

Many tectonic models have been proposed to fit the various geological features observed in this region into the framework of the plate tectonics. These include the models suggested by Hamilton (1973), Powell and Mills (1975, In: Crostella, 1977), Carter et al. (1976), Crostella (1977), Abbott and Chamalaun (1978), Audley-Charles (1981) and others. All these models are far from complete, and each has its own points of weakness. These models are mainly based on stratigraphy, igneous stratigraphy, metamorphism, geophysics or combinations of these. A detailed analysis of these models is beyond the scope of this thesis and only the relevant parts of the tectonic evolution and geology of Seram will be considered. However, a very brief summary of the basic principle of plate tectonic theory and its evidences will be presented here. This has a direct effect on understanding of the geology, earthquakes, volcanism, deformation, thrusting, faulting, imbrication, metamorphism and mountain building in Seram and the other islands of the Band Arc.

The plate tectonic theory involves a model of the earth in which many lithospheric plates are moving in various directions relative to each other. As they move, they drag with them the continental as well as the oceanic crust. This is the basic principle of sea floor spreading. The growth of the plates is achieved by magmatic activity and flow at the mid-oceanic ridges. These ridges are the former contact lines between the continents. The extensional movements of the plates are compensated by their consumption along the subduction zones (Benioff zone) (FIG. 10). The main tectonic activity on global scale is mainly concentrated on the plate boundaries, while the plates themselves are regarded to be stable.

Consequently, the subject of plate tectonics may be divided into:

1- <u>Zones of active plate formation</u>

This is mainly occurring along the mid-oceanic ridges. These are the sites of abnormally high heat flow. According to Watson (1980), this is achieved by the addition of parallel and symmetrical strips of igneous rocks on either side of the ridge.

2- Zones of active plate destruction (subduction zones):

These usually occur along the subduction zones (FIG. 10). According to the Natural Environment Research Council publications, Series B, no. 7 (1973), these zones include the island arcs (intra-oceanic zones), active boundaries between oceans and continents, and the intra-continental zones. Hamilton (1973) indicated that the plate tectonic evolution of a region can be deduced by following the assumptions that subduction zones are characterized by ophiolite, melange, wild flysch and blue schist. Other features from the Banda Arc islands indicative of this tectonic activity are the volcanic activity, earthquakes, metamorphism, overthrusting, deformation, imbrication, age inversion and others. The subduction stage is followed by a wide range of consequences for the geochemical cycle and the formation of ore deposit as well as overthrusting which is consistent with the plate absorbtion.

3- Transform and Transcurrent faults

These are strike-slip faults characteristic of Mid-oceanic ridges, and the boundaries between the plates.

As has been indicated before, many tectonic models have been proposed to fit the various geological phenomena present in the Molucas The model proposed by Carter et al. (1976), is based largely on stratigraphy of Timor and the other islands of the Banda Arc. The paper by Audley-Charles et al. (1979) is based on this model, and presented a detailed account of the

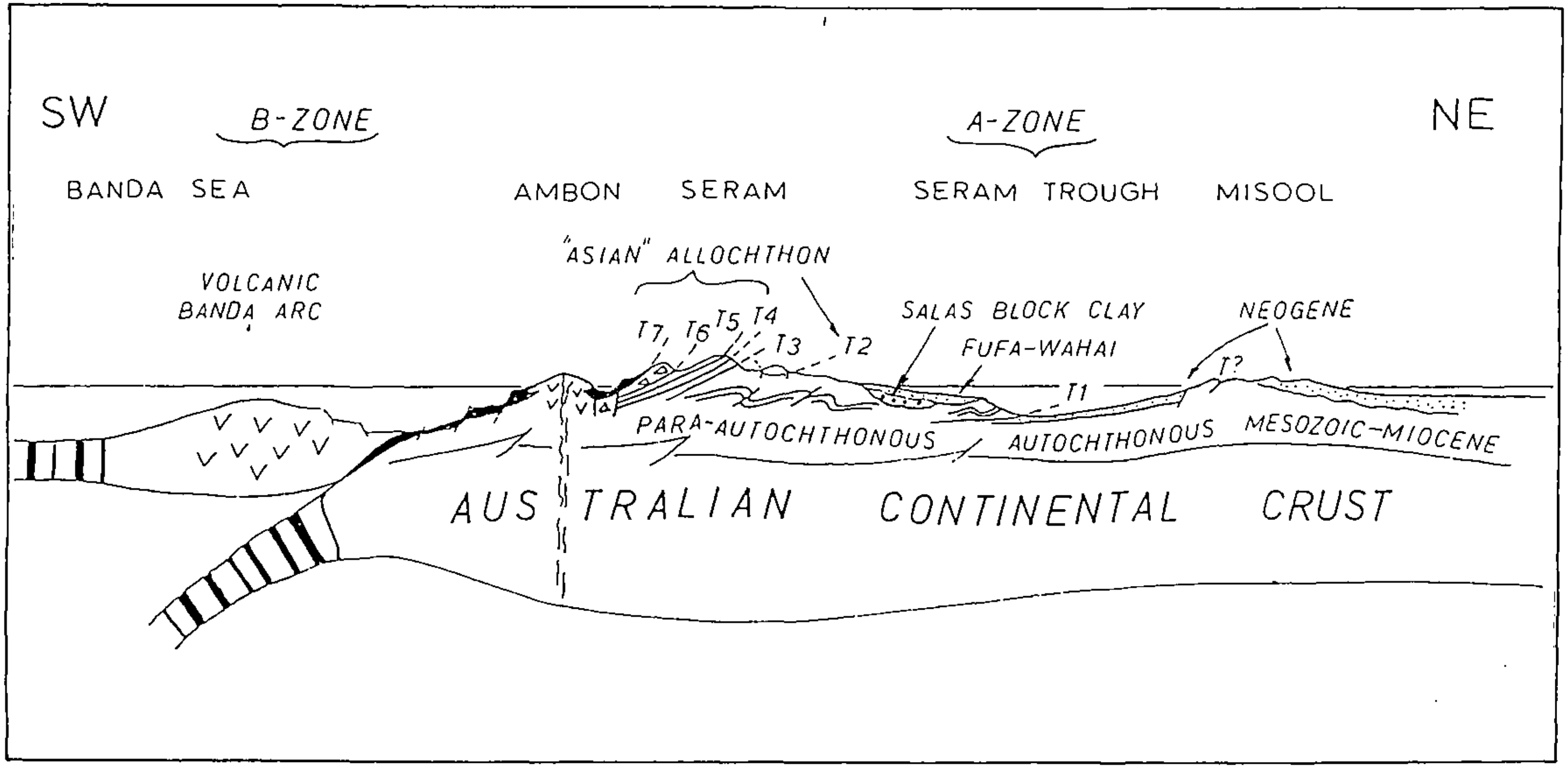


FIG. 10. Schematic cross-section through the volcanic Banda Arc, the Benioff zone (B-Zone), Ambon, Seram, the front and base of the imbricate zone (A-zone) and Misool. T1-6 are the main thrust sheets in Seram. The Pliocene-Pleistocene phase of steep angled faulting have been omitted here. This figure shows a tectonic model of seram region which accords well with the geology of Seram as well as with the general framework of the tectonism in the area. (After Audley-Charles et al., 1979).

various aspects of geology and tectonics of Seram. Both papers will be followed here as they show coherent elements of stratigraphy, geology and tectonism as far as the present knowledge of Seram is concerned. According to these papers, the present structure and stratigraphy in Seram are the result of collision of the northward drifting Australian continental margin and a detached sliver of land from southwest Asia (Sunda margin).

Audley-Charles et al. (1979) discussed the geology of Seram in terms of three main stratigraphical-structural elements; the allochthon (Asian facies), the para-autochthon (Australian facies) and the autochthon (Post-Orogenic facies) (FIG. 10). These three elements have different structural and stratigraphical histories. The allochthonous and the para-autochthonous elements are included in this work in a Pre-Late Cenozoic Orogeny group incorporating all the high tectonized Paleozoic to the Uppermost Miocene rocks affected by the Upper Miocene - Lower Pliocene (Zone 18) Orogenic Climax. The autochthonous element is the post-orogenic sediments which were deposited in a series of marginal basins (FIG. 11, 12) and are not dealt with here.

The allochthonous elements consist of many thrust sheets interpreted as having been originally derived from the southeastern Asian margin during the Cretaceous (Hutchison, 1973; Carter et al., 1976; Audley-Charles, 1978; Audley-Charles et al., 1979). According to Hutchison (op. cit.) and Carter et al. (op. cit.), this detachment has been initiated by transcurrent fault resulting from the northeasterly movement of the Indian Plate and the consequent obliquity of the subduction zone at the Sunda margin. The migration of this detached piece of land towards the northward drifting Australian margin and the southwesterly moving Pacific Plate, was interpreted as the result of two forces; the extensional force of the ocean crust within the transcurrent fault which tends to separate the two sides of the fracture, and the easterly component of the northeasterly moving Indian plate. The extensional force was originally proposed by Karig (1971) for the development of marginal basins.

Carter et al. (1976) linked the origin of the Banda Sea with the detachment of the allochthonous element, its emplacement onto the Australian margin, and the subsequent rotation by the pressure effect of the southwesterly moving Pacific Plate. The rotational movement in the eastern part of the Banda Arc was reported by Audley-Charles et al. (1972), Audley-Charles et al. (1979), Audley-Charles (1981), Carey (1958), Carter et al. (1976) and Green and Pitt (1967).

The tectonic model proposed by Carter et al. (1976) suggests that the Banda Arc acquired its rotation after the overthrust sheets were emplaced onto the subducted Australian basement. This is consistent with the divergent overthrust directions of the allochthonous sheets around the Banda Sea (FIG. 1). Consequently, the thrust sheets have moved northwards in the islands north of the Banda Sea, and southwards in the islands south of it. It appears that the geological and geographical distribution of the greenschist in the islands of the Outer Banda Arc (cf. Audley-Charles, Carter and Milson, 1972), the Pliocene-Pleistocene basins (Gribi, 1973, 1974; Zillman and Paten, 1975 a, b) and the S-shaped fossil subduction zone (Gribi, op. cit.) are also linked with the mechanism of the subduction and the sinuosity of the Banda Arc.

The convincing stratigraphical support for the presence of major overthrust faulting in Seram is the close juxtaposition of rocks of the same age but different facies (Audley-Charles et al., 1979). The paleogeographical reconstruction of such units requires them to have been widely separated at the time of deposition. The same criterion was used to confirm the presence of thrust sheets in Timor and other islands of the Outer Banda Arc (Audley-Charles et al., 1975; Barber et al., 1977; Carter et al., 1976). Such a relationship is clearly illustrated in the Manusella mountains of South Central Seram (FIG. 16) and the Loemoete Mountain range (FIG. 17). The higher structural element is the Asinepe Limestone with a rich lagoonal/reefal warm water fauna (Table 10) interpreted as representing an Asian facies. Comparable faunas were identified from the other islands of the Banda Arc, Sunda Arc, Borneo and Philippine (Audley-Charles, 1974; Carter et al., 1976; Fontaine et al., 1979). Directly underlying the Asinepe Limestone (Allochthonous) is the age overlapping, deep water Saman Saman Limestone (Para-autochthonous) with a Radiolarian-Halobia fauna (Table 9).

The contrast in degree of deformation, structural style, geometrical relationships as illustrated in maps and sections (FIGS. 11-17) between the different rock units can also be used to confirm the presence of overthrust faulting in Seram and the other islands of the Banda Arc. Audley-Charles (1981) cited abundant evidences indicating the presence of large scale overthrusting in the Outer Banda Arc. These are "the inversion of stratigraphical sequences, the presence of high grade metamorphic rocks sitting on serpentinite rafts bounded by unmetamorphosed sedimentary rocks, and the zones of imbrication".

Grady (1975), Grady and Berry (1977) and Chamalaun and Grady (1978) denied the presence of major overthrusting in Seram. According to them the Pliocene-Pleistocene block faulting is the dominant tectonic style. Carter et al. (1976), Barber et al. (1977), Audley-Charles et al. (1979) and Audley-Charles (1981) pointed out that the Pliocene-Pleistocene steep angled block faulting displaced, and thus obscured much of the zone N. 18 thrust faulting in Seram and the other islands of the Banda Arc (FIGS. 11, 12).

Earlier workers have expressed various views as to the presence of overthrust faulting in Seram. Their speculation on presence or otherwise of overthrusting is mainly based on visual assessment rather than micropaleontological, stratigraphical and petrographical analyses of the different rock units. Wanner (1907) indicated the possible occurrence of alpine structure in east Seram. Brouwer (1919) supposed the presence of an important overthrust of Triassic rocks over the Cretaceous. According to Valk (1945), no normal contact with the younger Upper Triassic rocks has ever been found. Germeraad (1946) and Bemmelen (1949) pointed out that some phenomena may point in the direction of the occurrence of a nappe. Sluis (1950), in his geological traverse in east Seram observed a quick change from metamorphic to non-metamorphic rocks and indicated that such features can not be explained without involving anamolous contacts.

The para-autochthonous part of Seram was interpreted as a subducted extension of northwest Australian continental margin (oceanic ?, slope, rise, and shelf deposits) below the Asian allochthon (Audley-Charles et al., 1979). This conclusion is based on a close correlation of the lithology, facies, fauna, microflora and stratigraphical breaks between the Mesozoic-Cenozoic of the northwestern Australian Shelf (Lofting et al., 1975; Powell, 1976) and the Australian Basement reported from Seram (Audley-Charles et al., 1979), Timor (Audley-Charles, 1968, 1978; Carter et al., 1976; Barber et al., 1977) and other islands of the Banda Arc (Audley-Charles et al., 1979, Table 1 and FIG. 9). Evidence from marine geophysical surveys (Cardwell and Isacks 1978) led to the same conclusion, and indicated that the Indian-Australian Plate has underthrust the Eurasia Plate below the south and north sectors of the Banda Arc including Timor and Seram.

The Australian continental margin sediments became deformed by folding and imbrication as they approached the subduction zone. The development of microstylolite and stretching of chert nodules in the Upper Senonian part of the Nief Beds are probably a consequence of such penetrative force. The stratigraphical and structural evidence for the imbrication in the Nief Beds is clearly indicated by the repetition of stratigraphical divisions with some inverted ages in the Loemoete mountain range (FIG. 17) and along the bay of Seleman (FIG. 14). The many repetitions in the sequences indicate that the Nief Beds are structurally thickened. The age of the imbrication was dated as zone N. 18, Upper Miocene - Lower Pliocene (Audley-Charles et al., 1979). This is based on the youngest member of the Australian basement involved in such imbrication (Zone N. 17) and the oldest part of the overlying unimbricated post-orogenic Wahai Beds (Zone N. 19).

The autochthonous element represent post-orogenic sediments deposited in a series of a large and small fringing, Pliocene - Pleistocene basins. The largest of these are the northern basins of Bula and Wahai (Zillman and Patten, 1975b). Renewed tectonic activity and uplift throughout the Banda Arc during the Pleistocene result in steep block faulting which displaced and obscured much of the thrust faulting in Seram (Audley-Charles et al., 1979; Audley-Charles, 1981).

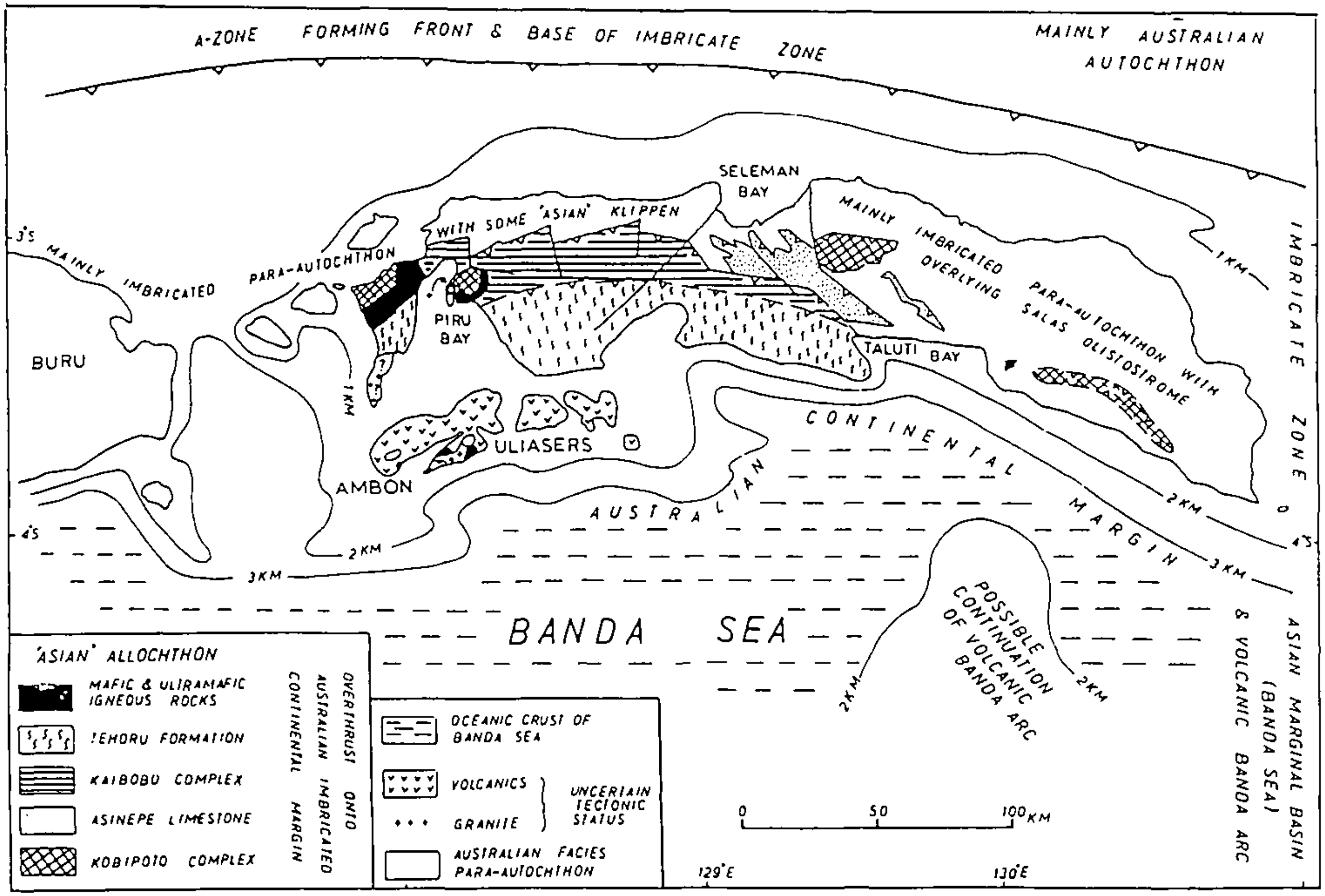


FIG. 11. Geologic sketch map of Seram. Identification of the A-zone follows Bally (1975). It represents the northern margin of the imbricate zone and is based on the reinterpretation of the phillips petroleum seismic reflection Line 143 by Audley-Charles & Carter (1978). (After Audley-Charles et al., 1979).

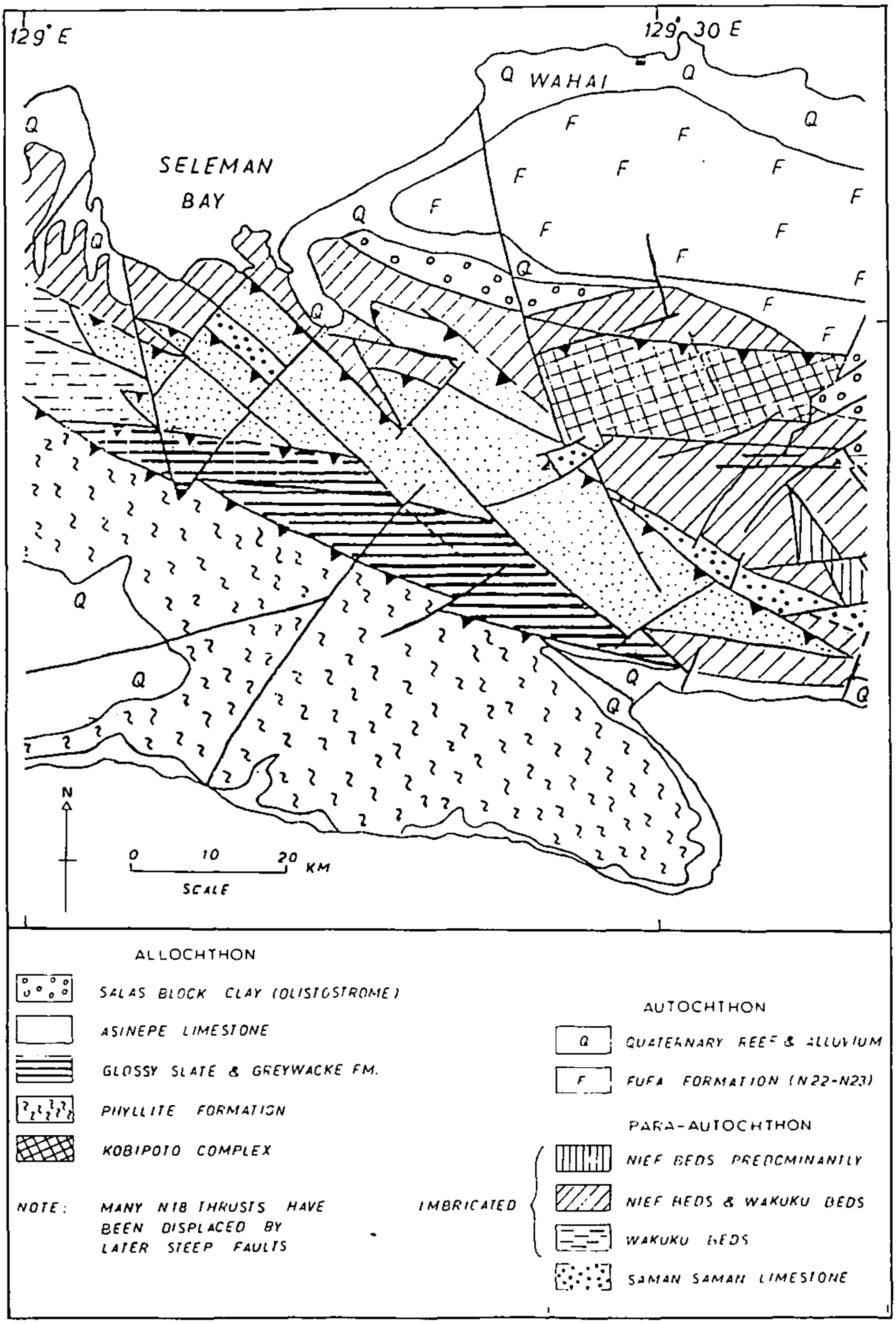


FIG. 12. Geologic sketch map of central Seram. (After Audley-Charles et al., 1979).

Regional Geology of Seram

The publication by Audley-Charles, Carter, Barber, Norvick and Tjokrosapoetro (1979) will be followed here concerning the different aspects of the geology of Seram. The stratigraphical nomenclature of the Pre-Neogene rock units used in this publication is regarded as informal owing to the reconnaissance nature of the investigation and are of Formation status. The Neogene strata were formally described by Zillman and Paten (1975a).

Audley-Charles et al. (1979) described the geology of Seram in terms of three principal stratigraphical structural elements (FIGS. 10, 11, 12):

A- Para-autochthon (Australian facies)) Pre-Orogenic
B- Allochthon (Asian facies)) facies
C- Autochthon - Post-Orogenic facies

The metamorphic continental basement complex which is of uncertain structural status and palaeogeographical affinity is provisionally referred here to the allochthonous element.

The Para-autochthonous element (Triassic - Upper Miocene)

The para-autochthonous facies is a highly imbricated, marine succession consisting of shelf, slope, rise and possibly oceanic sediments. Three new informal stratigraphic divisions of Formation status were suggested:

a- The Nief Beds (Late Jur. - Late Miocene) (FIG. 13)
b- The Wakuku Beds (Early Triassic - Jurassic) (FIG. 15).
c- The Saman Saman Limestone (Triassic) (FIG. 16).

A detailed analysis and description of these divisions will be presented under the section dealing with the stratigraphy of Seram.

The Allochthonous element

Composed of several different thrust sheets of igneous, metamorphic, sedimentary rocks and an Olistostrome:

1- The Asinepe Limestone (Upper Triassic)

The Asinepe Limestone is equivalent in part to the "Younger Upper Triassic" of West Seram (Valk, 1945) and to the "Normal Upper Triassic" of Central Seram (Germeraad, 1946). Detailed description and micropaleontological analysis will be presented under Chapter 3.

2- The Kaibobo Complex (probably Triassic in part)

The Kaibobo Complex is an informal name proposed by Audley-Charles et al. (1979) to incorporate all the rocks referred by early workers (Valk, 1945; Germeraad, 1946) as Triassic "Greywacke and Glossy (or Lustrous) slate Formation", and the crystalline schists, gneisses and amphibolites.

The Kaibobo Complex is composed of:

a- The Greywacke and Glossy Slate Formation

The lithology is predominantly black glossy slate. The limestone slices of the Asinepe and the Saman Saman within the Greywacke and Glossy Slate Formation are tectonically associated (Audley-Charles et al., 1979).

b- High grade metamorphic rocks north of Sahulau (= Valk's "Crystalline Schists")

This is composed of hornblende schists and gneisses, serpentinites and one specimen of garnet-pyroxene granulite.

3- Tehoru "Formation" (= "Phyllite Formation" or "Amphibiolite" in the Wallace mountains of Valk (1945) and Germeraad (1946)).

The Tehoru "Formation" consists of metamorphosed grits and interbedded argillaceous deposits which occupy most of the southern and southwest Seram (FIG. 11, 12).

4- Kobipoto Complex (= Germeraad's "Old Crystalline Schist")

The Kobipoto Complex outcrops in east and west Seram (FIGS. II, 12). It is well developed north of the central valley, forming an upland region called the Kobipoto Massif. In this region, the Kobipoto Complex consists of high grade metamorphic rocks overlain unconformably by unmetamorphosed sedimentary rocks:

a- The metamorphic rocks of the Kobipoto Complex

These consist of many types of high grade metamorphic rocks. Audley-Charles et al. (1979) suggested three possibilities as to the origin of the metamorphic part of the Kobipoto Complex:

1- Asian Origin

2- Australian continental plate origin

3- Upthrust as a horst through the overlying sediments from the Australian basement beneath

b- The unmetamorphosed rocks associated with the Kobipoto Complex

These include the Asinepe Limestone, Wakuku Beds, Wai Tuh Beds (Post-Senonian clastics) and an Early Miocene Limestone. They overlie the Kobipoto Complex unconformably.

5- Salas Block Clay (Olistostrome) (Zone N. 18)

Composed of mixed exotic blocks of different types, sizes and ages, locally with a greyish, scaly, waxy clay matrix. The blocks can be identified with the Nief Beds, Wakuku Beds, Saman Saman Limestone, Asinepe Limestone, volcanic clasts and rocks of other types.

6- Igneous rocks

The majority of igneous rocks occur in west Seram (FIG. 11).

The Autochthonous element (Neogene)

Zillman and Paten (1975a) formally described the autochthonous element in Seram in terms of two divisions:

1- Fufa Formation (Pleistocene, zone N. 22 and N. 23)

This consists of a mixture of marine and terrestrial sediments. It lies unconformably on the Wahai Beds and locally oversteps onto the Salas Block Clay.

2- Wahai Beds (Pliocene and Pleistocene, Zone N. 19 - N. 21).

These are mainly composed of marine mudstones and siltstones. The Wahai Beds lie unconformably on the Salas Block Clay. Locally, it unconformably overlies the metamorphic rocks of the Kobipoto Massif.

CHAPTER 3

REVISED MICROPALEONTOLOGICAL DETERMINATION OF THE AGE OF SELECTED STRATIGRAPHICAL UNITS

The Nief Beds

Type Locality

The Nief Beds take their informal name from the Nief river in the northeast of Seram where this unit is well developed (FIG. 13). This division is of Formational status (Audley-Charles et al., 1979).

Distribution

The Nief Beds are widely exposed in east and central Seram as highly deformed slices imbricated in with other beds (Germeraad, 1946; Sluis, 1950; Audley-Charles et al., 1979) (See FIGS. 11, 12, 13, 14). Minor occurrences were also reported from west Seram (Valk, 1945).

Age

The Nief Beds represent a stratigraphical sequence ranging in age from Upper Jurassic to the end of Miocene (N. 17, N. 18?). Many stratigraphical breaks were recognized; the Middle Miocene (N.10 - N.14), Upper Late Eocene to the end of the Oligocene (P. 15-N.3), Upper Maestrichtian to the Danian S.L., and Turonian to the Santonian, Lower Campanian? are missing (Table 8).

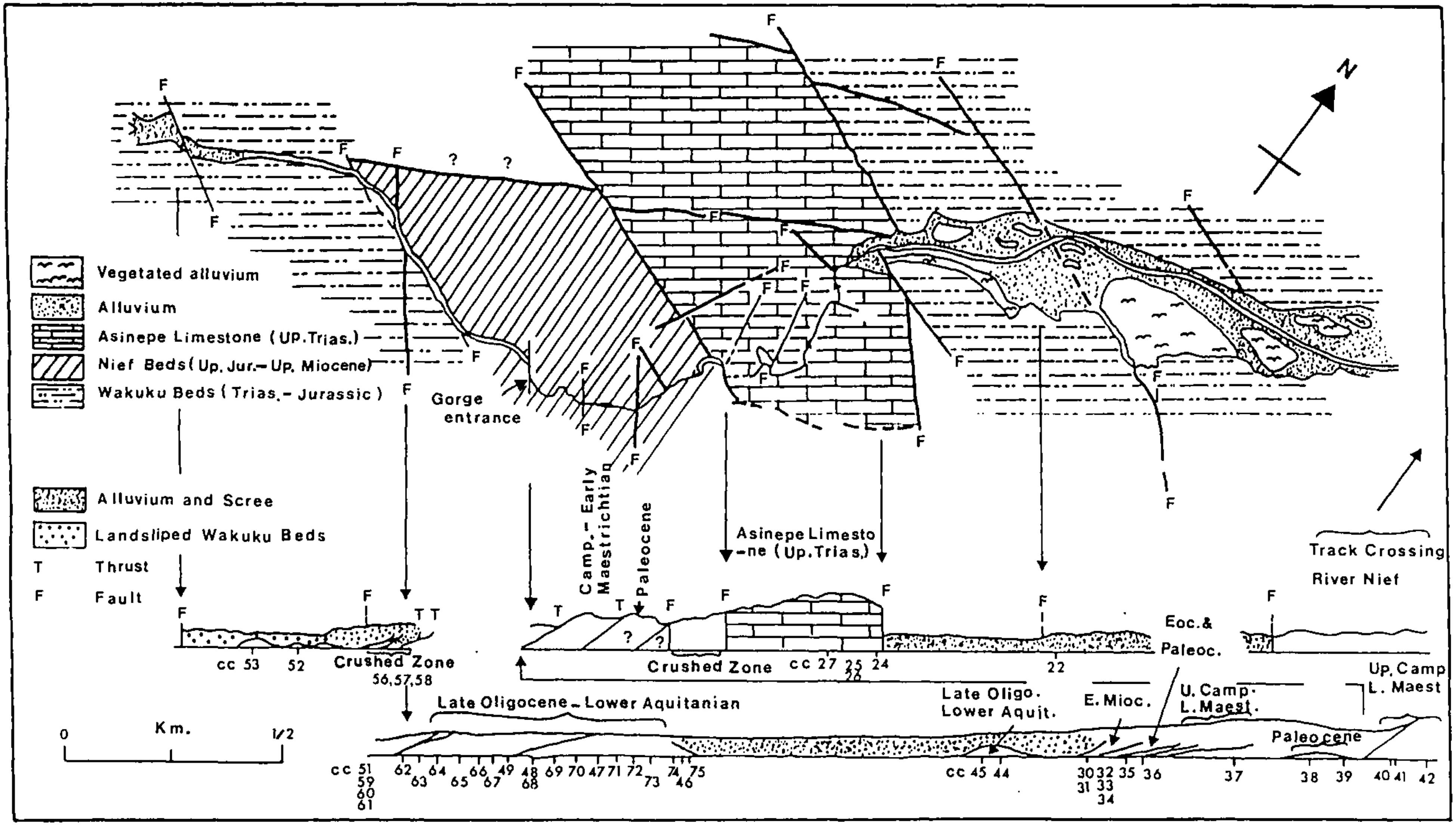


FIG. 13. Stratigraphical sections and sketch map of the Nief area of Seram. (After Audley-Charles et al., 1979, with slight modifications of the sample ages).

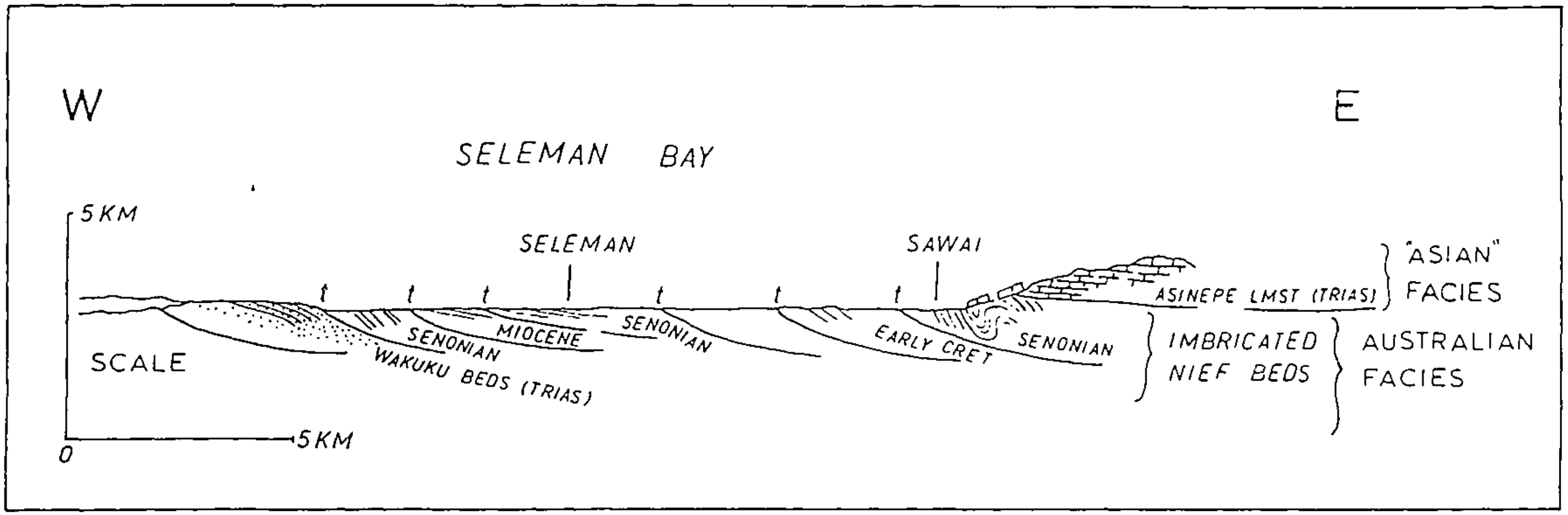


FIG. 14. Stratigraphic-structural section along the Bay of Seleman coast which shows the overthrusting of the Asinepe Limestone over the highly imbricated Nief Beds. It shows also the overthrusting of the Nief Beds over the Wakuku Beds. For approximate location of this section, see Bay of Seleman Traverse, FIG. 2. (After Audley-Charles et al., 1979).

Thickness

The total thickness of the Nief Beds can not be estimated since it is structurally deformed and imbricated. However, it is a highly condensed sequence, in which the rocks of Late Jurassic - Late Miocene age occur within a very thin section.

Lithology

Audley-Charles et al. (1979) divided the Nief Beds into 17 biostratigraphical - lithological units which represent deposition from Upper Jurassic to the Late Miocene. These units may be divided litholgically into two main categories:

1- Lower Cretaceous (Albian) to the Late Miocene part of the Nief Beds, consisting of fine grained micritic limestone full of planktonic foraminifera (Table 1, 3, 5).

2- Upper Jurassic to Lower Cretaceous part of the Nief Beds, consisting of bioturbated calcilutite and reddish brown to purple mudstones with abundant benthonic Foraminifera, Inoceramus prisms, corroded Radiolaria etc. (Table 7). The Mn-nodule bearing sediments at Bula (FIGS. 2, 6, Samples C.C.1 - C.C.5) are provisionally considered here as part of the Nief Beds.

Environment of deposition

The faunal and litholgical characteristics of the Lower Cretaceous (Albian) to the Miocene part of the Nief Beds (Table 1, 3, 5) suggest its deposition in a deep bathyal (slope and rise) environment. The presence of corroded Radiolaria in the Upper Jurassic to the Lower Cretaceous part of the Nief Beds (Table 7) indicates deposition in deep water close to the compensation depth for silica at about 4,000 metres (Audley-Charles et al. 1979).

Micropaleontological analysis

Micropaleontological analysis of all samples from the Lower Cretaceous (Albian) to the Upper Miocene Nief Beds (Table 1, 3, 5), revealed that planktonic Foraminifera outnumber benthonic Foraminifera as well as all other microfossils visible under the microscope. The re-evaluation of the age of, and the stratigraphical breaks in this part of the Nief Beds is based on the planktonic Foraminifera present in each sample and their stratigraphical ranges (Range Chart 1-3). In most cases crushed residues are more reliable for age determination than thin sections. This relates to the greater accuracy of identification of matrix free specimens.

The nature of the boundary between the base of the Nief Beds, the Wakuku Beds and the Saman Saman Limestone

The Nief Beds unconformably overlie the Wakuku-Saman Saman "Formation", with the middle and possibly some of the early Jurassic missing (Audley-Charles et al., 1979). A similar gap but of different magnitude has been found in the basins around the NW Australia off-shore region (Powell, 1976), Timor (Carter et al. (1976), and Misool (Van Bemmelen, 1949). According to Falvey (1972) and Powell (1976) this regional erosional phase is related to the development of Wharton Basin and the disruption of Gondwanaland.

The Miocene Part of the Nief Beds

General remarks

52 Miocene samples were processed and thin sectioned for micropaleontological identification (Table 1). This part of the Nief Beds is equivalent to the five highest biostratigraphical - lithological units of Audley-Charles et al. (1979). The exposures of these units show grey, argillaceous, occasionally porcellaneous calcilutite, becoming violet purple and fissile near the base where they are associated with silty argillaceous limestone.

Most of these samples were processes for crushed residues. Thin sections were prepared from rocks too hard to be satisfactorily disaggregated. Petrographically, these samples range from wackestone to grainstone and very few approach mudstone (Dunham, in Ham, 1962, a symposium on the classification of carbonate rocks). Some of the thin sections are completely recrystallized with only very few, badly preserved microfossils visible.

Micropaleontological analysis

51 species and subspecies of planktonic Foraminifera referred to 12 genera were recognized from the Miocene part of the Nief Beds. Most of these forms are important for age determination, notably species of the genus Globigerinoides. The species and subspecies distribution and abundances for each sample have been tabulated alphabetically (see Table 1).

Re-evaluation of the age and the stratigraphical breaks

From the distribution of the planktonic Foraminifera (Table 1) and their stratigraphical ranges (Range Chart 1), the age of each sample (Table 2) was determined using the "P/N" zonation by Blow (1969). The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits. From Table 2, it can be seen that the samples group themselves within the Early Miocene and (one sample) the Lower Middle Miocene. Most of the samples are referred to Zone N.3/N.4 (Uppermost Oligocene, Lower Miocene) based on the concurrent occurrence of Dentoglobigerina tripartita (Koch), Globigerina binaensis Koch, Globigerina

——————→ Continued

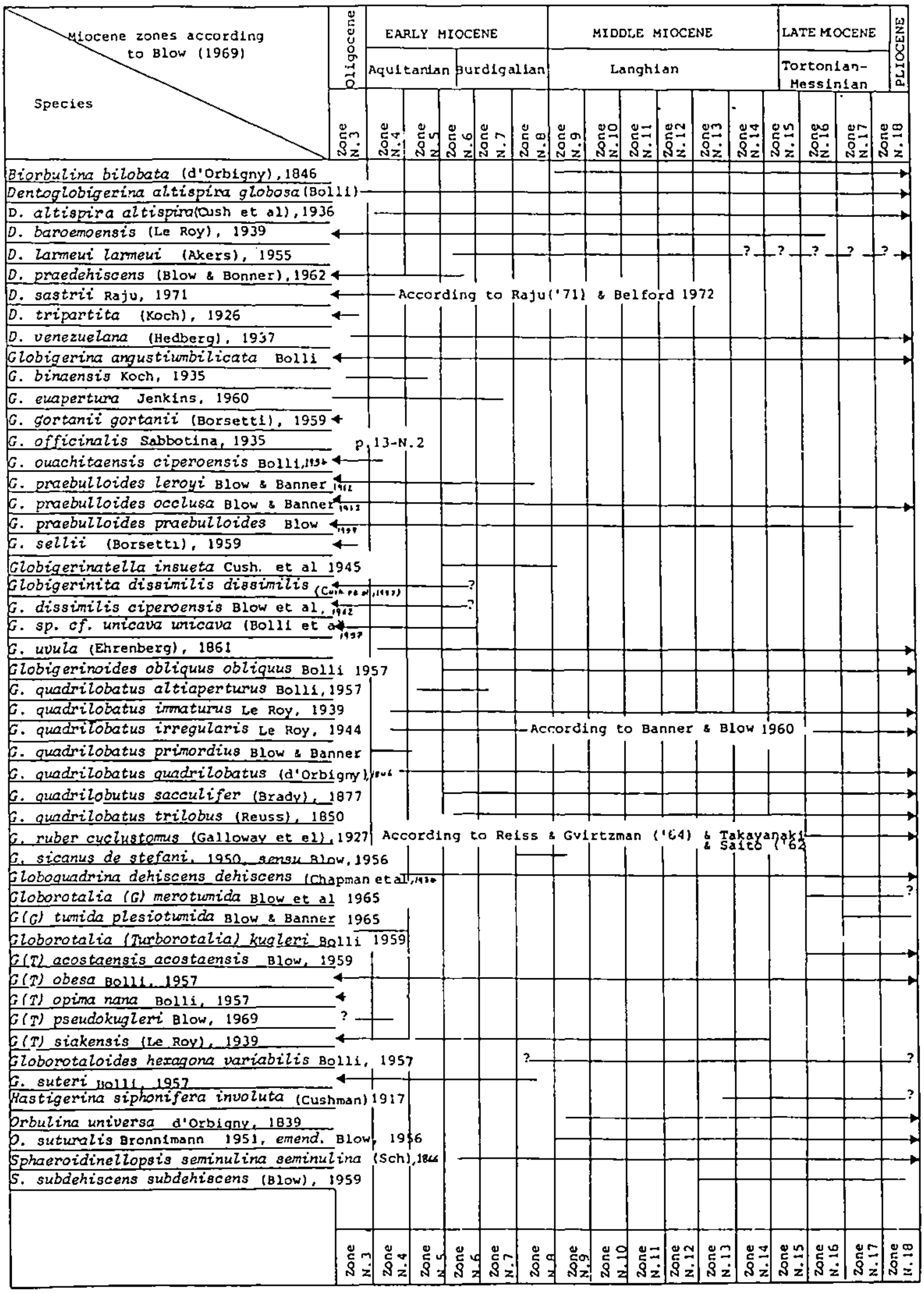
SPECIES / SAMPLES	C.C.30 •	C.C.31 •	C.C.44 •	C.C.45 •	C.C.46	C.C.47 •	C.C.48 •	C.C.49	C.C.56	C.C.57 •	C.C.58	C.C.59	C.C.60	C.C.61	C.C.62 •	C.C.63	C.C.64	C.C.65	C.C.66	C.C.68	C.C.69	C.C.70	C.C.71	C.C.72	C.C.73	C.C.74
Planktonic foraminifera																										
BiOrbulina bilobata (d'Orbigny), 1846																										
Chiloguembelina spp.				VR	R																					
Dentoglobigerina altispira globosa (Bolli),1957									VR																	
D. altispira altispira (Cush et al), 1936			VR	VR			VR		C	R					VR							VR				
D. baroemoensis (Le Roy), 1939						R	VR		F			C	VR													
D. larmeui larmeui (Akers), 1955																										
D. praedehiscens (Blow and Banner), 1962								R				VR	VR				R		R	VR		R		R		
D. sastrii Raju, 1971					R			VR										C	VR	R	VR		R			
D. tripartita (Koch), 1926			VR	R	VF	R	C	VF	C	C	VR	VF	F	VF	VR	VF	VF	VF	VF	VF	C	C	F	F	VF	C
D. venezuelana (Hedberg), 1937			R		VR	VR		R		VR	R	C		R	VR		F	VF	R	C			R	F		C
Globigerina angustiumblicata Bolli, 1957																	C				F	C		F		VF
G. binaensis Koch, 1935								C		C	C						VF	VF	VF	C	VF	VF	F	VF	C	C
G. sp. cf. euapertura Jenkins, 1960																										
G. gortanii gortanii (Borsetti), 1959					R							VR					R				C			C		
G. officinalis Subbotina, 1935																	C	R		C	R					
G. ouachitaensis cipproensis Bolli, 1954				R	VF	R	VR					C			VR		R	C		C	F		VF	VF	C	VF
G. praebulloides leroyi Blow & Banner, 1962								C			R	F	R	R		C	VF	R		R	VR			C	R	VR
G. praebulloides occlusa Blow & Banner,1962					VF			C				R	VR	R			R	F	VF	C	VF	F		F	F	F
G. praebulloides praebulloides Blow, 1959	R	R	C	C	VF	C	C	C		C					C	C	VF	F		F	VF	C	F	C	C	C
G. sellii (Borsetti), 1959	R		R	R	C		VR				C	C	C	VR			C	VF	C	F	F	F	VF	F	C	F
Globigerinatella insueta Cush.et al, 1945?									R																	
Globigerinita dissimilis dissimilis Cush etal.					VF						VR	C	VR	R		C	R		F		C		C	F	C	VF
G. dissimilis ciperoensis Blow et al, 1962					R							R							F		C		VR	F	VR	C
G. sp. cf. dissimilis S.L.			VR	C			R								R											
G. sp. cf. unicava unicava (Bolli et al)1957																										
G. uvula (Ehrenberg), 1981?					VR																		C	VR		
Globigerinoides obliquus obliquus Bolli,1957																										
G. quadrilobatus altiaperturus Bolli, 1957																										
G. quadrilobatus immaturus Le Roy, 1939									F																	
G. quadrilobatus irregularis Le Roy, 1944																										
G. quadrilobatus primordius Blow et al,1962			VR	C	VF	VR	C	F		C	C	R	VR	R	C	C	F	C	VF	F	VF	F	F	C	R	C
G. quadrilobatus quadrilobatus (dOrbigny),1846																										
G. quadrilobatus sacculifer (Brady), 1877																										
G. quadrilobatus trilobus (Reuss), 1850									R																	
G.ruber cyclostomus (Galloway et al),1927																										
G. sicanus de Stefani, 1950, sensu Blow,1956																										
Globoquadrina dehescens dehiscens (Chapman et al		R					R								VR				VF	VR						
Globorotalia (G) merotumida Blow et al, 1965																										
G(G) tumida plesiotumida Blow & Banner,1965																										
Globorotalia (Turborotalia) Kugleri Bolli,1957				VR			VR				VR	VF	C	C			R									
G(T) acostaensis acostaensis Blow, 1959																										
G(T) obesa Bolli, 1957					R													C	F	R			R	F		
G(T) opima nana Bolli, 1957																				VR				R		
G(T) pseudokugleri Blow, 1969								R											R					VR		R
G(T) siakensis (Le Roy), 1939	R					VR	VR	VF	R		VR	VF	VR				F		VF	R					R	
Globorotaloides hexagona variabilis Bolli, 1957																										
G. suteri Bolli, 1957																										R
Hastigerina siphonifera involuta (Cushman),1917																										
Orbulina universa d'Orbigny, 1839																										
O.suturalis Bronnimann, 1951,emend. Blow,1956																										
Sphaeroidinellopsis seminulina seminulina (Sch																										
S. subdehiscens subdehiscens (Blow), 1959																										
Genus "A" sp. 1																		C		F						
Benthonic foraminifera					VF			VF	VF		F	F	F	F		R	F	C	VF	VF	F	F	C	VF	C	F
Ostracoda					C			R			VR	VR	R	R			C		R	VR	C	C		C		C
others	R				R						VR		VR	VR			R		C	VR						

Table 1. Distribution and abundance of planktonic foraminiferal species and other fauna in samples from the Miocene part of the Nief Beds. Dentoglobigerina altispira altispira, D. baroemoensis, D. venezuelana, Globigerina praebulloides praebulloides and Globorotalia (T) siakensis identified from the thin section are tentatively included here.

• Thin section cf. ☐ aff. ☐

SPECIES / SAMPLES	C.C.75	C.C.79	(21-2)*	(61-1)	(62-1)*	(70-1)	(71-1)	(71-2)*	(72-1)	(75-1)	(75-4)	(80-1)	(81-1)	(82-1)	CER.4	CER.5	CER.14B*	CER.16*	CER.49(2)	CER.50B	CER.56	CER.60	CER.62	CER.63A	CER.63B	CER.64
Planktonic foraminifera																										
BiOrbulina bilobata (d'Orbigny), 1846		VR				C																				
Chiloguembelina spp.			R															VR								
Dentoglobigerina altispira globosa (Bolli),1957		VR					VR			VR											R					
D. altispira altispira (Cush et al), 1936		VF					F			F						R			VR	VF	C		R			R
D. baroemoensis (Le Roy), 1939	R						VF		VR	C			R				R			VF	VF	VF	F			
D. larmeui larmeui (Akers), 1955																				R						
D. praedehiscens (Blow and Banner), 1962				R							R	VR														
D. sastrii Raju, 1971																VR										
D. tripartita (Koch), 1926	VF		R	VF				R	C		R	C	R	VR	VF	VF	VR		VF				F	VF	C	R
D. venezuelana (Hedberg), 1937	R		R				R					R				C	VR	R			C			R		VR
Globigerina angustiumblicata Bolli, 1957	R															R										
G. binaensis Koch, 1935	C			F					F			R	C	C	VF	VF	VR		C				F		R	C
G. sp. cf. *euapertura* Jenkins, 1960																									VR	
G. gortanii gortanii (Borsetti), 1959																C										
G. officinalis Subbotina, 1935																									R	
G. ouachitaensis cipproensis Bolli, 1954	C		VR					R								VF	R									
G. praebulloides leroyi Blow & Banner, 1962	C															F										
G. praebulloides occlusa Blow & Banner,1962	F			C												F							R			
G. praebulloides praebulloides Blow, 1959			VR		C			R			R					R	C	R								
G. sellii (Borsetti), 1959	F			VF					C		R	R	R	C	F	VF			F				F	R	R	C
Globigerinatella insueta Cush.et al, 1945?																				R						
Globigerinita dissimilis dissimilis Cush etal	F			C					VR		R	VR	VR			VF			VR				C		VR	
G. dissimilis ciperoensis Blow et al, 1962				R							R	VR			VR	C										
G. sp. cf. *dissimilis* s.l.			R															R								
G. sp. cf. *unicava unicava* (Bolli et al)1957																										
G. uvula (Ehrenberg), 1961?																										
Globigerinoides obliquus obliquus Bolli,1957		R				F																				
G. quadrilobatus altiaperturus Bolli, 1957																				VR						
G. quadrilobatus immaturus Le Roy, 1939		C				C														R		R				
G. quadrilobatus irregularis Le Roy, 1944						R														VR		C				
G. quadrilobatus primordius Blow et al,1962	R		R	C	R			R	R		R		R	R	R	F	VR	R	VR				C	F	R	C
G. quadrilobatus quadrilobatus (dOrbigny)1846		R																								
G. quadrilobatus sacculifer (Brady), 1877		C				F	R			VR										C	R	VF				
G. quadrilobatus trilobus (Reuss), 1850		R				R	VF	R		VF										C		C				
G.ruber cyclostomus (Galloway et al),1927							F																			
G. sicanus de Stefani, 1950, sensu Blow,1956																				VF		VF				
Globoquadrina dehescens dehiscens (Chapman et al)				R						C										C						
Globorotalia (G) merotumida Blow et al, 1965		R				VF																				
G(G) tumida plesiotumida Blow & Banner,1965		F				F																				
Globorotalia (turborotalia) Kugleri Bolli,1957			VR					VR	VR			R	VF					VR							R	
G(T) acostaensis acostaensis Blow, 1959		VF				VF																				
G(T) obesa Bolli, 1957																										
G(T) opima nana Bolli, 1957																										
G(T) pseudokugleri Blow, 1969	R										VR															
G(T) siakensis (Le Roy), 1939									R		R	VR	R	R		VR	R	VR		R						
Globorotaloides hexagona variabilis Bolli, 1957						C	R													VR						
G. suteri Bolli, 1957													R			C										
Hastigerina siphonifera involuta (Cushman),1927		C				VR																				
Orbulina universa d'Orbigny, 1839		VF				VF														R						
O.suturalis Bronnimann, 1951,emend. Blow,1956		R				C														VR						
Sphaeroidinellopsis seminulina seminulina (Sch		R				F														R						
S. subdehiscens subdehiscens (Blow), 1959		VF				VF																				
Genus "A" sp. 1																										
Benthonic foraminifera	F	VF		R		VF	F		C	VR	VR	R	R		F	VF			C		F	F	R	F	F	C
Ostracoda	C	VR				R										R										
others						R							VR		R	VR								VR		

Table 1. - continued



Range Chart 1. Stratigraphic ranges of the Miocene planktonic foraminiferal species present in Seram according to the "P/N" zonation by Blow (1969) unless otherwise indicated on the range lines. All genera, and species assigned to each genus are arranged alphabetically.

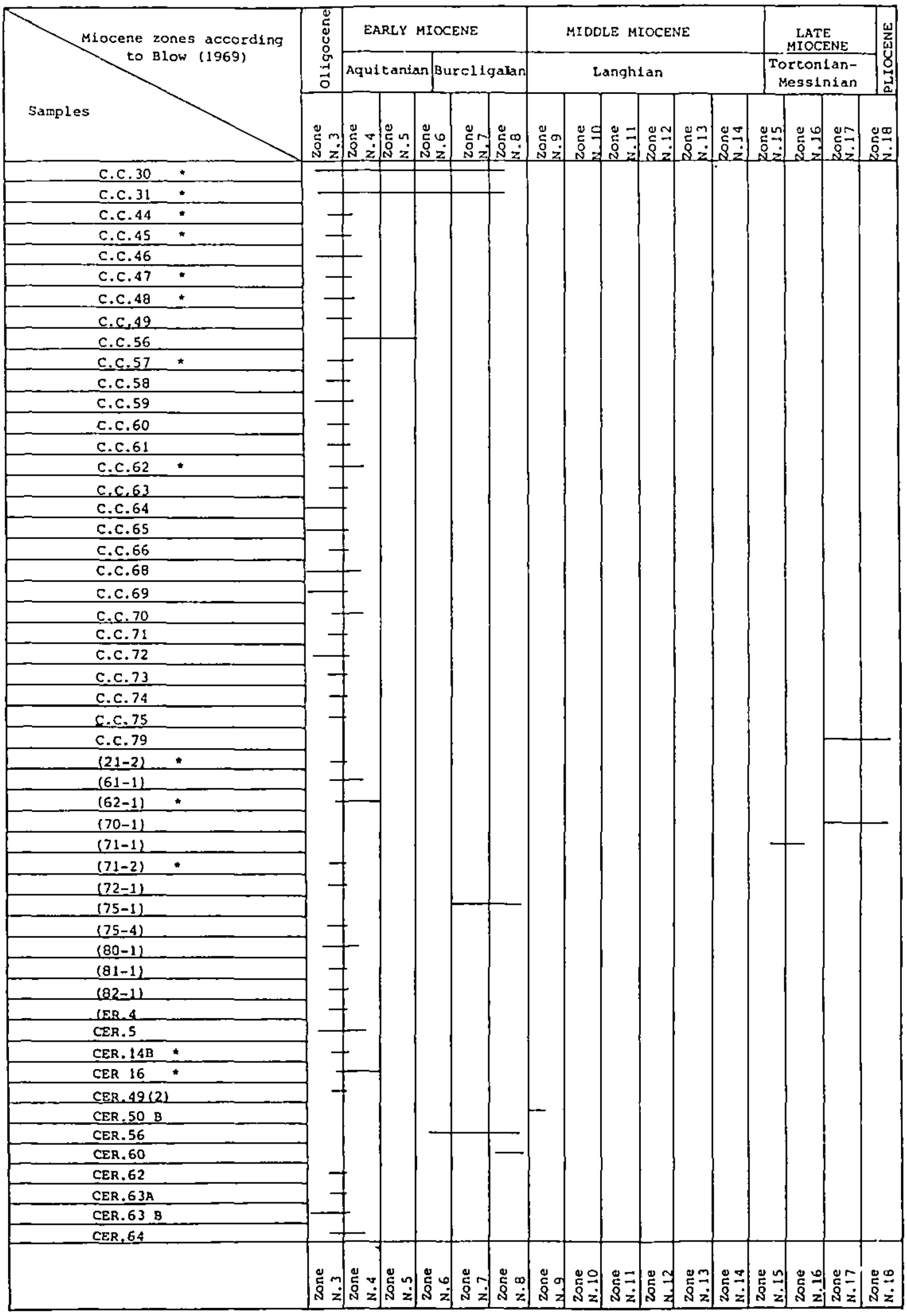


Table 2. The "P/N" zonation by Blow (1969) with the distribution of the Miocene samples. The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits.

* Identification based on thin section.

gortanii gortanii (Borsetti), Globigerina ouachitaensis Bolli, Globigerina Sellii (Borsetti), Globigerinoides quadrilobatus primordius Blow and Banner, Globorotalia (T) acostaensis acostaensis Blow and Globorotalia (T) pseudokugleri Blow. No samples were found from the Zone N.10 N.14 interval. This stratigraphical break is most probably due to the sampling failure, since no similar gap was reported from the para-autochthon of the neighbouring islands of Timor and Misool or the NW Australian shelf (Audley-Charles et al., 1979, Table 1). Comparison with the age of the Miocene rocks of Seram and the stratigraphical breaks within the sequence given by Audley-Charles et al. (1979, Table 1), and their re-evaluation based on the present work is shown in Table 8.

The nature of the contact between the Lower Miocene and Upper Eocene

The presence of the Oligocene in Seram is established neither in the present work nor reported in the published literature (Audley-Charles et al. 1979). This hiatus was also recorded from the other islands of the Outer Banda Arc (Bemmelen, 1949; Carter et al., 1976). According to Carter et al. (op. cit.), this may be related to a tectonic phase of uplift that affected the southeast margin of Sundaland. A regressive phase on the NW Australian shelf during the Oligocene was also reported by Laws and Klaus (1974). Consequently, the Miocene system in Seram is separated from the Eocene below by an unconformity

(Table 8). However, the recognition of *Globigerina officinalis* Subbotina and *Globorotalia* *(T) opima nana* Bolli in some of the samples may indicate the presence of the uppermost part of the Oligocene.

The Eocene and Paleocene Part of the Nief Beds

General remarks

19 samples were processed and thin sectioned for micropaleontological identification (Table 3). This part of the Nief Beds is equivalent to the five biostratigraphical - lithological units of Audley-Charles et al. (1979) below the Miocene System. Exposures of these units consist of cream and white calcilutite, reddish or purple, usually fissile, argillaceous calcilutites and red and green marl. Petrographically, these samples range from wackestone to grainstone (Dunham, in Ham, 1962, a symposium on the classification of carbonate rocks).

Micropaleontological Analysis

45 species and subspecies of planktonic Foraminifera referred to 10 genera were recognized from the Paleogene. Their distribution and abundances in each sample have been tabulated alphabetically in Table 3. The presence of very frequent bioclasts and Algae in sample (63-3) are interpreted as a slide of contemporaneous shallow water material.

Re-evaluation of the age and the stratigraphical breaks

From the distribution of the planktonic Foraminifera (Table 3) and their stratigraphical ranges (Range Chart 2), the age of each sample (Table 4) was determined using the "P/N" zonation by Blow (1979). The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits.

From Table 4, it can be seen that no samples of an Upper Late Eocene (zone p. 15) age were found. Also there is some indication that part of the Upper Paleocene is missing from Seram (Table 4, 8). These stratigraphical breaks were not recorded by Audley-Charles et al. (1979, Table 1) in Seram but were documented by the same authors from Timor. The Lower Paleocene hiatus recorded by Audley-Charles et al. (op. cit.) is confirmed in the present work. Comparison with the age of the Eocene and Paleocene rocks of Seram and the stratigraphical breaks within the sequence given by Audley-Charles et al., (1979, Table 1), and their re-evaluation based on the present work is shown in Table 8.

The Maestrichtian And Campanian Part of the Nief Beds

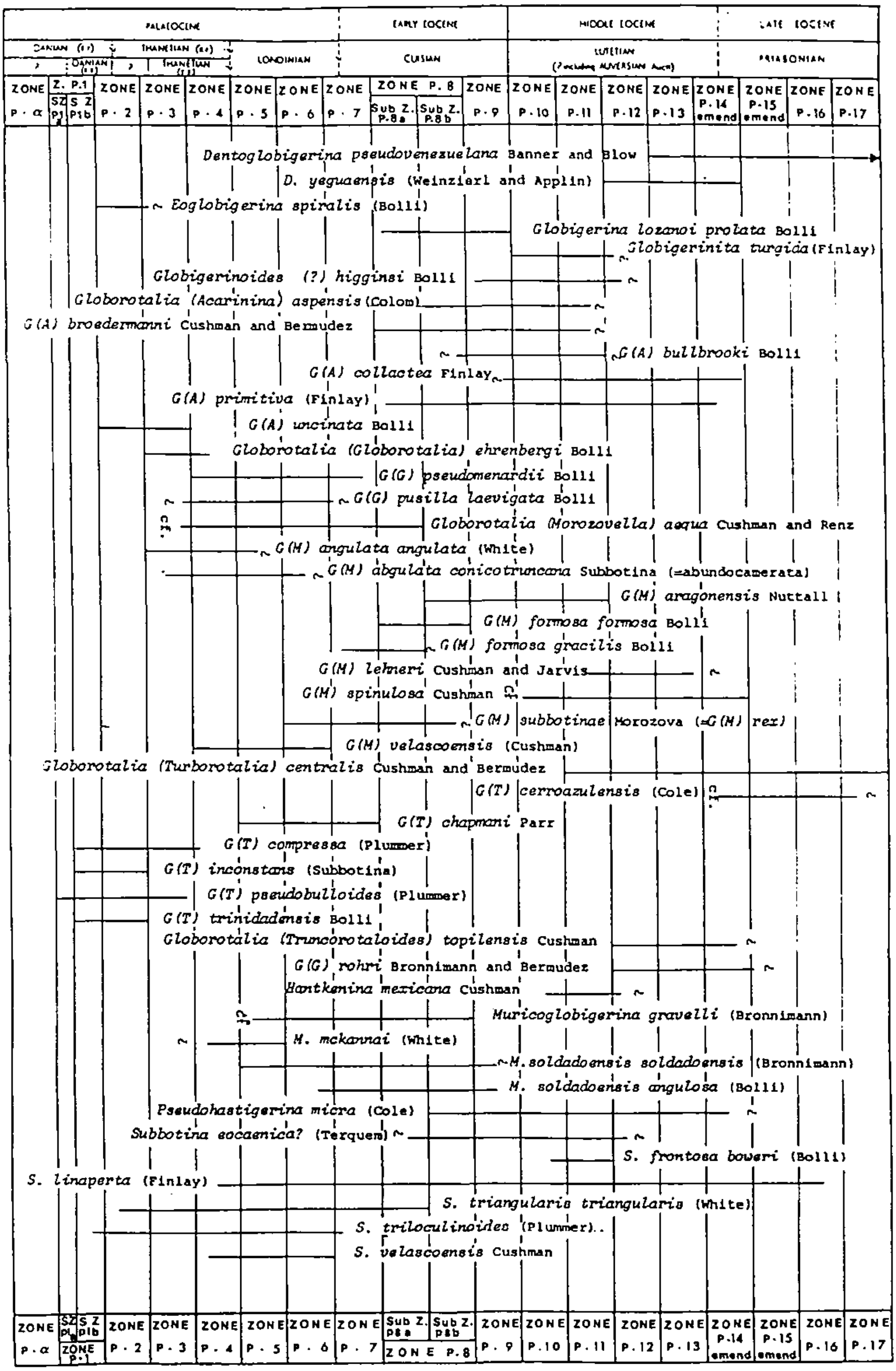
General Remarks

27 Late Senonian samples were thin sectioned for micropaleontological identification. This part of the Nief Beds is equivalent to the single Late Senonian unit

SAMPLES / SPECIES	EOCENE SAMPLES									PALEOCENE SAMPLES									
	C.C.32*	C.C.34(1)	C.C.34(2)*	C.C.76	(60-1)	(63-3)*	(73-2)	(79-1)	CER.14A	C.C.33*	C.C.37	C.C.38	C.C.39*	(14-1)	(63-1)*	(74-1)	(74-2)	CER.18*	CER.66*
Planktonic foraminifera																			
Chiloguembelina sp.												R	R						
Dentoglobigerina pseudovenezuelana (Banner & Blow) 1962							C	F											
D. yeguaensis (Weinzierl and Applin), 1929	C						C												
Eoglobigerina spiralis (Bolli), 1957												VR	VR						
Globigerina lozanoi prolata Bolli, 1957				C															
Globigerinita turgida (Finlay), 1939?				R															
Globigerinoides (?) higginsi Bolli, 1957				R															
Globorotalia (Acarinina) aspensis (Colom), 1954									VF										
G(A) broedermanni Cushman & Bermudez, 1949				R				C	R										
G(A) collactea Finlay, 1939				C															
G(A) primitiva (Finlay), 1947				C	C														
G(A) uncinata Bolli, 1957													R				VR		VR
Globorotalia (Globorotalia) ehrenbergi Bolli, 1957													C					C	C
G(G) pseudomenardii Bolli, 1957			VR							R									
G(G) pusilla laevigata Bolli, 1957															VR				R
Globorotalia (morozovella) aequa Cush. & Renz, 1942					C								VR	VR	R				R
G(M) angulata angulata (White), 1928											VF		C		VR			R	C
G(M) angulata conicotruncana Subbotina, 1947											C								
G(M) aragonensis Nuttall, 1930		R		VF				C	VF										
G(M) formosa formosa Bolli, 1957			R	R	F				VF										
G(M) formosa gracilis Bolli, 1957				C	C				C										
G(M) lehneri Cushman & Jarvis, 1929						VR	F												
G(M) spinulosa Cushman, 1927						VR	C	C											
G(M) subbotinae Morozova, 1939				F	R				C										
G(M) velascoensis (Cushman), 1925										C				R	VR				VR
Globorotalia (Turborotalia) centralis Cush. et al 1937						R	VR	R											
G(T) cerroazulensis (Cole), 1928	VR					R													
G(T) chapmani Parr, 1938													VR						
G(T) compressa (Plummer), 1926												VR	C						
G(T) sp. cf. inconstans (Subbotina), 1953										VR									
G(T) pseudobulloides (Plummer), 1926												F	VR			R	VR	R	C
G(T) trinidadensis Bolli, 1957												VF	R?			F	R		R?
Ex.Interc. *G(T)trinidadensis/inconstans* & *G(A) uncinata*																R	C		
Globorotalia (Truncorotaloides) topilensis (Cush). '25?							VF	VF											
G(T) rohri Bronnimann & Bermudez, 1953							C	R											
Hantkenina sp. cf. mexicana Cushman, 1924	R																		
Muricoglobigerina gravelli (Bronnimann), 1952			VR		R				R										
M.mckannai (White), 1928?										R									R
M.soldadoensis soldadoensis (Bronnimann), 1952				VF	VR				VF										
Ex. Interc *M.gravelli* & *M.soldadoensis soldadoensis*					R				R										
M.soldadoensis angulosa (Bolli), 1957				VF	VF				VF										
Pseudohastigerina micra (Cole), 1927	VR																		
Subbotina sp. cf. eocaenica(?) (Terquem), 1882							VR												
S. sp. cf. frontosa boweri (Bolli), 1957							C	R	C										
S.linaperta (Finlay), 1939		R		R				C		VR									
S.triangularis triangularis (White), 1928				C							F	VF		VR			VR		
S.triloculinoides (Plummer), 1926										VR	C	R	C	R			VR	R	
S.velascoensis Cushman, 1925											C			R					
Benthonic foraminifera		R									VF			F		C	C		
Derived Cretaceous planktonic foraminifera																			
Biglobigerinella sp.												VR							
Globotruncana sp.												R		R				R	F
Heterohelix sp.																		C	R
Planoglobulina sp.																			C
Bioclasts and Algae						VF													
Radiolaria																VF	VF		

Table 3 Distribution and abundance of planktonic foraminiferal species and other fauna in samples from the Eocene and Paleocene part of the Nief Beds.

* Identification based on thin section. cf. ☐ aff. ☐



Range Chart 2. Stratigraphic ranges of the Eocene and Paleocene planktonic foraminiferal species present in Seram according to the "P/N" zonation by Blow (1979). The genera, and the species assigned to each genus are arranged alphabetically.

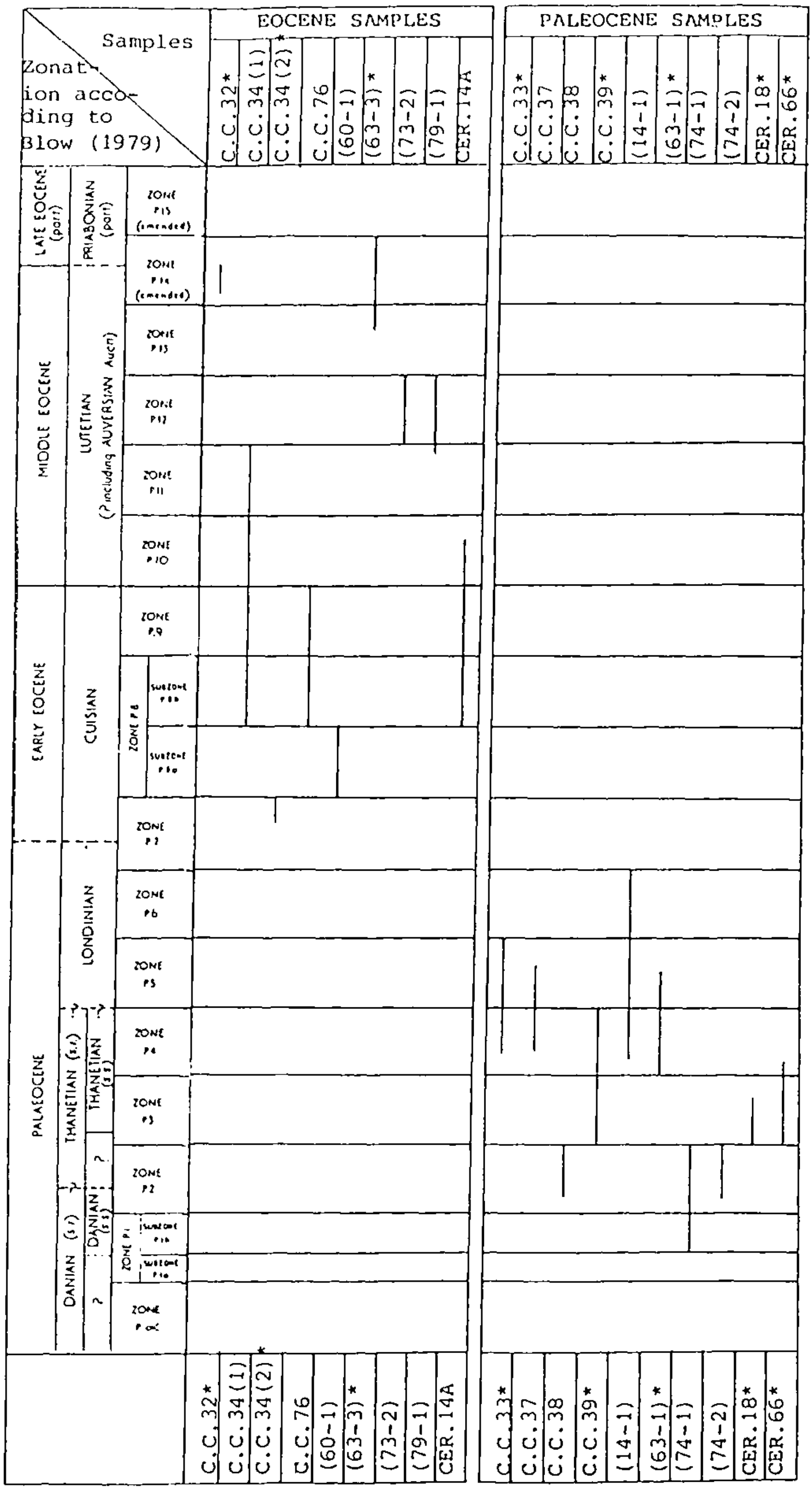


Table 4. The "P/N" zonation by Blow (1979) with the distribution of the Eocene and Paleocene samples. The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits. * Identification based on thin section.

of Audley-Charles et al. (1979). It consists of dense, brittle, often porcellaneous and occasionally finely recrystallized calcilutite with or without chert.
This unit has a white, cream, violet or pink colour with strongly developed parallel or subparallel microstylolite
Petrographically, these samples range from wackestone to grainstone: very few approach mudstone (Dunham, in Ham, 1962, a symposium on the classification of carbonate rocks).

Micropaleontological analysis

31 species and subspecies of planktonic *Foraminifera* referred to 14 genera were recognized from the Late Senonian. Their distribution and abundances have been tabulated alphabetically in Table 5.

Re-evaluation of the age and the stratigraphical breaks

From the distribution of the planktonic *Foraminifera* (Table 5) and their stratigraphical ranges (Range Chart 3), the age of each sample (Table 6) was determined using the zonation by Pessagno (1967). The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits.

From Table 6, it can be seen that the Upper Senonian samples are grouped mainly in the Upper Campanian and Lower Maestrichtian. No samples have been found indicating the presence of Middle and Upper Maestrichtian. Also, there is an indication that the Lower Campanian is missing from the Nief Beds (Table 6 and 8). Comparison with the age of the Late Senonian rocks of Seram and the stratigraphical breaks within the sequence given by Audley-Charles et al. (1979) and their re-evaluation based on the present work is shown in Table 8.

The Cenomanian to Santonian in the Nief Beds

General Remarks

Three samples were referred to the Upper Cenomanian. Samples (17-2) and CER. 21(i) may be referred either to the Lower Cenomanian or Albian. They most probably belong in the Albian as they contain abundant Radiolaria. The few benthonic Foraminifera are characteristic of the Lower Cretaceous (See Table 5 & 7).

Micropaleontological Analysis

Eight species and subspecies of planktonic *Foraminifera* referred to three genera were recognized from the Cenomanian. Their distribution and abundances have been tabulated alphabetically in Table 5.

Re-evaluation of the age and the stratigraphical breaks

From the distribution of the planktonic *Foraminifera* (Table 5) and their stratigraphical ranges (Range Chart 3), the age of each sample (Table 6) was determined using

——→ Continued

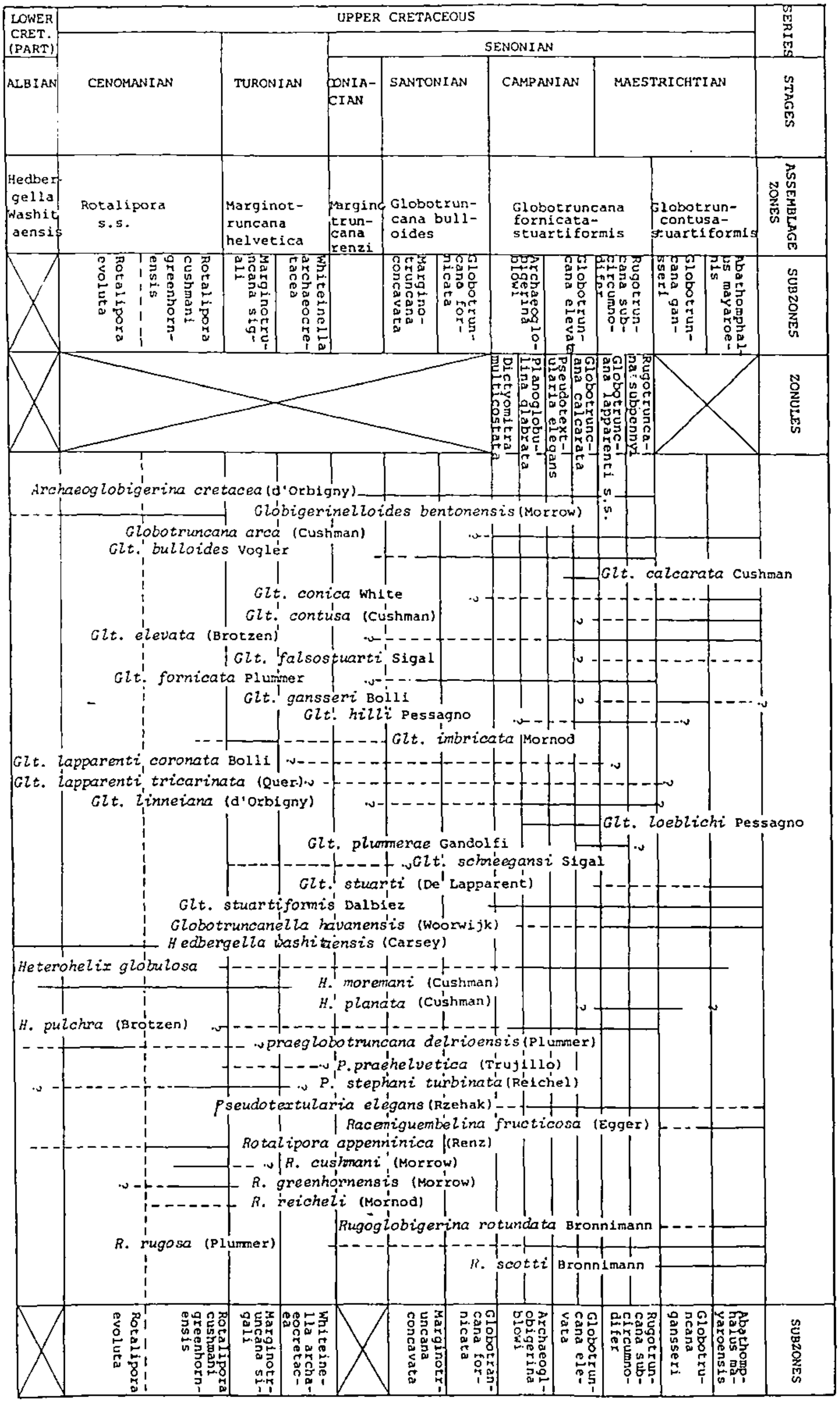
SAMPLES SPECIES	MAESTRICHTIAN AND CAMPANIAN																	
	C.C.35	C.C.36	C.C.40	C.C.41	C.C.42	C.C.43	CER.3	CER.7	CER.7A	CER.8	CER.10	CER.61	CER.65	(12-1)	(12-8)A	(13-3)	(17-1a)	(17-1b)
Planktonic foraminifera																		
Archaeoglobigerina cretacea (d'Orbigny), 1840		VR												R				
Globigerinelloides bentonensis (Morrow), 1934																		
G. sp.1											C							
G. sp.2												R						
G. sp.3																		
Globotruncana arca (Cushman), 1926	C				R	C				R	R	VR	VR	R	C	VR		
Gt. bulloides Vogler, 1941						R			R	VR	R		R					
Gt. calcarata Cushman, 1927			R	VR			C	VR	C				R					
Gt. conica White, 1928		VR		R	R	C	C		R				R					
Gt. contusa (Cushman), 1926					VR						VR						VR	VR
Gt. elevata (Brotzen), 1934			R	C		C		VR										
Gt. falsostuarti Sigal, 1952	VR											VR						
Gt. fornicata Plummer, 1931	VR		R	C	C		R				C	R		C	R		R	C
Gt. gansseri Bolli, 1951															VR		R	
Gt. hilli Pessagno, 1967											VR							
Gt. imbricata Mornod, 1949																		
Gt. lapparenti coronata Bolli, 1944		VR						VR	R					C	R			
Gt. lapparenti tricarinata (Quereau), 1893	C	C	VR	R	R		R	VR		R	C	VR	R	C	C			
Gt. linneiana (d'Orbigny), 1839	R	F	VR	C					C	R	R		R	C	C			
Gt. loeblichi Pessagno, 1967																		
Gt. schneegansi Sigal, 1952																		
Gt. stuarti (De Lapparent), 1918	R				C	R	C	VR	R	R	R				R			VR
Gt. stuartiformis Dalbiez, 1955	C		C		C	C					C		R					
Gt. sp.1					C		R											
Gt. sp.2						VR												
Gt. sp.3																	VR	
Gt. sp.4											VR						VR	
Gt. sp.5																		
Gt. sp.6																		
Gt. sp.7																	VR	
Globotruncanella havanensis (Voorwijk), 1937			VR	VR		VR	C										VR	
Gublerina sp.	VR			C	VR	C	R				R							
Hedbergella sp. cf. washitensis (Carsey), 1926																		
H. sp.1	R	VR					R				VR							R
H. sp.2											C			R				
H. sp.3								R										F
H. sp.4																		
Heterohelix globulosa (Ehrenberg), 1840	R	R	C	C	F		C	VR	C	VR	C		C	R	R			
H. pulchra (Brotzen), 1936	VR	VR												VR				
H. sp.1						VR	VR											
H. sp.2						VR					VR							
Planoglobulina sp.			R	C	C		R											
Praeglobotruncana delrioensis (Plummer), 1931																		
P.?praehelvetica (Trujillo), 1960																		
P. stephani turbinata (Reichel), 1949																		
P.? sp.																		
Pseudotextularia elegans (Rzehak), 1891	R	VR	C	C	C	C	R						R		R	VR		
P. sp.1						VR												
P. sp.2						VR												
Racemiguembelina fructicosa (Egger), 1899			C	VR		C												
R. sp.																		
Rotalipora appenninica (Renz), 1936																		
R. cushmani (Morrow), 1934																		
R. greenhornensis (Morrow), 1934																		
R. reicheli (Mornod), 1949																		
Rugoglobigerina rotundata Bronnimann, 1952?		VR												VR				
R. rugosa (Plummer), 1927				R	C						C							
R. sp. cf. scotti Bronnimann, 1952											VR							
Schackoina sp.																		
Benthonic foraminifera							R		R		R	VR	C					
Ostracoda	VR								VR									
Radiolaria																		
Others								R					VR					

Table 5. Distribution and abundance of planktonic foraminiferal species and other fauna in samples from the Upper Cretaceous part of the Nief Beds. All identifications are based on thin section, unless otherwise indicated by asterisk.

cf. ▭ aff. ▭

SPECIES / SAMPLES	MAESTRICHTIAN & CAMPANIAN											CENOMANIAN				
	(18-2)	(20-1)	(29-1)	(56-2)	(61-3)	(61-4)	(72-2)	(72-3)	(72-4)	(75-2)	(75-3)	(13-2)	(13-5)	(17-2)	CER. 27	CER.21 8*
Planktonic foraminifera																
Archaeoglobigerina cretacea (d'Orbigny), 1840																
Globigerinelloides bentonensis (Morrow), 1934																VR
G. sp.1											C					
G. sp.2																
G. sp.3													R		R	
Globotruncana arca (Cushman), 1926					VR		C	VR								
Gt. bulloides Vogler, 1941		VR		C					VR	VR	VR					
Gt. calcarata Cushman, 1927					R											
Gt. conica White, 1928							R									
Gt. contusa (Cushman), 1926						R										
Gt. elevata (Brotzen), 1934				VR												
Gt. falsostuarti Sigal, 1952							VR									
Gt. fornicata Plummer, 1931		R	R	C	C	F	C	R			R					
Gt. gansseri Bolli, 1951																
Gt. hilli pessagno, 1967																
Gt. imbricata Mornod, 1949												VR	R		R	
Gt. lapparenti coronata Bolli, 1944			VR				R				R					
Gt. lapparenti tricarinata (Quereau), 1893		R	VR	R	C			VR	VR							
Gt. linneiana (d'Orbigny), 1839		C	VR	C	C			C	C	C	C					
Gt. loeblichi pessagno, 1967											VR					
Gt. schneegansi Sigal, 1952															R	
Gt. stuarti (De Lapparent), 1918				R			VR									
Gt. stuartiformis Dalbiez, 1955	VR	R		R		VR		VR								
Gt. sp.1																
Gt. sp.2																
Gt. sp.3																
Gt. sp.4																
Gt. sp.5						VR										
Gt. sp.6		R									VR					
Gt. sp.7																
Globotruncanella havanensis (Voorwijk), 1937						R										
Gublerina sp.							VR									
Hedbergella sp. cf. washitensis (Carsey), 1926													VR			
H. sp.1	VR	C										VR		VR		
H. sp.2		VR				R										
H. sp.3			C	C	C	R		R	VR	C					R	
H. sp.4												VR				
Heterohelix globulosa (Ehrenberg), 1840		C	C	C	R		R	R	R		C					
H. pulchra (Brotzen), 1936		VR	VR						VR							
H. sp.1																
H. sp.2																
Planoglobulina sp.							R									
Praeglobotruncana delrioensis (Plummer), 1931												VR	VR			
P.?praehelvetica (Trujillo), 1960															VR	
P. stephani turbinata (Reichel), 1949															R	VR
P.? sp.												R	R			
Pseudotextularia elegans (Rzehak), 1891				C												
P. sp.1																
P. sp.2																
Racemiguembelina fructicosa (Egger), 1899																
R. sp.																
Rotalipora appenninica (Renz), 1936														VR	VF	
R. cushmani (Morrow), 1934															VR	
R. greenhornensis (Morrow), 1934													C			
R. reicheli (Mornod), 1949												C	R		C	
Rugoglobigerina rotundata Bronnimann, 1952?		VR	VR			C				VR						
R. rugosa (Plummer), 1927	VR					R			R							
R. sp. cf. scotti Bronnimann, 1952																
Schackoina sp.															VR	
Benthonic foraminifera						R		VR			R		R		R	VF
Ostracoda																
Radiolaria														VF		VF
Others										VR					R	

Table 5. - continued



Range Chart 3. Modified stratigraphic ranges of the Cretaceous planktonic foraminiferal species present in Seram according to the zonation by Pessagno (1967). Solid lines are the species ranges according to Pessagno (1967). Dashed lines are the extensions of ranges as reported from the other zonations and reliable references.

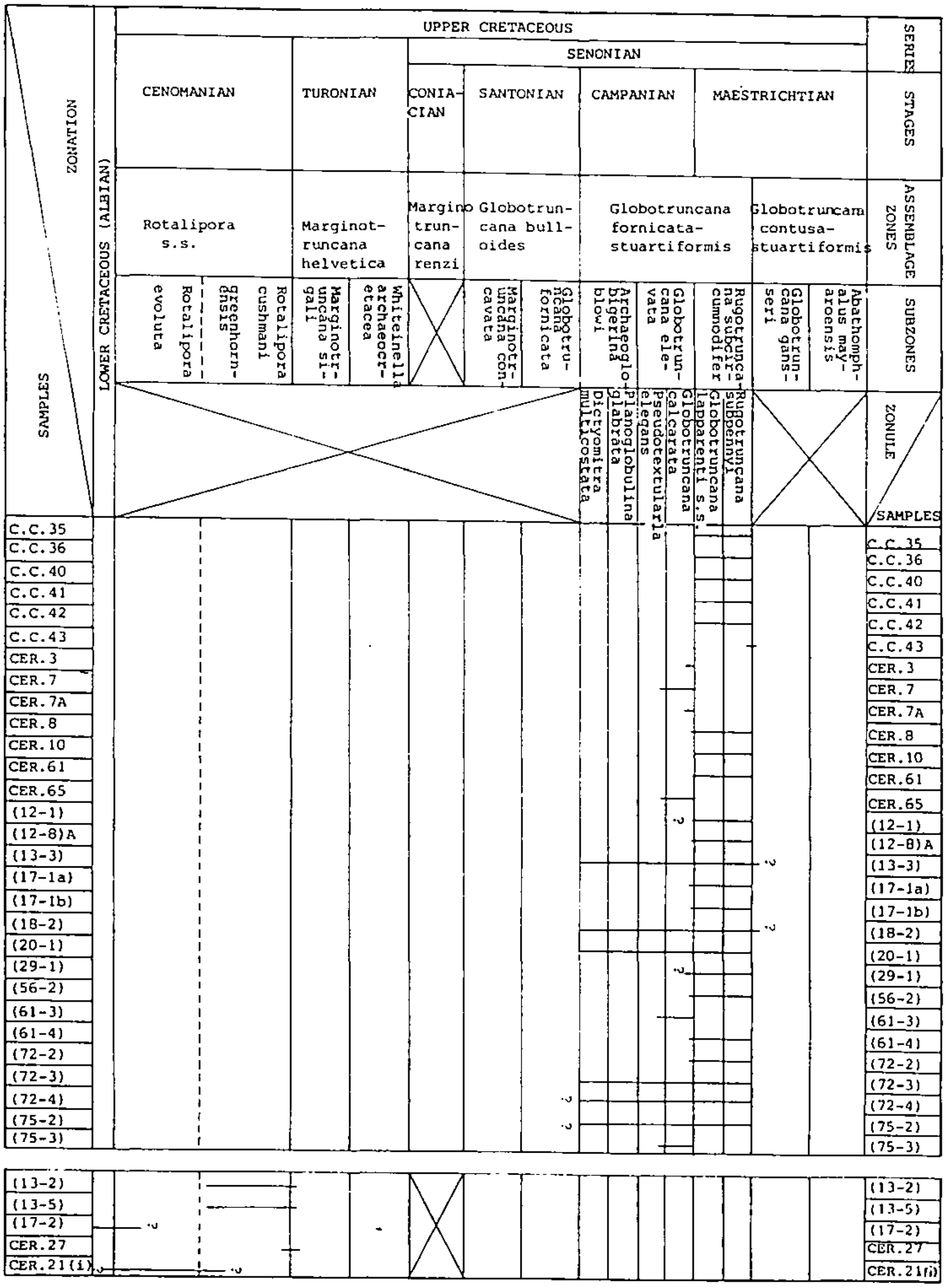


Table 6. Upper Cretaceous zonation (after Pessagno, 1967) with the distribution of the Maestrichtian, Campanian and Cenomanian samples. The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits.

? A possible extension.

the zonation by Pessagno (1967). The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits.

From Table 6, it can be seen that all the samples group themselves within the Upper Cenomanian with the exception of two samples (17-2) & CER. 21(i), which are doubtfully assigned to the Lower Cenomanian. No samples have been found indicating the presence of Turonian, Coniacian or Santonian. According to Audley-Charles et al. (1979), the Late Cenomanian and Turonian are missing, but they indicated the presence of Coniacian and Santonian. Comparison with the age of the Cenomanian rocks of Seram and the stratigraphical breaks within the sequence given by Audley-Charles et al. (1979), and their re-evaluation based on the present work is shown in Table 8.

The Upper Jurassic and Lower Cretaceous of the Nief Beds

Remarks

38 samples were referred to the Upper Jurassic - Lower Cretaceous part of the Nief Beds. They are composed of bioturbated calcilutite and reddish-brown to purple mudstones.

Micropaleontological analysis and stratigraphical age

The most common fauna recognized from this part of

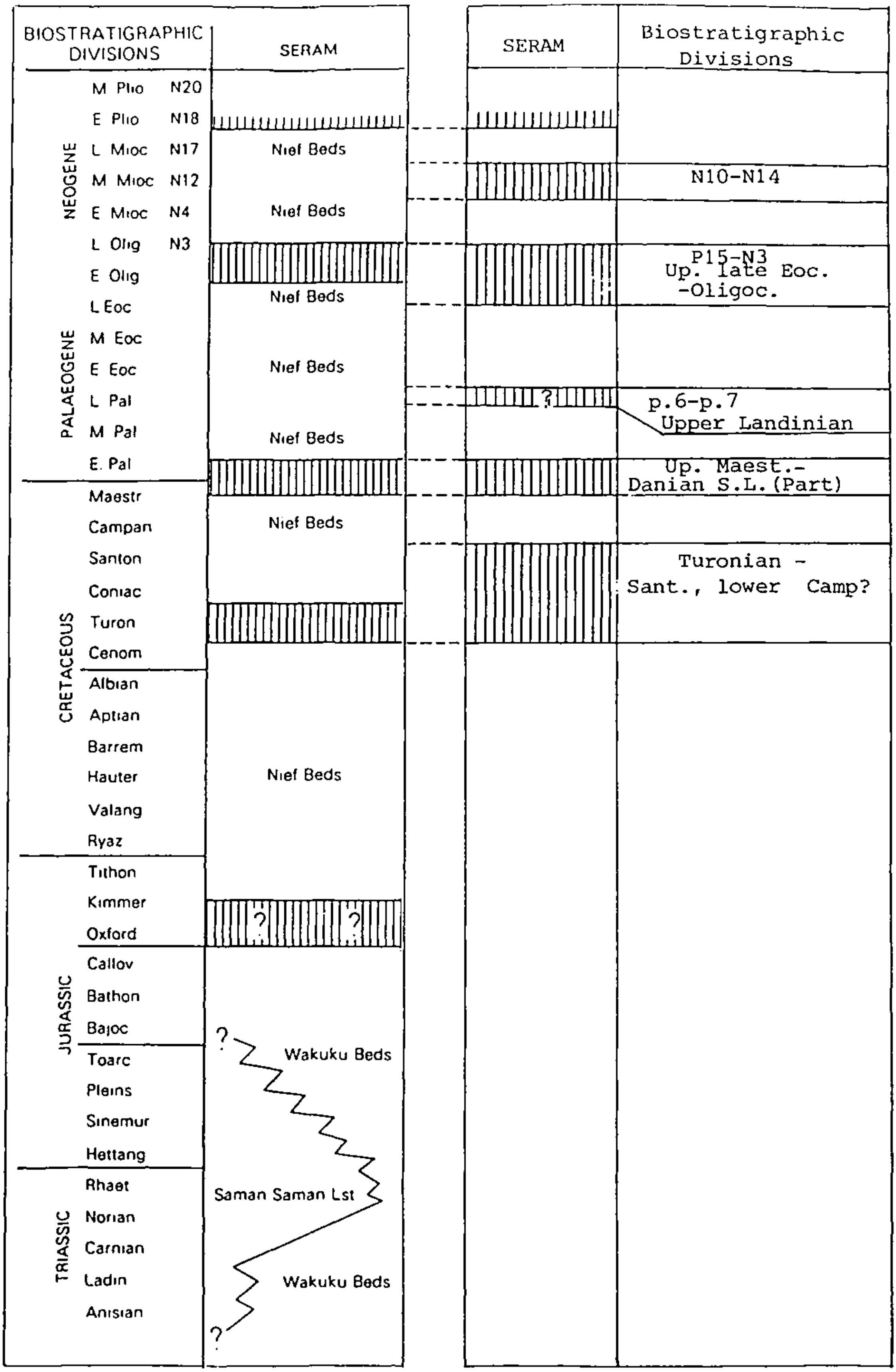
→ Continued

SAMPLES GENUS / SPECIES	C.C.1	C.C.1A	C.C.2	C.C.2A	C.C.3	C.C.3A	C.C.5	C.C.5A	C.C.77	(12-5)*	(17-2)*	(19-1a)*	(19-1b)*	(38-1)*	(38-2)*	(61-5)*	(61-6)*	(72-5)*	(761a-1)*
Planktonic foraminifera																			
Clavihedbergella ? spp.																			
Globigerinelloides bentonensis (Morrow), 1934																			
G. spp																			
Hedbergella sp. 5																			
H. spp										VR	VR				R	R			
Praeglobotruncana stephani turbinata (Reichel) 1949																			
Rotalipora sp. cf. appenninica (Renz), 1936											VR								
Schakoina sp.																			
Benthonic foraminifera																			
Ammobaculites sp. cf. fisheri Crespin, 1953							R												
A. sp. cf. implanus Crespin, 1963							VR												
A. sp. cf. wallalensis Crespin, 1963							VR												
A. spp																			
Ammodiscus cretaceous (Reuss), 1845				R			R												
A. sp. cf. gaultinus Berthelin, 1880							R												
A. sp. cf. parvulus Ten Dam, 1945																			
A. spp.							C												
Ammolagena clavata (Jones and Parker), 1860																			
Astacolus spp.																			
Astrorhiza spp.																			
Bathysiphon spp.	C	R	VR	R			C											VR	
Cyclammina sp.																			
Dentalina spp.	VR																		
Dorothia sp. cf. gradata (Berthelin), 1880	R			VR	C			VR											
Fissurina sp.																			
Frondicularia sp.																			
Gaudryina ? spp.																			
Glomospira charoides (Jones and Parker), 1860																			
G. spp.																			
Glomospirella spp.																			
Haplophragmoides sp. cf. canui Cushman, 1930																			
H. sp. cf. concavus (Chapman), 1892			VR				R												
H. spp.																R			
Hyperammina spp.																			
Lagena spp.																			
Lenticulina spp.																		R	R
Marginulina spp.																			
Nodosaria spp.	VR																		
Polymorphinids spp.																			
Psamminopelta sp. cf. bowsheri Tappan, 1957							VR												
Psammosphaera sp. cf. parva Crespin, 1962						R													
Pseudonodosaria spp.																			
Ramulina spp.																			
Rhizammina spp.				VR	VR	VR	VR												
Saccammina globosa Crespin, 1963							VR												
Spirillina sp.																			
Spiropleatammina sp.																			
Trochammina spp.																			
Turrispirillina sp.																		R	
Vaginulinopsis spp.																			
Verneuilina spp.																			
Verneuilinoides sp. cf. asperulus Crespin, 1963					R														
V. spp.																			
Genus and species?												R	R	R	R	C			
Echinoidea Ossicles	R						VR											VR	
Inoceramus Prisms				VR								R	R			VR		VF	VF
Other Mollusca																		C	
Ostracoda							R												
Radiolaria	F	R		R		VR	F	R	F	VF	VF	VF	VF	VF	VF	VF	VF	C	F
Sponge Spicules	VR	VR					VR												
Others																			

Table 7. Distribution and abundance of planktonic and benthonic foraminiferal, and other microfaunal remains in samples from the Lower Cretaceous and Upper Jurassic part of the Nief Beds. The Ceromanian? Alblan? sample CER.21(1) is listed here to show its benthonic foraminifera. All samples of the Bula traverse (CER.6, CER.6A & CER.21(2)) are provisionally kept in the Nief Beds. All identifications are based on matrix free specimens, unless otherwise indicated by asterisks.

GENUS / SPECIES \ SAMPLES	(82-2)*	(82-3)*	(82-4)*	(82-5)*	(82-6)*	CER.6	CER.6A	CER.21(1)	CER.21(2)	CER.22A*	CER.22B*	CER.22C*	CER.36	CER.37	CER.38	CER.39	CER.40a	CER.58	CER.59
Planktonic foraminifera																			
Clavihedbergella ? spp.			R																
Globigerinelloides bentonensis (Morrow), 1934								VR											
G. spp			R																
Hedbergella sp. 5			R																
H. spp	R	R	F	R	VF														
Praeglobotruncana stephani turbinata (Reichel) 1949								VR											
Rotalipora sp. cf. appenninica (Renz), 1936																			
Schakoina sp.			R																
Benthonic foraminifera																			
Ammobaculites sp. cf. fisheri Crespin, 1953																			
A. sp. cf. implanus Crespin, 1963																			
A. sp. cf. wallalensis Crespin, 1963																			
A. spp																			VR
Ammodiscus cretaceous (Reuss), 1845																			VR
A. sp. cf. gaultinus Berthelin, 1880																			
A. sp. cf. parvulus Ten Dam, 1945																			
A. spp.													VF	VF	VR				
Ammolagena clavata (Jones and Parker), 1860													R	VR					
Astacolus spp.														R	R		F		
Astrorhiza spp.															VR				
Bathysiphon spp.						VR	VF	VF					C	R			VR		C
Cyclammina sp.																			F
Dentalina spp.													VR				C		
Dorothia sp. cf. gradata (Berthelin), 1880																			
Fissurina sp.															VR				
Frondicularia sp.													VR						
Gaudryina ? spp.								VR											
Glomospira charoides (Jones and Parker), 1860													R	C					
G. spp.													R						C
Glomospirella spp.													R						VR
Haplophragmoides sp. cf. canui Cushman, 1930								VR											
H. sp. cf. concavus (Chapman), 1892								R										VR	
H. spp.																			VR
Hyperammina spp.							VF						C	C					VF
Lagena spp.													C						
Lenticulina spp.													R	C	F		F		
Marginulina spp.														R					
Nodosaria spp.													VR				R		
Polymorphinids spp.													R	R	VR		R		
Psamminopelta sp. cf. bowsheri Tappan, 1957																			
Psammosphaera sp. cf. parva Crespin, 1962																			
Pseudonodosaria spp.													R	VR					
Ramulina spp.														R					
Rhizammina spp.								C					VF	C					
Saccamina globosa Crespin, 1963																			
Spirillina sp.														F					
Spiroplectammina sp.								VR											
Trochammina spp.								R											
Turrispirillina sp.													R	F					
Vaginulinopsis spp.																	R		
Verneuilina spp.								VR											
Verneuilinoides sp. cf. asperulus Crespin, 1963								C								VR			
V. spp.																VR			
Genus and species?				R	R								C	VF	C	VR			C
Echinoidea Ossicles								R			R			R	C				
Inoceramus Prisms	VR		F	C	C								VF	R	F	VF	VF	R	
Other Mollusca			C								C	C	R	VF	F		R		
Ostracoda													R	F	C		VF		
Radiolaria	VF	VF	VF	VF	VF	R		VF		VF	VF	VF	VF	F	VF				F
Sponge Spicules								C											
Others								R	R				R	R	R			R	R

Table 7. - continued



After Audley-Charles et al. (1979) Re-Evaluation

Table 8

Comparision of the age and the stratigraphical breaks of the Nief Beds based on Audley-Charles et al. (1979) and their re-evaluation on the present work.

the Nief Beds consists of benthonic Foraminifera, Radiolaria and Inoceramus prisms. Very badly preserved planktonic Foraminifera, Mollusca, Ostracoda, Echinoid ossicles and Sponge spicules (See Table 7) are also present.

The samples which contain planktonic Foraminifera are referred here to the Albian (See general remarks under Cenomanian). The benthonic Foraminifera recognized from the other samples are not reliable age indicators. According to Audley-Charles et al. (1979), the stratigraphical age of this part of the Nief Beds ranges from Upper Jurassic to Lower Cretaceous.

The Wakuku Beds

Type Locality

The Wakuku Beds take their informal name from the Wakuku river, south east of Manusela village in central Seram where this unit is well developed (FIG. 2, 15). This division is of Formational status (Audley-Charles et al., 1979).

Distribution

The Wakuku Beds are widely exposed in central and north east of Seram (FIGS. 11, 12). They have been reported from north west of Seram as part of the Upper Triassic Formation (Valk, 1945).

In Central Seram they are well developed along the Wakuku river, south east of Manusela village (FIG. 15).

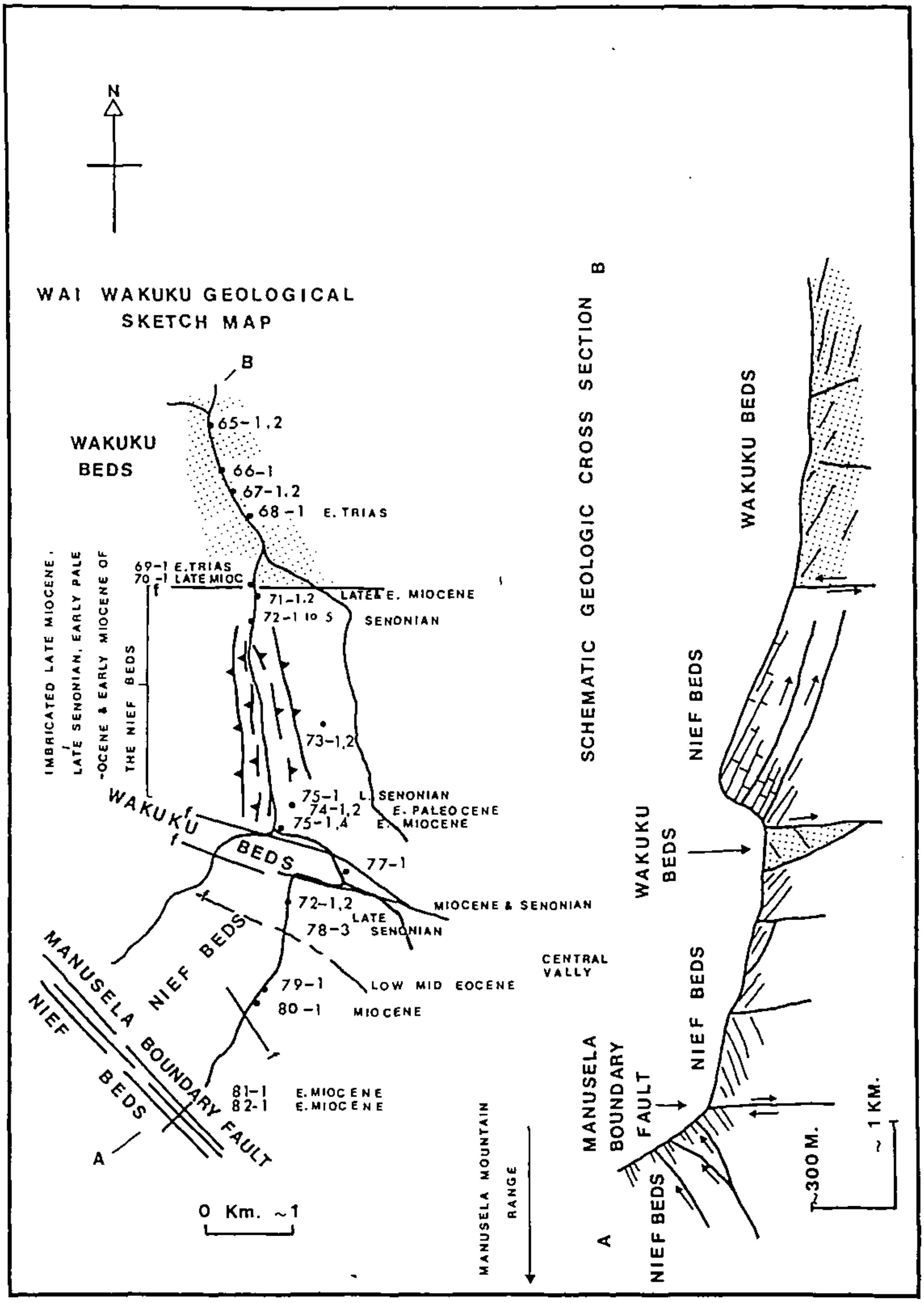


FIG. 15. Stratigraphical section and sketch map of the Wakuku river, southeast Manusela village, central Seram, where the Wakuku Beds are well developed "Type Locality". This section also shows the imbrication of the Nief Beds. For approximate location of this section and map, see Isal-Wakuku River Traverse, FIG. 5.
(After Audley-Charles et al., 1979).

Also they are exposed as an imbricated layers with the Nief Beds in the Central Valley (FIG. 16) and the Loemoete Mountain range (FIG. 17). In the north east of Seram, they are exposed north east and south west of the Nief river (FIG. 13).

Age

According to the palynological analysis given in the A.A.R. Limited Lab. Report N.200/1 (Price 1976), and by Audley-Charles et al. (1979), the age of the Wakuku Beds ranges from Early Triassic to Early Jurassic. None of the Foraminifera identified from this "Formation" are age indicators.

Thickness

Approximately 1,000 metres.

Lithology

The Wakuku Formation consists mainly of dark siliciclastics showing sedimentary structures and bioturbation. In central Seram, it is composed of various proportions of dark, carbonaceous and micaceous siltstones, mudstones and sandstones. South of Seleman Bay, quartz arenites containing small quartz pebble conglomerate bands occur. In the Nief region, it consists mainly of mudstones with subordinate arenites.

Environment of deposition

Low energy, in moderately deep marine environment.

Micropaleontological analysis

Micropaleontological analysis of the samples from the Wakuku Beds shows that the microfauna consists mainly of benthonic Foraminifera and Ostracoda. Conodonts, Echinoid ossicles, Microgastropods, Microbivalvia, Radiolaria, Rhyncolite, Sponge spicules and other unidentified forms (Table 9) also occur.

Saman Saman Limestone

Type Locality

The Saman Saman Limestone takes its informal name from Saman Saman mountain in the Manusela range of Central Seram (FIG. 16).

Distribution

This limestone is exposed mainly in the Manusel mountains of central Seram (FIG. 16). It has been reported from the north west of Seram as part of the "Upper Triassic Formation" (Valk, 1945). Limestone in a similar facies is found as thin intercalations in the Wakuku Beds (Audley-Charles et al., 1979).

ROCK UNITS	WAKUKU BEDS																			SAMAN SAMAN LIMESTONE							OTHER UNITS ?				
TIME UNITS	EARLY TRIASSIC-EARLY JURASSIC																			M.TRIAS.-E.JUR.							PRE-MIDDLE CRETACEOUS				
SAMPLES / GENUS/SPECIES	C.C.8	C.C.13A?	C.C.13B?	C.C.13E	C.C.23	C.C.52? L.B.	C.C.53?	C.C.55? L.B.	C.C.81?	C.C.82?	(11-3)?	(39-1)	(65-1)	(65-2)	(68-1)	(69-1)	(77-1)	CER.14C	CER.53C?	(18-1) *	CER.40b *	CER.41 *	CER.42 *	CER.49(1) *	CER.52? *	CER.57	C.C.78	C.C.14	C.C.54* L.B.	C.C.80 L.B.	C.C.84
Benthonic foraminifera																															
Ammobaculites spp.	VF	R	VR	R					R		R																				
Ammodiscus spp.	R	F		F					VF	F																					
Astacolus spp.		R	R	C						R																					
Bathysiphon spp.				VR						C	C							VF										R	VR		
Dentalina sp	VF	F	F	VF					R																						
Frondicularia spp.										VR										VR					VR						
Glomospirella spp.			VR																												
Guadryina spp.	F									C	R																				
Haplophragmoides spp.	R	VR																VR									VR				
Hippocrepina spp.																												VR			
Hyperammina spp.	R								F	C	VR					R	R	F										R	R		
Lagena spp.	C	C	C	R						R																					
Lenticulina spp.	R			C					R	R						VR	VR														
Marginulina spp.				C						R																					
Nodosaria spp.	R	R	R	R																											
Pelosina spp.	VR	VR	R						VR																						
Polymorphinids spp.				F																											
Pseudonodosaria spp.	R	R	C	F						C																					
Reophax spp.	R									VR																					
Rhizammina spp.	VF		VR						R	C																					
Spiroplectammina spp.			VR			N	N	N					N	N	N				N											N	N
Tolypammina spp.	VR					E	E	E					E	E	E				E											E	E
Trochammina spp.	VF	R				R	R	R	VF	VF			R	R	R		VF		R											R	R
Thuraminoides sphaeroidalis	VF					R	R	R	C	R			R	R	R	C	VF	C	R											R	R
Genus and species?	C		C			A	A	A	C	C		R	A	A	A		F		A	R					R					A	A
Conodonts	R					B	B	B					B	B	B		VR		B											B	B
Echinoid ossicles			C																						VR						
Mollusca																															
Microgastropods																VF	VF														
Microbivalvia											R					VF	C										C	R	C		
Halobia like fragments																				VF	VF	VF	VF	VF	F	R			R		
Ostracods																															
Bairdia sp.				F																											
Bythocypris sp.			R	R																											
Cytherella sp.				C						R																					
Hungarella sp.		C																													
Isobythocypris sp.		VF	R	F																											
Paracypris sp.			R																												
cf. Pleurocythere sp.		VR																													
Other forms	F	F		C					VR							R	R				R										
Radiolaria			R	R	R							R						R		VF	C	C	F	VF	VF	F			F		
Rhyncholite (cephalopod teeth)																		VR													
Sponge spicules		VR	R	VR																											
Other organic remains			R						R																						

Table 9. Distribution and abundance of benthonic foraminifera and other microfaunal remains in samples from the Wakuku Beds, Saman Saman Limestone and other rock units including loose boulders (L.B.) containing various rock fragments (C.C.45), scaly calcareous clay (C.C.14) and Manganese-stained breccia (C.C.80 & C.C.84).

(Anisian-Ladinian)? and (Ladinian-Carnian) ages are assigned to sample (68-1) and (69-1) respectively according to the palynological analysis of the A.A.R. Limited Lab. Rep. No. 200/1 (Price, 1976).

* Identification based on thin section.

? Doubtful assignment.

Age

According to Audley-Charles et al. (1979), the age of Saman Saman Formation is Middle Triassic to Early Jurassic.

Thickness

Approximately 1,000 metres (tentative thickness).

Lithology

The samples available consist of laminated marl flooded with moulds of Radiolaria and fragments of Halobia-type bivalves. Microscopic examination in one thin section (CER. 40) shows that these fragments are aligned in one direction.

Environment of deposition

The fine grain-size sediments and the planktonic microfossils suggest that the Saman Saman Limestone was deposited in very deep water beyond the shelf.

Micropaleontological Analysis

Micropaleontological analysis of the samples from the Saman Saman Limestone shows that microfossils consist mainly of Radiolarian moulds and fragments of

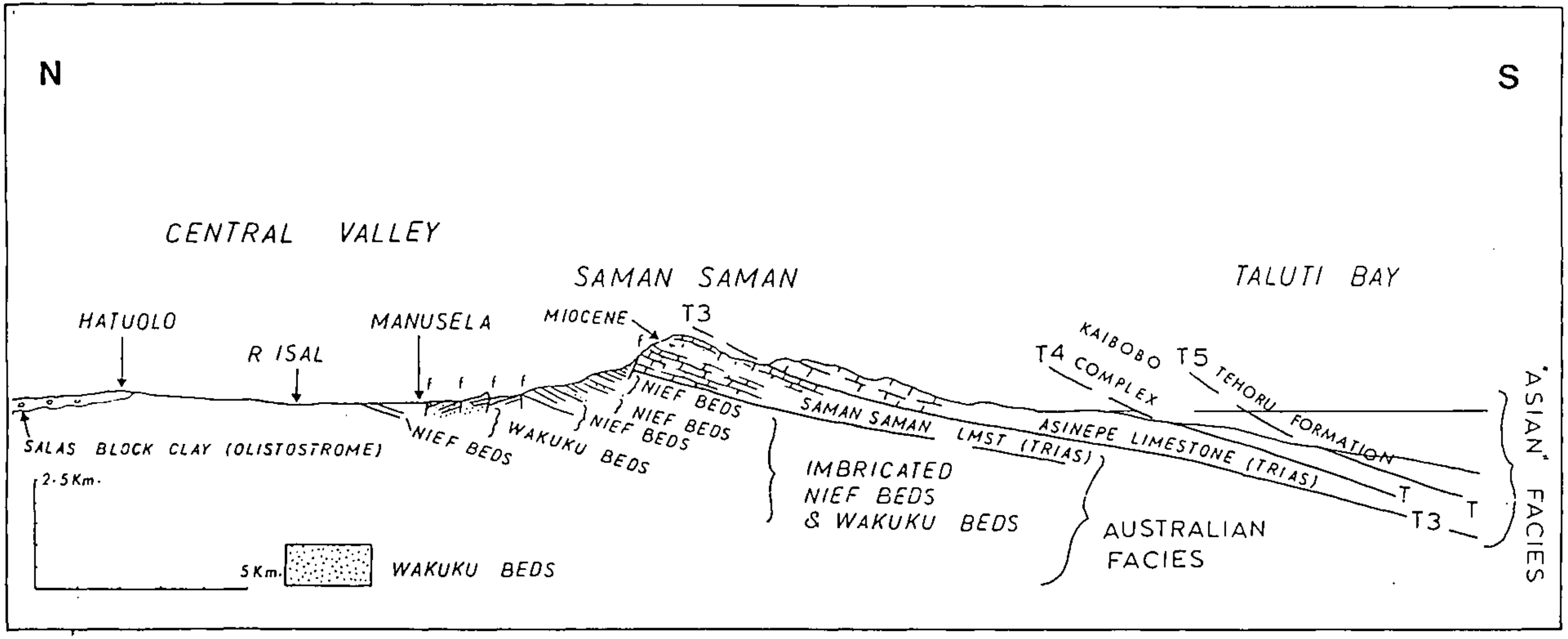


FIG. 16. Stratigraphical-structural sections in mountain Saman Saman (Manusela mountains range) near the southern coast (Taluti Bay) of central seram where the Saman Saman Limestone is well developed "Type Locality". This section also shows the overthrusting of the Saman Saman Limestone over the imbricated Nief Beds and the Wakuku Beds. For approximate location of this section see Isal-Wakuku River Traverse (FIG. 5) and the location map of sample traverses (FIG. 2). (After Audley-Charles et al., 1979).

Halobia-type Bivalves (Table 9).

The Asinepe Limestone

Type Locality

The Asinepe Limestone takes its informal name from Asinepe mountain in the Loemoete mountain range of north central Seram, near the south east coast of the Bay of Seleman (FIG. 17). This division is of Formational status (Audley-Charles et al. 1979).

Distribution

The Asinepe Limestone outcrops widely in central Seram, extending from the Manusela range of south Seram to the Loemoete mountains in the north and north west (FIGS. 11, 12, 16, 17). Minor occurrences described as small Klippe were also reported from west Seram (Valk, 1945) and east Seram (Sluis, 1950). According to Audley-Charles et al. (1979), the Asinepe Limestone in the eastern part of Seram seems to form "Fatus" (local name for isolated, steep sided, limestone hills), which are probably large exotic blocks in the Salas Block Clay. It also occurs as exotics in the Salas Block Clay of north Seram.

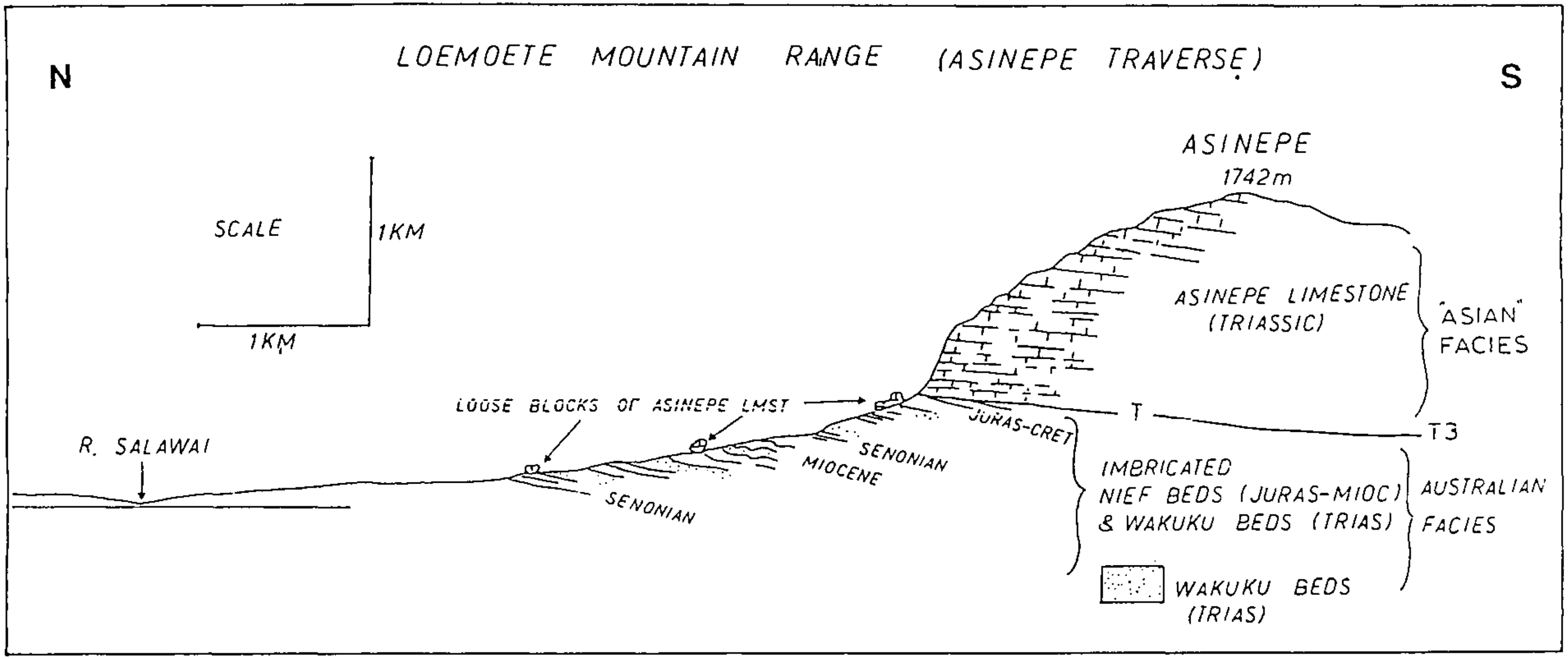


FIG. 17. Stratigraphical-structural sections in mountain Asinepe (Loemoete mountain range) near the north coast of central seram where the Asinepe Limestone is very well developed "Type Locality". This section also shows the overthrusting of the Asinepe Limestone over the imbricated Nief Beds and the Wakuku Beds. For approximate location of this section see Bay of Seleman Traverse (FIG.3) and the location map of sample traverses (FIG.2).
(After Audley-Charles et al., 1979).

Thickness

The true thickness of the Asinepe Limestone is about 1,500 m.

Lithology

The Asinepe Limestone is usually grey, and may be oolitic or bioclastic. Petrographically most samples are of grainstone, and few approach crystalline carbonate with only very few badly preserved microfossils visible (Dunham, in Ham, 1962, a symposium on the classification of carbonate rocks).

Environment of deposition

From the distribution of the benthonic *Foraminifera* (Table 10), and the paleoecological scheme of Sadati (1981, p. 213), the Asinepe Limestone represents a warm water, reefal and lagoonal facies. It has close affinities with the Asian continental margin in both facies and fauna (Audley-Charles et al., 1979).

Micropaleontological analysis

The Asinepe Limestone consists largely of bioclasts of various types including small and large *Foraminifera*, *Algae*, *Corals*, *Echinoid* ossicles, *Ostracoda*, problematica and others (FIG. 10). A very few *Foraminifera* were

→ Continued

Samples / Genus/Species & Inorganic Structure	C.C.10	C.C.13C	C.C.13D	C.C.28	C.C.85*	(12-2)	(12-4)	(12-6)	(12-7)	(12-9)	(13-1)	(13-4)	(21-1)	(46-2)	(61-2)
Benthonic foraminifera															
Ammobaculites sp.			VR												
Ammodiscus sp.										VR					
Duotaxis birmanica Bronnimann et al, 1975															
Duotaxis sp.											C		R		
Duostomina sp.					VR										
Frondicularia spp.			VR		C		R			C					
Galeanella panticae Zaninetti et al, 1973	C		VR												
Galeanella sp.	R		R								R				
Glomospira sp.1										R					
Glomospira spp.			VR				VR			VR					
Glomospirella friedly Kristan-Tollmann, 1962							VR			VR					
Glomospirella sp.						VR									
Involutina communis (Kristan), 1957					C		C						R		
I. gaschei (Koehn-Zaninetti et al), 1968					C	C	F			C	R				
I. impressa (Kristan-Tollmann), 1964															
I. sinuosa sinuosa (Weynschenk), 1956															
I. sinuosa pragsoides (Oberhauser), 1964					R		R			C	R				
I. aff. tenuis Kristan, 1957										R	VR				
I. tumida (Kristan-Tollmann), 1964								R		C					
I.? sp.												VR			
Miliolipora cuvillieri Bronnimann & Zaninetti 1971			C												
Ophthalmidium spp.	VR		R	R	VR						VR				
Planiinvoluta carinata Leischner, 1961											R				
Sigmoilina sp.			C												
Tetrataxis sp.			R												
Triasina hantkeni Majzon, 1954										VF					
Trochammina alpina Kristan-Tollmann, 1964			R										R		
"Trochammina" spp.													R		
Genus "B" species 1 ?							VR								
Other *benthonic foraminifera*	F	F	C	R	C	C	C	C	R	C	C		C		
Algae	C	F		VR	C		R	C	VR		R	R	C		
Corals	R			VR		R	R	C	R		R		C	C	
Echinoid ossicles	R	C	R		C			VR	R		VR	R		C	
Mollusca															
Gastropoda	R	R								R					
Bivalvia	C	R								R					
Others			VR		R		F	C	C	R	R	C	C		
Ostracoda					VR										
Trace fossils, Borings & Problematica															
Annelid traces and tubes		C					R								
Favreina sp.		C										C			
Globochaete gregaria Schafer et al, 1982											R				
Microoncolite? sp.															
Muranella sphaerica Bozza, 1975			R												
Others													C		
Other bioclasts	VF	VF	C		F		VF	VF	F	F	F	C	VF		
Oolites and Pellets (Inorganic structure)			R	VR											VF

Table 10. Distribution and abundance of benthonic foraminifera and other microfaunal remains in samples from the Asinepe Limestone (Upper Triassic).

Samples Genus/Species & Inorganic Structure	CER.1	CER.1A	CER.10A	CER.19	CER.19A	CER.20	CER.20A	CER.20B	CER.20C	CER.28A	CER.43	CER.44	CER.45	CER.54	CER.55
Benthonic foraminifera															
Ammobaculites sp.															
Ammodiscus sp.															
Duotaxis birmanica Bronnimann et al, 1975														VR	VR
Duotaxis sp.						R									
Duostomina sp.															
Frondicularia spp.	VR						VR	VR		VR		VR			
Galeanella panticae Zaninetti et al, 1973														VR	
Galeanella sp.															
Glomospira sp.1		VR										VR			
Glomospira spp.		R							VR			VR	VR		VR
Glomospirella friedly Kristan-Tollmann, 1962															
Glomospirella sp.											R				VR
Involutina communis (Kristan), 1957	VR	R													
I. gaschei (Koehn-Zaninetti et al), 1968		VR		R	VR								VR		
I. impressa (Kristan-Tollmann), 1964															VR
I. sinuosa sinuosa (Weynschenk), 1956		R													
I. sinuosa pragsoides (Oberhauser), 1964		VR		C					R						
I. aff. tenuis Kristan, 1957															
I. tumida (Kristan-Tollmann), 1964													VR		
I.? sp.												VR			
Miliolipora cuvillieri Bronnimann & Zaninetti 1971															
Ophthalmidium spp.	VR														
Planiinvoluta carinata Leischner, 1961						VR									
Sigmoilina sp.															
Tetrataxis sp.															
Triasina hantkeni Majzon, 1954	VR	R		C	R		VR	R				R	R		
Trochammina alpina Kristan-Tollmann, 1964									VR	R		R		VR	
"Trochammina" spp.													R		
Genus "B" species 1 ?												VR			
Other *benthonic foraminifera*		VF	R	C	C	C	C	C	C		VR	C	C	R	C
Algae			C	C			R		R	R				C	R
Corals	R	R	R				R	C		C				R	C
Echinoid ossicles			C	VF	VF	R				VR				R	
Mollusca															
Gastropoda										R					R
Bivalvia															R
Others	R			C			C	R						F	
Ostracoda	VR		VR				VR							R	VR
Trace fossils, Borings & Problematica															
Annelid traces and tubes										F				R	
Favreina sp.						C			R	R					VR
Globochaete gregaria Schafer et al, 1980															
Microoncolite? sp.							VR	C	VR				VR	R	
Muranella sphaerica Borza, 1975															
Others							R	R	R	R		R			
Other bioclasts	VF	VF	F	VF	VF	VF	VF	VF	VF	VF	R	VF	VF	VF	VF
Oolites and Pellets (Inorganic structure)															

Table 10. - continued

recognized from the oolitic part of the Asinepe Limestone but these are stratigraphically valueless.

Re-evaluation of the age

Current confusion concerning the age of the Asinepe Limestone in Seram renders it necessary to give a short summary of the previous palaeontological work on which the dating has been based before giving the results of the present work.

Reporting on the *Corals* and *Sponges* of the Asinepe Limestone, De Regny (1915, in Valk, 1945), Krumbeck (1923, in Valk, 1945) and Wilckens (1937, in Valk, 1945) indicated that these show the Alpine characteristics of the Triassic of the Malay Archipelago. Wilckens (op. cit.) dated *Sponges* from eastern West Seram collected by Deninger (1914) as Upper Norian. Valk (1945) regarded the age of the Asinepe Limestone in West Seram (The coralligenous part of his "Younger Upper Triassic") as Upper Triassic, basing his conclusion on the presence of many species of *Sponges* and *Corals* (notably *Lovcenipora* *vinassai* Giattini) and on their resemblance to these in the Upper Triassic of central and east Seram, Timor, Montenegro and the Salt Range of India. Valk stated: "In any case there is evidence for the presence of Upper Norian".

Germeraad (1946) also assigned the Asinepe Limestone in Central Seram (The coralligenous part of the "Normal Triassic") to the Triassic, basing his conclusion on the presence of many species of *Sponges*, Corals and Algae notably the Coral species Lovcenipora vinassai Giattini.

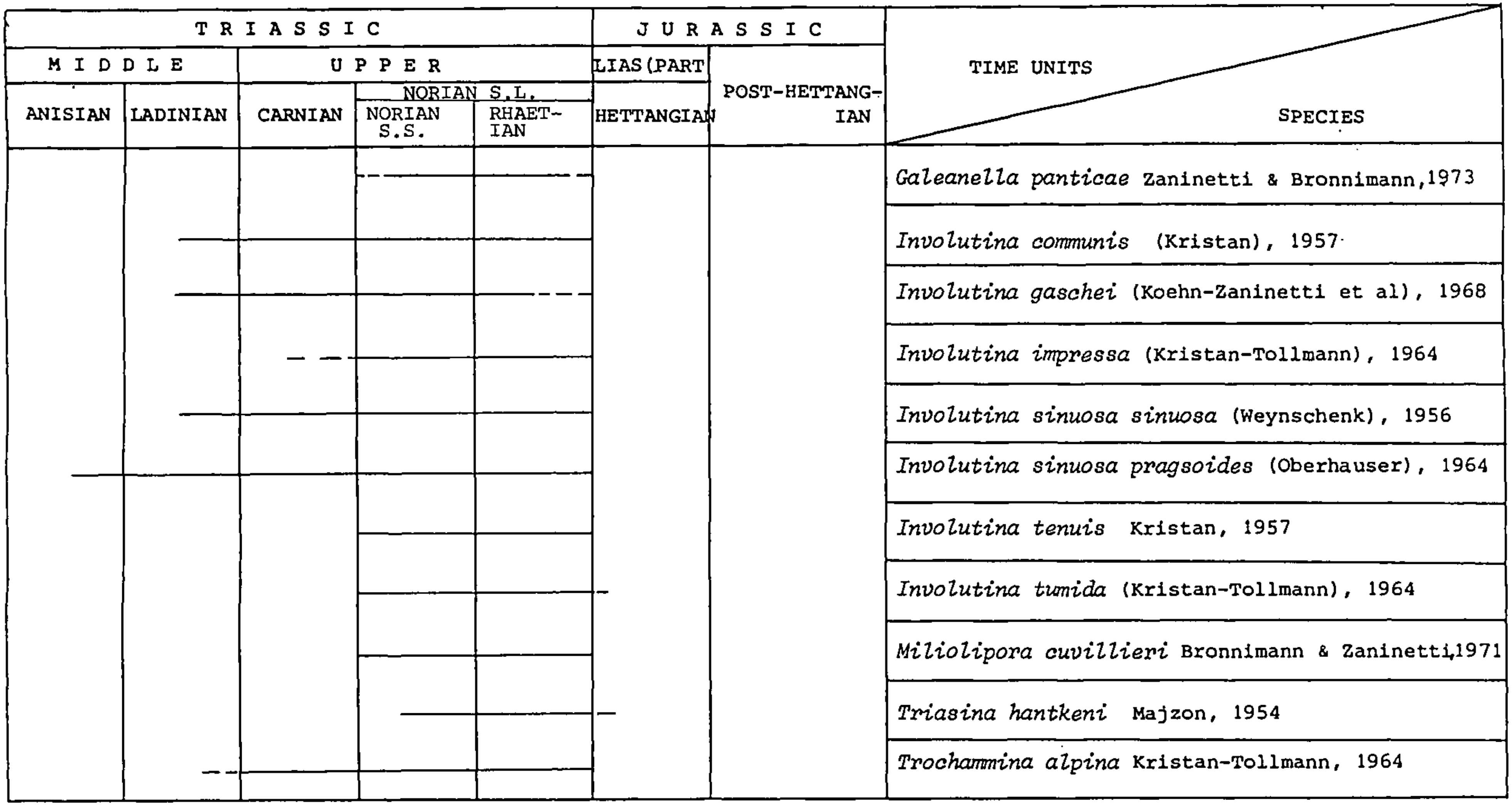
Bemmelen (1949) and Sluis (1950) regarded the age of the Asinepe Limestone as Upper Jurassic. They considered the Coral Lovcenipora or Lovcenipora and Pseudocyclammina as good indicators for the Upper Jurassic. Bemmelen (1949) stated "The supposed Triassic age of Lovcenipora is the result of a wrong estimate of the age of the Formation in which it was originally found". According to Sluis (1950), wherever Lovcenipora limestone is described (and probably all the Asinepe Limestone contains this genus), the age is Upper Jurassic and not Upper Triassic.

According to Audley-Charles et.al. (1979), a Triassic age for at least part of the Asinepe Limestone seems to be likely. Their conclusion is based on the similar fauna and facies from Timor, which have been dated as Late Triassic by Yamagiwa (1963). In the present study, the author has recognized for the first time many short-lived foraminiferal species in the Asinepe Limestone which are very useful guide fossils, and can be used to re-evaluate the age of this "Formation".

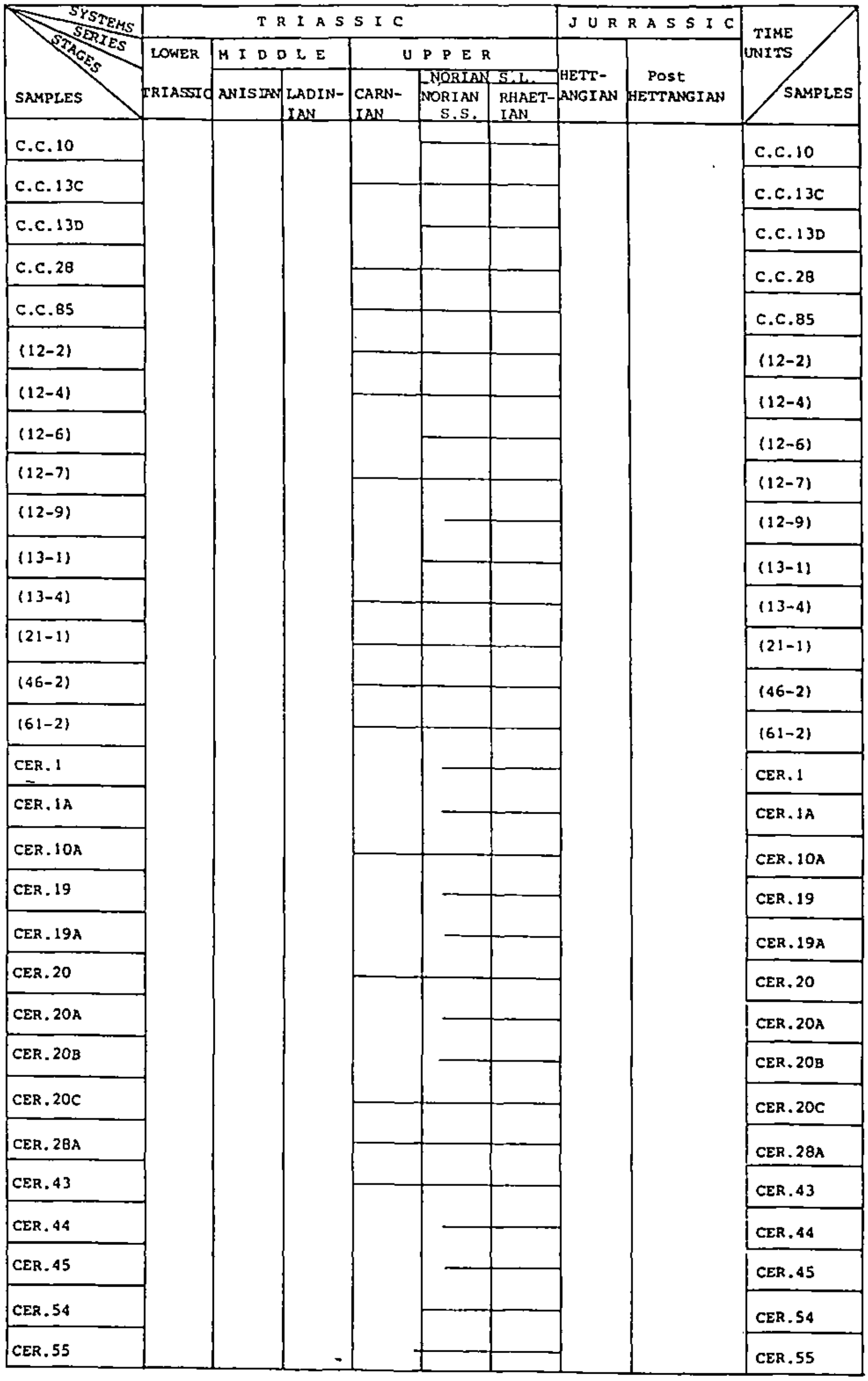
From the distribution of the Foraminifera (Table 10) and their stratigraphic ranges (Range Chart 4), the age of each sample (Table 11) was determined. The age limits for each sample are indicated by a solid line; the age of each sample lies somewhere between these limits. The dominant age range of the samples from the

Asinepe Limestone (See Table 11) is inferred here to be Norian S.L.

No index Foraminifera were recognized in the samples from the oolitic part of the Asinepe Limestone. Valk (1945, p. 1.1, figs. 3, 7-10) reported ?? *Cymbalopora* *sp*. (= *Triasina hantkeni*) and ?? *Hydrozoans* (= *Involutina* ex. gr. *sinuosa*) from the Oolitic limestone of the W. Lela and P. Boano of Seram. If this is the case, the age of this unit is Norian S.L.



Range Chart 4. Stratigraphical ranges of the age diagnostic Upper Triassic foraminiferal species present in Seram. They are synthesised from the ranges reported in the world literature.



SYSTEMS SERIES STAGES SAMPLES	TRIASSIC						JURRASSIC		TIME UNITS SAMPLES
	LOWER	MIDDLE		UPPER					
					NORIAN S.L.				
	TRIASSIC	ANISIAN	LADINIAN	CARNIAN	NORIAN S.S.	RHAETIAN	HETTANGIAN	Post HETTANGIAN	
C.C.10									C.C.10
C.C.13C									C.C.13C
C.C.13D									C.C.13D
C.C.28									C.C.28
C.C.85									C.C.85
(12-2)									(12-2)
(12-4)									(12-4)
(12-6)									(12-6)
(12-7)									(12-7)
(12-9)									(12-9)
(13-1)									(13-1)
(13-4)									(13-4)
(21-1)									(21-1)
(46-2)									(46-2)
(61-2)									(61-2)
CER.1									CER.1
CER.1A									CER.1A
CER.10A									CER.10A
CER.19									CER.19
CER.19A									CER.19A
CER.20									CER.20
CER.20A									CER.20A
CER.20B									CER.20B
CER.20C									CER.20C
CER.28A									CER.28A
CER.43									CER.43
CER.44									CER.44
CER.45									CER.45
CER.54									CER.54
CER.55									CER.55

Table 11. Triassic samples of the Asinepe Limestone. The age limits of each sample are indicated by a solid line; the age of each sample lies somewhere between these limits.

CHAPTER 4

Comparison of Micropaleontological Zonations

Since the work of Thalmann (1932, 1934), Renz (1936) and Glaessner (1937a), the planktonic Foraminifera have proved to be of great stratigraphical value for regional and intercontinental correlation. Subsequently, a large number of Tertiary and Cretaceous zonal schemes have been proposed and published in the extensive international literature. No attempt is made here to review the historical background and the evolution of the different zonations which has already been presented in many publications including those of Bandy (1967), Parker (1967), Cita and Gartner (1971), and Stainforth et al. (1975), etc.

The abundance of planktonic Foraminifera from Seram and the short ranges of many, make them very useful guides in the construction of the stratigraphy and structure of the island.

For the Tertiary portion of the Nief Beds, the "P/N" zonation by Blow (1969, 1979) was applied. The equivalents in schemes of other selected authors, and the revised age of the Nief Beds are given in three tables; the Miocene (Table 12), the Eocene (Table 13), and the Paleocene (Table 14). For the Cretaceous, the zonal subdivisions of Pessagno (1967) was followed. The relationship of these subdivisions to the zonal schemes of other selected authors, and the revised age of the Nief Beds is given in Table 15.

Because of the complex tectonics in central and eastern Seram, the Nief Beds are strongly disturbed, cut by many reverse faults and covered in many places by slip masses. This geologic setting results in a complete absence of long, continuous, undisturbed, stratigraphical sections in the Nief Beds (See Chapter 1, sample collections). This has complicated the study of the original stratigraphical sequence and hinders detailed local biostratigraphical zonation and evolutionary study of the planktonic foraminifera of this island. Consequently, the local Foraminiferal zonation of the Nief Beds is not generally applicable since it does not indicate the stratigraphical levels of the first appearance and extinction of each species. However, the age limits for each sample are indicated; the age of each sample lies somewhere between these limits. These are determined from the overlapping of the species ranges in each sample (See Chapter 3). A narrower age limit indicates the presence of large numbers of species in the sample, and/or the presence of short-lived, index species. Consequently, the zonal equivalent can be narrowly determined for some samples. Others may show a broader spread (See Table 2, 4, 6).

SERAM	EPOCH & STAGE		BLOW 1969		H.M.Bolli, 1957 (U.S.Nat.Mus.Bull.215) TRINIDAD	W.H.Blow, 1959 (Bull.Amer.Pal.39, No.178) VENEZUELA	H.M.Bolli, 1966 (Bol.Informativo, Assoc. Venez.de Geol., Min.y Pet)	Jenkins 1965, 1966 NEW ZEALAND
			ZONAL SERIES AND NUMBER	FORMAL TAXON NAMES				
	PLIOCENE							
NIEF BEDS	LATE MIOCENE	Tortonian-Messinian	ZONE N.18	*Globorotalia (G.) tumida tumida*–*Sphaeroidinellopsis subdehiscens paenedehiscens* Partial-range Zone			*Globorotalia margaritae* Zone	Globorotalia (G.) miozea sphericomiozea Zone
			ZONE N.17	*Globorotalia (G.) tumida plesiotumida* Consecutive-range Zone		*Globigerina bulloides* Zone "*Sphaeroidinella seminulina* Zone". "ZONES" APPLICABLE TO POZON FMT. ONLY (see figure 17)	*Globorotalia dutertrei* Zone	Globorotalia (G.) miotumida miotumida Zone
			ZONE N.16	*Globorotalia (T.) acostaensis acostaensis* – *G. (G.) merotumida* Partial-range Zone	?	"*Globorotalia menardii* / *Globigerina nepenthes* Zone"	*Globorotalia acostaensis* Zone	
			ZONE N.15	*Globorotalia (T.) continuosa* Consecutive-range Zone	? *Globorotalia menardii* Zone		*Globorotalia menardii* Zone	
	MIDDLE MIOCENE	Langhian						
NIEF BEDS			ZONE N.9	*Orbulina suturalis* — *Globorotalia (T.) peripheroronda* Partial-range Zone	*Globorotalia fohsi barisanensis* Zone	*Globorotalia fohsi barisanensis* Zone	*Globorotalia fohsi barisanensis* Zone	Orbulina suturalis Zone
	EARLY MIOCENE	Burdigalian	ZONE N.8	*Globigerinoides sicanus* — *Globigerinatella insueta* Partial-range Zone	*Globigerinatella insueta* Zone	*Globigerinatella insueta* / *Globigerinoides bisphericus* Subzone	*Praeorbulina glomerosa* Zone	Praeorbulina glomerosa curva Zone
			ZONE N.7	*Globigerinatella insueta* – *Globigerinoides quadrilobatus trilobus* Partial-range Zone		*Globigerinatella insueta* / *Globigerinoides trilobus* Subzone	*Globigerinatella insueta* Zone	Globigerinoides trilobus trilobus Zone
			ZONE N.6	*Globigerinatella insueta* / *Globigerinita dissimilis* Concurrent-range Zone	*Catapsydrax stainforthi* Zone	*Catapsydrax stainforthi* Zone	*Catapsydrax stainforthi* Zone	
		Aquitanian	ZONE N.5	*Globoquadrina dehiscens praedehiscens* – *(G.) dehiscens dehiscens* Partial-range Zone	*Catapsydrax dissimilis* Zone	*Catapsydrax dissimilis* Zone	*Catapsydrax dissimilis* Zone	
			ZONE N.4 emended	*Globigerinoides quadrilobatus primordius* / *Globorotalia (T.) kugleri* Partial-range Zone	*Globorotalia kugleri* Zone	*Globorotalia kugleri* Zone	*Globorotalia kugleri* Zone	Globigerina (G.) woodi connecta Zone
	OLIGOCENE		ZONE N.3 (= P.22) emended	*Globigerina angulisuturalis* Partial-range Zone	*Globigerina ciperoensis ciperoensis* Zone		*Globigerina ciperoensis ciperoensis* Zone	

Table 12. Relationship of the Miocene "P/N" zones by Blow (1969) to other zonations and the Miocene portion of the Nief Beds.

Compiled from Blow (1969) and Bolli (1966).

SERAM	EPOCH	STAGE	BLOW, 1979 FORMAL TAXONOMIC NAME	BLOW, 1979 ZONAL "P" No.	SUBBOTINA, 1953, 1960, CAUCASUS	BOLLI, 1957, TRINIDAD	BOLLI AND CITA 1960, ITALY	LUTERBACHER & PREMOLI-SILVA, 1964, AND LUTERBACHER, 1964, ITALY	HILLEBRANDT, 1965, ZUMAYA — GUETARIA, SPAIN	JENKINS, 1965, NEW ZEALAND	BOLLI, 1966, (Composite evidence)	BLOW, 1969, (Part I of this work)	BERGGREN, 1969, (Ascribed to Blow and Berggren unpub.) (Composite evidence)	ZONAL "P" NO.
	LATE EOC (part)	PRIABON (part)	(emended)	ZONE P.15		HIATUS	NOT RECORDED	NOT RECORDED	NOT RECORDED	*linaperta* Zone (part)	– – ? – –			ZONE P.15
NIEF BEDS	MIDDLE EOCENE	LUTETIAN (? including AUVERSIAN, Auctt.)	*Globorotalia (Morozovella) spinulosa spinulosa* Partial-range zone	ZONE P.14 (emended)	ZONE OF THIN WALLED PELAGIC FORAMINIFERA	*Truncorotaloides rohri* Zone				*Globorotalia inconspicua inconspicua* Zone	*Truncorotaloides rohri* Zone	[Zone P.14] *Truncorotaloides rohri Globigerinita howei* Partial-range zone	[Zone P.14] *Truncorotaloides rohri Globigerinita howei* Partial-range zone	ZONE P.14 (emended)
			Globigerapsis beckmanni Total-range zone	ZONE P.13		*Porticulasphaera mexicana* Zone					*Porticulasphaera mexicana* Zone	[Zone P.13] *Orbulinoides beckmanni* Total-range zone	[Zone P.13] *Orbulinoides beckmanni* Total-range zone	ZONE P.13
			Globorotalia (Morozovella) lehneri Partial-range zone	ZONE P.12		*Globorotalia lehneri* Zone	– – ? – – *Hantkenina aragonensis* or *Globigerapsis kugleri* Zones	– – ? – –		BOUNDARY NOT DEFINED ON THE GLOBIGERINACEA (Boundary defined on the first appearance of *Chiloguembelina cubensis*)	*Globorotalia lehneri* Zone	NOT RECORDED	[Zone P.12] *Globorotalia lehneri* Partial-range zone	ZONE P.12
			Globigerapsis kugleri / Subbotina frontosa boweri Concurrent-range zone	ZONE P.11	ZONE OF ACARININIDS *Acarinina crassaformis* and *A. rotundimarginata* Subzones (Combined)	*Globigerapsis kugleri* Zone and *Hantkenina aragonensis* Zone (Combined)	*Hantkenina aragonensis* Zone	*Globorotalia bullbrooki* Zone		*Globigerapsis index* Zone	*Globigerapsis kugleri* Zone and *Hantkenina aragonensis* Zone (Combined)		[Zone P.11] *Globigerapsis kugleri* Partial-range zone	ZONE P.11
			Subbotina frontosa frontosa / Globorotalia (T.) pseudomayeri Concurrent-range zone	ZONE P.10			– – ? – –						[Zone P.10] *Hantkenina aragonensis* Partial-range zone	ZONE P.10
	EARLY EOCENE	CUISIAN	*Globorotalia (A.) aspensis / Globigerina lozanoi prolata* Concurrent-range zone	ZONE P.9	ZONE OF CONICAL GLOBOROTALIIDS *T. caucasica* Subzone	BELIEVED MISSING "*Globorotalia*" *palmerae* Zone	?		L + M *Globorotalia caucasica* Zone and *Globorotalia palmerae* Zone (Zones L and M combined)	*Pseudogloboquadrina primitiva* and *Globorotalia crater crater* Zones (combined)	"*Globorotalia*" *palmerae* Zone		[Zone P.9] *Acarinina densa* Partial-range zone	ZONE P.9
			Globorotalia (Morozovella) formosa Total-range zone *G. (M.) aragonensis / G. (M.) formosa* Concurrent-range subzone	SUBZONE P.8b ZONE P.8	*G. lensiformis* Subzone	*Globorotalia aragonensis* Zone and *Globorotalia formosa formosa* Zone (Combined)	– – ? – – *Globorotalia formosa formosa / Globorotalia aragonensis* Zone	– – ? – – *Globorotalia aragonensis* Zone	I + K Zones I and K combined		*Globorotalia aragonensis* Zone and *Globorotalia formosa formosa* Zone (Combined)		[Zone P.8] *Globorotalia aragonensis* Partial-range zone	SUBZONE P.8b ZONE P.8
			G. (M.) formosa – G. (M.) lensiformis Partial-range subzone	SUBZONE P.8a		BELIEVED MISSING	*Globorotalia rex* Zone	*Globorotalia formosa formosa / Globorotalia subbotinae* Zone	H *Globorotalia lensiformis* Zone		*Globorotalia rex* Zone		[Zone P.7] *Globorotalia formosa* Partial-range zone	SUBZONE P.8a
			Globorotalia (Acarinina) wilcoxensis berggreni Partial-range zone	ZONE P.7	*Globorotalia marginodentata* Zone	*Globorotalia rex* Zone		*Globorotalia aequa* Zone (part)	G2 *G. marginodentata / G. subbotinae* Zone (part)	*Globanomalina wilcoxensis* Zone			[ZONE P.6 (part)] [Subzone P.6b] *Globorotalia subbotinae / Pseudohastigerina wilcoxensis* Zone	ZONE P.7

Table 13. Relationship of the Eocene "P/N" zones by Blow (1979) to other zonations and the Eocene portion of the Nief Beds. (After Blow, 1979).

SERAM	SYSTEM	STAGE	ZONES DESCRIBED IN THIS WORK, (PART II) (Composite evidence): FORMAL TAXONOMIC NAME	ZONAL "P" No	SUBBOTINA, 1953, N. CENTRAL CAUCASUS	BOLLI, 1957, TRINIDAD	BOLLI AND CITA 1960. ITALY	LEONOV AND ALIMARINA, 1961, CAUCASUS	STRATIGRAPHICAL COMMISSION OF THE U.S.S.R., 1963	HILLEBRANDT, 1962, SALZBURG, AUSTRIA	LUTERBACHER AND PREMOLI – SILVA 1964, ITALY	JENKINS, 1965, NEW ZEALAND	BOLLI, 1966, (Composite evidence)	BERGGREN, MM, (Ascribed to Blow and Berggren unpub.) (Composite evidence)	ZONES DESCRIBED IN THIS WORK (Composite evidence)	STAGE
	EARLY EOCENE (part)	CUISIAN (part)	*Globorotalia* (A.) *wilcoxensis berggreni* Partial-range zone	ZONE P.7 (see also figure 58)	*Globorotalia marginodentata* Subzone	*Globorotalia rex* Zone	*Globorotalia rex* Zone	*Globorotalia praenartanensis* Zone	*Globorotalia subbotinae* Zone *Globorotalia marginodentata* Subzone	ZONE G	*Globorotalia aequa* Zone	*Globanomalina wilcoxensis* Zone	*Globorotalia rex* Zone (part only) (according to definition given by Bolli, 1966, p.14)	[ZONE P.6] *Globorotalia subbotinae* – *Pseudohastigerina wilcoxensis* [P.6b]	ZONE P7	CUISIAN (part)
?	PALAEOCENE	LONDINIAN	*Globorotalia* (M.) *subbotinae subbotinae* – *Globorotalia* (M.) *velascoensis acuta* Partial-range zone	ZONE P6	"*Globorotalia crassata*" – *Acarinina intermedia* Subzone	Mainly missing in Trinidad	?		*Globorotalia subbotinae* Subzone	ZONE F / ZONE G BOUNDARY CANNOT BE EVALUATED	Zonal boundary cannot be evaluated	*Globigerina triloculinoides* Zone		*Globorotalia velascoensis* – *Globorotalia subbotinae* [P.6a]	ZONE P6	LONDINIAN
NIEF BEDS			*Muricoglobigerina soldadoensis soldadoensis* / *Globorotalia* (M.) *velascoensis pasionensis* Concurrent-range zone	ZONE P5		*Globorotalia velascoensis* Zone	*Globorotalia velascoensis* Zone	*Globigerina subsphaerica* and *Globorotalia tadjikistanensis* Subzones (Combined)	*Acarinina acarinata*, *A. subsphaerica* and *Acarinina tadjikistanensis* Zones (Combined)	ZONE F	*Globorotalia velascoensis* Zone		*Globorotalia velascoensis* Zone	[Zone P.5] *Globorotalia velascoensis* Partial-range Zone	ZONE P5	
		THANETIAN (sensu lato) THANETIAN (s.s.)	*Globorotalia* (G.) *pseudomenardii* Partial-range zone	ZONE P4	?	*Globorotalia pseudomenardii* Zone	*Globorotalia pseudomenardii* Zone		*A. conicotruncata* Zone	ZONE E	*Globorotalia pseudomenardii* Zone		*Globorotalia pseudomenardii* Zone	[Zone P.4] *Globorotalia pseudomenardii* Total-range Zone	ZONE P4	THANETIAN (s.s.) THANETIAN (sensu lato)
			Globorotalia (M.) *angulata angulata* Partial-range zone	ZONE P3	[Probably included with *G. inconstans* Subzone]	*Globorotalia pusilla pusilla* Zone	*Globorotalia pusilla pusilla* Zone	*Globorotalia angulata* Subzone	*Globorotalia angulata* Zone	ZONE D ZONE C	*Globorotalia pusilla pusilla* Zone		*Globorotalia pusilla pusilla* and *Globorotalia angulata* Zones (Combined)	[Zone P.3] *Globorotalia pusilla* – *G. angulata* Concurrent-range Zone	ZONE P3	
		?	*Globorotalia* (A.) *praecursoria praecursoria* Partial-range zone	ZONE P2	*Globigerina inconstans* Subzone	*Globorotalia uncinata* Zone	*Globorotalia uncinata* Zone	*Globigerina inconstans* Subzone	NO BIOSTRATIGRAPHIC INTERVALS FORMALISED	ZONE B	*Globorotalia uncinata* Zone		*Globorotalia uncinata* Zone	[Zone P.2] *Globorotalia uncinata* *Globorotalia spiralis* Concurrent-range Zone	ZONE P2	?
		DANIAN (sensu lato) DANIAN (s.s.)	*Globorotalia* (T.) *pseudobulloides* / *Eoglobigerina eobulloides simplicissima* Concurrent-range zone G. (T.) *compressa compressa* / E. [illegible] Concurrent-range subzone	SUBZONE P.1b ZONE P.1		*Globorotalia trinidadensis* Zone	*Globorotalia trinidadensis* / *Globigerina daubjergensis* Zone			ZONE A	*Globorotalia trinidadensis* Zone	*Globigerina pauciloculata* Zone ?	*Globorotalia trinidadensis* Zone	[Zone P.1] [illegible] SUBZONE P.1c and P.1b (combined)	SUBZONE P.1b ZONE P.1	DANIAN (s.s.) DANIAN (sensu lato)
		?	G. (T.) *pseudobulloides* / G. (T.) *archeocompressa* Concurrent-range subzone	SUBZONE P.1a	*Globigerina trivialis* Subzone			*G. pseudobulloides* / *G. daubjergensis* Zone ?			*G. pseudobulloides* / *G. daubjergensis* Zone ?	?	*Globorotalia pseudobulloides* Zone	SUBZONE P.1a	SUBZONE P.1a	?

Table 14. Relationship of th Paleocene "P/N" zones by Blow (1979) to other zonations and the Paleocene portion of the Nief Beds.
(After Blow, 1979).

SERAM	AGE after Bolli 1957a, 1959	TRINIDAD Bolli 1957a, 1959	BOLLI 1966	U.S.A. WESTERN GULF COASTAL PLAIN (PESSAGNO, 1967) Assemblage zones	Subzones	AFRICA TUNESIA Dalbiez 1955	CENTRAL SWISS ALPS Mohler 1966	NORTHERN CALCAREOUS ALPS Herm 1962	COMPILED FROM LITERATURE van Hinte 1965		
▥	CAMPANIAN ? MAASTRICHTIAN	Abathomphalus mayaroensis	ABATHOMPHALUS MAYAROENSIS	Globotruncana contusa-stuartiformis	Abathomphalus mayaroensis	Globotruncana contusa	Globotruncana mayaroensis	F E		Gt. stuarti	Gt. contu
▥		Globotruncana gansseri	GLOBOTRUNCANA GANSSERI		Globotruncana gansseri		Globotruncana contusa contusa	D	Globotruncana gansseri		
NIEF BEDS		Globotruncana lapparenti tricarinata	GLOBOTRUNCANA LAPPARENTI TRICARINATA	Globotruncana fornicata-stuartiformis	Rugotruncana subcircumnodifer	Globotruncana arca					Gt. calci formis
		▨	GLOBOTRUNCANA CALCARATA		Globotruncana elevata	Globotruncana elevata	Globotruncana calcarata	C	Globotruncana calcarata		
▥ ?		Globotruncana stuarti	GLOBOTRUNCANA STUARTI s. l		Archaeoglobigerina blowi		forms of Globotruncana thalmanni / flexuosa group		Globotruncana stuartiformis		
▥											
▥	TURONIAN	Globotruncana inornata	GLOBOTRUNCANA HELVETICA	Marginotruncana helvetica	Whiteinella archaeocretacea	Globotruncana helvetica	Globotruncana helvetica		Globotruncana ? helvetica		
▥		▨	PRAEGLOBOTRUNCANA GIGANTEA		Marginotruncana sigali	Upper Rotalipora			"Hedbergella gigantea"		
NIEF BEDS	CENOMANIAN	▨	ROTALIPORA CUSHMANI	Rotalipora s.s.	Rotalipora cushmani-greenhornensis		Rotalipora cushmani and turonica		Rotalipora cushmani-reicheli		Prae steph
		▨	ROTALIPORA REICHELI			Middle Rotalipora	Rotalipora brotzeni		Rotalipora appenninica		
		Rotalipora appenninica appenninica	ROTALIPORA BROTZENI		Rotalipora evoluta	Lower Rotalipora	Rotalipora appenninica				
		Globigerina washitensis	ROTALIPORA APPENNINICA APPENNINICA						Rotalipora balernaensis		

Table 15. Relationship of the Cretaceous zonation of the Western Gulf Coastal Plain by Pessagno (1967) to other selected areas and the Cretaceous portion of the Nief Beds. Compiled from Bolli (1966) and Pessagno (1967).

CHAPTER 5

SYSTEMATIC MICROPALEONTOLOGY

For the Cenozoic planktonic Foraminifera, the new scheme of classification published by Blow (1979) is adopted. It involves a more detailed and precise analysis of the nature of the morphological and structural features of the tests of the different taxa, and their links with the various evolutionary lineages. It is easily applicable to the Cenozoic species identified from the Nief Beds. All the described taxa were arranged in the same order as given by Blow (1979).

As far as the Cretaceous planktonic Foraminifera are concerned, since almost all the identifications are based on thin section studies, the classification outlined by Loeblich and Tappan (1964) in the Treatise of the Invertebrate Paleontology is followed with the addition of the new taxa described by Pessagno (1967). The modified classifications by Loeblich and Tappan (in Hedley and Adams, 1974) and Blow (1979) were considered but were not followed in this work. The classification by Loeblich and Tappan (1964) in the Treatise of Invertebrate Paleontology and its emendation (Loeblich and Tappan, 1981) is adopted for the Triassic Foraminifera.

The remaining microfauna of the Lower Cretaceous, Jurassic and Triassic which are stratigraphically less important, have been tabulated in order of age (Table 7 & 9) without systematic description or illustration.

The Cenozoic, Cretaceous and Triassic Foraminifera of stratigraphical significance are described and illustrated. These are referred to 5 suborders, 5 superfamilies, 19 families, 15 subfamilies, 39 genera and 178 species and subspecies.

The systematic description of each species includes:

1- "A synonymy"

The purpose of the synonymy is two fold ; (a) to outline the historical changes in the taxonomy of the species, and (b) to provide some of the important references relevant to the species concerned.

2- "Remarks"

Comments here fall into two categories. The first deals with the published literature, reported comparisons with other similar species, and the postulated evolution and stratigraphical value of the species. The second deals with the species from Seram, the species' diagnosis and its similarity (or otherwise) with the published accounts.

3- "Range"

The stratigraphical ranges of the Cenozoic species (Range Chart 1 & 2) are basically those given by Blow (1969, 1979). The ranges of the Cretaceous species (Range Chart 3) used, are those of Pessagno (1967) with modifications suggested by the literature. The ranges of the Triassic species (Range Chart 4) were synthesised from the ranges reported in the world literature. Since the Triassic Foraminifera are poorly known, the ranges are tentative.

4- "*Dimensions of figured specimens*"

Although the magnification of each photographed specimen is indicated on the plates, the dimensions of the specimen give better idea about its size.

5- "*Abundance, distribution, faunal association and stratigraphical occurrence in the various rock units in Seram*"

All this information has been tabulated in order of age (Table 1, 3, 5, 7, 9, 10). The genera and species within each table are arranged alphabetically.

Phylum *Protozoa*
Subphylum *Sarcodina*
Class *Rhizopoda*
Subclass *Granuloreticulosia*
Order *Foraminiferida* Eichwald, 1830

Miocene Planktonic Foraminifera of The Nief Beds

Suborder *Globigerinida* Blow, 1979
Superfamily *Globigerinacea* Carpenter, Parker and Jones, 1862
Family *Globigerinida* Carpenter, Parker and Jones, 1862, partim, emend. Blow, 1979
Subfamily *Sphaeroidinellinae* Banner and Blow, 1959

Genus *Sphaeroidinellopsis* Banner and Blow, 1959
Genotype: *Sphaeroidinella dehiscens subdehiscens* Blow, 1959 by original designation

Sphaeroidinellopsis seminulina seminulina (Schwager), 1866

Plate 1, figs. 1-3

1866 Globigerina seminulina Schwager, p. 256, pl. 7, fig. 112.

1940 Sphaeroidinella disjuncta Finlay, p. 469, pl. 67, figs. 224-228.

1957e Sphaeroidinella grimsdalei (Keijzar); Bolli (part), p. 114, pl. 26, figs. 8-11, not figs. 12a-c (= S. Seminulina Kochi).

1959 Sphaeroidinella seminulina seminulina (Schwager); Blow, p. 196, figs. 74-77.

1960 Globigerina seminulina Schwager; Banner and Blow, p. 24, pl. 7, figs. 2a-b.

1969 Sphaeroidinellopsis seminulina seminulina (Schwager); Blow, p. 337, pl. 30, fig. 7.

1977 Sphaeroidinella seminulina (Schwager); Miles, p. 944, pl. 8, figs. 5-6.

1979 Sphaeroidinellopsis seminulina seminulina (Schwager); Salvatorini and Cita, p. 325, 326, 327 and FIG. 6.

Remarks

Schwager's form consists of three chambers in the final convolution, the last chamber is smaller in size than the other two combined. This mainly distinguishes this subspecies from Sphaeroidinellopsis subdehiscens subdehiscens Blow, in which the last chamber is approximately equal to the other two combined. Some species of Sphaeroidinellopsis seminulina seminulina (Schwager) are similar to the neotype of the subspecies selected by Banner and Blow (1960, p. 24, pl. 7, figs. 2a-b) which consists of four chambers in the last whorl. These are regarded by these authors to be the ancestor of Sphaeroidinellopsis seminulina Kochi (Caudri) which consists of five chambers in the last convolution.

Two main types of S. seminulina seminulina were recognized from the Nief Beds. The first (pl. 1, fig. 2) is identical with the neotype illustrated by Banner and Blow (1960, pl. 7, figs. 2a-b), and to the figures given by Miles (1977, pl. 8, figs. 5, 6). It differs from the neotype in having a less lobulate equitorial periphery, and almost equal chambers in the last convolution. The second type (pl. 1, fig. 1) of which these are only a few specimens, has a square shaped equitorial profile as compared to the parallelogram shaped of the first. This type is similar to the Sphaeroidinella grimsdalei (Keijzer) (= S. seminulina seminulina) illustrated by Bolli (1957e, pl. 26 figs. 10a-b).

Most of the specimens from Seram are decorticated, although a few show the typical shiny surface.

Sphaeroidinellopsis seminulina (Schwager), has also been identified in thin section. It is comparable to the thin section figure illustrated by Postuma (1971, p. 275) with its typical thick wall, although there is a slight difference in the orientation of the two sections.

Dimensions of the figured specimens

Pl. 1, figs. 1, 2, 3.

Max. diam. = 0.57 mm, 0.63, 0.62.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known Range

In the eastern Falcon, Venezuela, it ranges from the Lower Miocene (Burdigalian) to the Late Miocene (Blow, 1959). According to the "P/N" zonation by Blow (1969), it ranges from within zone N.6 to near the zone N.20/ zone N.19 boundary (Upper Aquitanian to Lower Pliocene). (See Range Chart 1).

Sphaeroidinellopsis subdehiscens subdehiscens (Blow), 1959

Plate 1, Figs. 4-5

1941 Sphaeroidinella rutchi Cushman and Renz (part), p. 25, pl. 4, fig. C. Not figures 5a, b (= holotype of rutchi).

1959 Sphaeroidinella dehiscens subdehiscens Blow, p. 195, pl. 12, figs. 71 a-c, 72.

1960 Sphaeroidinellopsis subdehiscens (Blow); Banner and Blow, p. 15, text - figs. 4f, 5a-c.

1967 Sphaeroidinella subdehiscens Blow; Parker, p. 162, pl. 23, figs. 6, 7.

1969 Sphaeroidinellopsis subdehiscens subdehiscens (Blow), p. 338, pl. 30, figs. 1-3, 6.

1977 Sphaeroidinellopsis subdehiscens Blow; Berggren, p. 594, pl. 1, fig. 21.

Remarks

Sphaeroidinellopsis subdehiscens subdehiscens (Blow) is distinguished from S. Subdehiscens paenedehiscens Blow by possessing a non-crenulated umbilical aperture, a less tightly coiled test, visible sutures between the three chambers of the final convolution, a smaller size and a lobulate equitorial periphery.

The individuals of S. subdehiscens subdehiscens from the Nief Beds are variable with regard to the size of the final chamber and the shape of the equitorial profile. The majority of the specimens (pl. 1, fig. 5) are identical with the holotype illustrated by Blow (1959, pl. 12, figs. 71 a-c). A few specimens (pl. 1, fig. 4) show a slightly smaller final chamber than the other two combined, but not as small as the one in the holotype of *Sphaeroidinellopsis seminulina* illustrated by Schwager (1866, pl. 7, fig. 112). These forms are similar to the *S. subdehiscens* Blow illustrated by Parker (1967) on plate 23, figs. 6 a-c.

Dimensions of the figured specimens

Pl. 1, figs. 4-5.

Max. Length = 0.57 mm, 0.44 (holotype = 0.50 mm)

Abundance, distribution, faunal association and stratigraphical occurence in the Nief Beds

See Table 1 & 2.

Known Range

According to the "P/N" zonation by Blow (1969), it ranges from the base of zone N.13 to within zone N.19 (Middle Miocene to the Lower Pliocene). (See Range Chart 1).

Subfamily *Candeininae* Cushman, 1927, Partim, emend. Blow, 1979

Genus *Globigerinatella* Cushman and Stainforth, 1945

Genotype: *Globigerinatella insueta* Cushman & Stainforth, 1945

Remarks

Blow (1979), has emended the subfamily Candeininae Cushman, to include the genera Candeina d'Orbigny and Globigerinatella Cushman & Stainforth, on the basis of a separate phyletic ancestry from that of the other subfamilies of the Globigerinidae Carpenter, Parker and Jones (See Blow, 1979, FIG. 64). He associated it with the family Globigerinidae on a temporary basis, and indicated that it possibly should stand as a family of the superfamily Globigerinacea Carpenter, Parker and Jones.

The subfamily Candeininae Cushman, Partim, emend. Blow, 1979, differs from the subfamily Orbulininae Schlutze, 1854, partim, emend. Blow, 1979, basically in having a trochospiral test throughout the Ontogeny, primary chambers not embracing one another siginficantly, and the last or later primary chambers not enveloping the earlier parts of the test.

Globigerinatella insueta Cushman & Stainforth, 1945?

Plate 1, fig. 6

1945 Globigerinatella insueta Cushman & Stainforth, p. 69, pl. 13, figs. 7-9.

1969 Globigerinatella insueta Cushman & Stainforth; Blow, p. 330, pl. 26, figs. 1-7.

1979 Globigerinatella insueta Cushman & Stainforth; Salvatorini and Cita, p. 336, pl. 2, fig. 16.

Remarks

Globigerinatella insueta? is a rare species in the Nief Beds. All the morphologic features are obscured, except the traces of the sutural bullae which can be seen in some of these individuals. The sutural bullae, the globular shape and the age of the sample involved, gave a clue to the identification of this species. These individuals are comparable to the topotypic specimen illustrated by Stainforth et al. (1975, 289, Fig. 125, no. 1). However, the diameter is smaller than the size range (0.4 mm - 0.5 mm) given by Stainforth et al. (op. cit.).

Dimensions of the figured specimen

Max. diameter = 0.31 mm

Abundance, distribution, faunal association and stratigraphical occurence in the Nief Beds

See Table 1 & 2.

Known range

Bolli (1957e), gave the range from *Catapsydrax stainforthi* zone to the *Globigerinatella insueta* zone, Lower Miocene. It ranges from zone N.6 to within the earlier part of zone N.9, Lower Miocene (Blow, 1969). (See Range Chart 1).

Subfamily *Globigerininae* Carpenter, Parker & Jones, 1962, partim, emend. Blow, 1979

Genus *Globigerina* d'Orbigny, 1928, emend. Blow, 1979

Genotype: *Globigerina bulloides* d'Orbigny, 1826.

Remarks

Blow (1979) excluded the forms with portici, portical umbilical teeth and muricae from *Globigerina* d'Orbigny, emend. Blow, 1979. He placed these forms in the genera *Subbotina* Brotzen and Pozaryska, *Dentoglobigerina* Blow, *Eoglobigerina* Morozova and *Muricoglobigerina* Blow respectively.

Globigerina angustiumbilicata Bolli, 1957

Plate 1, figs. 7 a-c

1957e *Globigerina ciperoensis angustiumblicata* Bolli, p. 109, pl. 22, figs. 12a-13c.

1959 *Globigerina angustiumbilicata* Bolli; Blow, p. 172, pl. 17, figs. 33 a-c.

1962 *Globigerina angustiumbilicata* Bolli; Blow & Banner (in Eames et al., 1962), p. 85, pl. 4, figs. X-Z.

1972 *Globigerina angustiumbilicata* Bolli; Jenkins, p. 1085, pl. 4, figs. 5, 6; pl. 5, figs. 6-8.

1975 *Globigerina angustiumbilicata* Bolli; Stainforth et al., p. 253, Fig. 105.

Remarks

Blow and Banner (in Eames et al., 1962) pointed out that *Globigerina officinalis* Subbotina gives rise to *Globigerina angustiumblicata* in Late Eocene. The morphogenesis accompanying this evolution is the increase in the growth rate with the addition of a fifth chamber in the final convolution concomitant with an increase in the size of the umbilicus.

The individuals of *Globigerina angustiumbilicata* from the Nief Beds are distinguished by a small and low trochospiral test, 4-5 subglobular chambers in the last convolution and which increase slowly as added. The aperture is a low, lip-less arch, opening into a small umbilicus. The surface is finely rugose.

These individuals differ from the holotype of G. angustiumbilicata in having less appressed chambers and a large umbilicus. They agree closely with the figures given by Stainforth et al. (1975) on Fig. 105, nos. 1 & 3.

Dimensions of the figured specimens

Pl. 1, figs. 7a-c.

Max. diameter = 0.36 mm, 0.37, 0.38 (holotype = 0.24 mm).

Abundance, distributions, faunal association and stratigraphica occurrence in the Nief Beds

See Table 1 & 2.

Known range

This is a long ranging species. According to the "P/N" zonation by Blow (1969), it ranges from the lowermost part of zone P.16 to zone N.22, ? 23 (Late Eocene to the Pleistocene or Holocene). (See Range Chert 1).

Globigerina binaensis Koch, 1935

Plate 1, figs. 8a-b, 9

1935 Globigerina binaensis Koch, p. 558

1969 Globigerina binaensis Koch; Blow, p. 316, pl. 13, figs. 1, 2.

1971 Globigerina binaensis Koch; Postuma, p. 262, 263.

1975 Globigerina binaensis Koch; Stainforth et al., p. 254, Fig. 106.

Remarks

The individuals of Globigerina binaensis from the Nief Beds are fairly well preserved and characterized by the unique large, flattened apertural face of the last chamber. The free specimens are similar to the Hypotypic figure illustrated by Blow (1969) on plate 13, figs. 1, 2. The thin section specimen is identical with the illustration of Postuma (1971, p. 263).

According to the available literature, this species is restricted to the Indo-Pacific province.

Dimensions of the figured specimens

Pl. 8a-b, 9

Max. diam. = 0.47 mm, 0.48, 0.57.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), it ranges from zone N.3 to within zone N.5, (Uppermost Oligocene to the Lower Miocene). A similar range was reported in the general zonation by Postuma (1971). (See Range Chart 1).

Globigerina gortanii gortanii (Borsetti), 1959

Plate 1, figs. 10 a-c

1959 Catapsydrax gortanii Borsetti, p. 205, pl. 1, figs. 1a-d.

1962 Globigerina turritilina turritilina Blow and Banner, (in Eames et al., 1962), p. 98, pl. 13, figs. D-G.

1969 Globigerina gortanii gortanii (Borsetti); Blow, p. 320, pl. 17, fig. 1.

1972 Globigerina gortanii gortanii (Borsetti); Belford, p. 9, pl. 8, figs. 1-6.

1979 Globigerina gortanii gortanii (Borsetti); Blow, p. 851, pl. 247, fig. 4; pl. 251, fig. 9.

Remarks

Both Borsetti (1959) and Blow and Banner (in Eames et al., 1962, as G. turritilina turritilina), show their types with a bulla-like chamber across the umbilicus. Borsetti (op. cit.) considered this as a true bulla and placed this species in the genus Catapsydrax. Blow and Banner (in Eames et al., 1962) regarded it as an aborted final chamber, a view agreed with here.

The specimens from the Nief Beds are distinguished by the loftiness of their spires, pitted walls and four chambers in the final convolution. The aperture is obscured by matrix. These specimens agree well with Globigerina gortanii gortanii illustrated by Blow and Banner (in Eames et al., 1962) on plate 13, figs. D-G. A few specimens possessing an abortive chamber partly covering the umbilicus have been observed.

Dimensions of the figured specimens

Pl. 1, figs. 10a-c.

Max. diameter = 0.48 mm, 0.56, 0.47 (holotype = 0.6 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known Range

Borsetti (1959), first described this species from the Lower Oligocene of northern Italy. According to the "P/N" zonation by Blow (1979), the stratigraphic range is from the base of zone p. 17 to zone N.3 (latest Eocene to Late Oligocene). (See Range Chart 1).

Globigerina sp. cf. *euapertura* Jenkins, 1960

Plate 2, Fig. 1

cf. 1960 *Globigerina euapertura* Jenkins, p. 351, pl. 1, figs. 8a-c.

Remarks

A single specimen of *Globigerina sp.* cf. *euapertura* was recognized from the Nief Beds. It differs from the *Globigerina euapertura* Jenkins basically in having radially less compressed final chamber, a higher arched aperture and a large and elongated test as compared with the semicircular one of the holotype.

Dimension of the figured specimen

Max. Length = 0.52 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

Globigerina sp. cf. *euapertura* was identified from a sample assigned to zone N.4/N.3. For faunal association see Table 1 & 2.

Globigerina officinalis Subbotina, 1935

Plate 2, figs. 2a-c

1953 *Globigerina officinalis* Subbotina (part), p. 78, pl. 11, figs. 1a-c.

1957e *Globigerina parva* Bolli, p. 108, pl. 22, figs. 14 a-c.

1962 *Globigerina officinalis* Subbotina; Blow and Banner, p. 88, pl. 9, figs. A-C; Fig. 16.

Remarks

Globigerina officinalis Subbotina from the Nief Beds is in accordance with the description and the illustration of this species presented by Blow and Banner (in Eames et al., 1962) on page 88, pl. 9, Figs. A-C. It is characterised by rather tightly coiled and embracing chambers as seen from the ventral side, 4 chambers in the last convolution and a low trochospire. Apertural details are obscured by matrix.

Dimensions of the figured specimens

Pl. 2, figs. 2a-c.

Max. diameter = 0.35 mm, 0.32, 0.47

Abundance, distribution, faunal association and stratigraphica occurrence in the Nief Beds

See Table 1 & 2.

Known range

Globigerina officinalis Subbotina has been reported from the Eocene and Oligocene in many parts of the world (Hofker, 1956; Srinivasan, 1968; Samanta, 1970; Poore and Brabb, 1977). According to the "P/N" zonation by Blow (1969), it ranges from zone P. 13? zone P.14 to within zone N.3 (Late Middle Eocene to the Upper Oligocene). (See Range Chart 1).

Globigerina ouachitaensis ciperoensis Bolli, 1954

Plate 2, figs. 3a-c.

1954 *Globigerina ciperoensis* Bolli, p. 1, text-figs. 3-6.

1957c *Globigerina ciperoensis ciperoensis* Bolli, p. 109, pl. 22, figs. 10a-b.

1962 *Globigerina ouachitaensis ciperoensis* Bolli; Blow and Banner (in Eames et al., 1962), p. 90, pl. 9 E-G, Fig. 9 (1-3).

1969 *Globigerina ouachitaensis ciperoensis* forma typica Bolli; Blow p. 320, pl. 17, fig. 7.

1972 *Globigerina ciperoensis* Bolli; Poag, p. 269, pl. 1, fig. 4.

Remarks

Bolli (1954) first described this form as *Globigerina ciperoensis*. Bolli (1957e), described *Globigerina ciperoensis angulisuturalis* and *Globigerina ciperoensis angustiumbilicata* as new subspecies, changing the central form to *G. ciperoensis ciperoensis*. Blow and Banner (in Eames et al., 1962) elevated the first two subspecies to a specific rank, and regarded *ciperoensis* as a subspecies of *Globigerina ouachitaensis* S.L.

According to Blow and Banner (op. cit.), *Globigerina* ouachitaensis ciperoensis Bolli evolved from G. ouachitaensis Howe & Wallace from which it differs in having five chambers in the final convolution as compared to four.

Globigerina ouachitaensis ciperoensis from the Nief Beds is identical with the figure illustrated by Blow and Banner (in Eames et al., 1962, p. 90, pl. 9, figs. E-G). The apertural details cannot be determined.

Dimensions of the figured specimens

Pl. 2, figs. 3a-c.

Max. diameter = 0.48 mm, 0.44, 0.48.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Globigerina ouachitaensis ciperoensis has been reported from the Oligocene and Lowermost Miocene in many parts of the world (Bolli, 1957e; Blow and Banner (in Eames et al., 1962); Raju, 1971). According to the "P/N" zonation by Blow (1969), it ranges from the lower part of zone P.19 (Middle Oligocene) to within zone N.4 (Lowermost Miocene). (See Range Chart 1).

Globigerina praebulloides leroyi Blow & Banner, 1962

Plate 2, figs. 4a-c.

1962 Globigerina praebulloides leroyi Blow and Banner (in Eames et al., 1962), p. 93, pl. 9, figs. R-T; Fig. 9 (5).

1966 Globigerina leroyi Blow and Banner; Jenkins, p. 5, pl. 1, figs. 13a-c.

1969 Globigerina praebulloides leroyi Blow and Banner; Blow, p. 265.

Remarks

Globigerina praebulloides leroyi Blow & Banner from the Nief Beds is comparable with the holotype of this subspecies illustrated by Banner and Blow (in Eames et al., 1962, pl. 9, figs. R-T). It differs only in the absence of the fragile lip characteristic of this subspecies, which is mostly broken off. The specimens from the Nief Beds have a slightly larger size than the holotype.

Dimensions of the figured specimens

Pl. 2, figs. 4a-c

Max. Length = 0.35 mm, 0.31, 0.38 (holotype = 0.26 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), it ranges from zone P.16 (Late Eocene) to within zone N.8 (latest part of Early Miocene). (See Range Chart 1).

Globigerina praebulloides occlusa Blow & Banner, 1962

Plate 2, Figs. 5a-c

1962 Globigerina praebulloides occlusa Blow & Banner, (in Eames et al., 1962), p. 93, pl. 9, figs. U-W; Fig. 14 (i-ii). (cum. syn.).

1969 Globigerina praebulloides occlusa Blow & Banner; Samanta, p. 331, pl. 1, figs. 5a-c.

1972 Globigerina praebulloides occlusa Blow and Banner; Belford, p. 6, pl. 5, figs. 1-5.

Remarks

According to Blow and Banner (in Eames et al., 1962, Lineage C), Globigerina praebulloides occlusa gives rise to Globigerina praebullodies leroyi Blow & Banner in the Upper Eocene from which it differs in having less tightly embracing chambers, a shallower umbilicus and an asymmetrical aperture which lacks lip.

Many variations of this subspecies were observed within its population in the Nief Beds, with regard to the size of the test, the enlargement rate of the chambers of the last convolution and the laxity of the coiling. Only typical forms of G. praebullodies occlusa were photographed and illustrated. They are identical with the figure of the holotype illustrated by Blow and Banner (in Eames et al., 1962), on plate 9, figs. U-W. However, they differ in having larger tests, larger umbilici, and wider and lower apertures.

Dimensions of the figured specimens

Pl. 2, figs. 5a-c.

Max. Length = 0.47 mm, 0.39, 0.44 (holotype = 0.37 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to Blow (1969), it ranges from Late Middle Eocene (zone P. 14) to the Pliocene (Zone N.19). (See Range Chart 1).

Globigerina praebulloides praebulloides Blow, 1959

Plate 3, figs. 1a-c, 2?

1959 Globigerina praebulloides Blow, p. 180, pl. 8, figs. 47 a-c; pl. 9, fig. 48.

1962 Globigerina praebulloides praebulloides Blow and Banner, (in Eames et al., 1962), p. 92, pl. 9, figs. O-Q. (Cum. Syn.).

1971 Globigerina praebulloides Blow; Postuma, p. 268, 269.

1977 Globigerina praebulloides Blow; Poore and Brabb, p. 256 pl. 7, figs. 6-7.

1981 Globigerina praebulloides praebulloides Blow; Belford, pl. 2, figs. 4-6.

Remarks

Many variations in the size of the specimens, the rate of the chambers enlargement, the height of the spire, and the size of the ultimate as compared to the penultimate chamber have been noticed within the population of G. praebulloides praebulloides in the Nief Beds. The illustrated specimens are characterized by having large tests, four chambers in the last convolution as viewed ventrally, and fairly high apertures. They are comparable to the ideotypic forms of this subspecies illustrated by Blow and Banner (in Eames et al., 1962) on plate 9, figs. O-Q. They differ from the holotype in having twice its size.

The thin section specimens are similar to the Globigerina praebulloides Blow, illustrated by Postuma (1971) on page 269.

Dimensions of the figured specimens

Pl. 3, figs. 1a-c, 2?

Max. Length = 0.63 mm, 0.63, 0.56, 0.26 (holotype = 0.30 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known Range

Globigerina praebulloides praebulloides has been reported from the base of the Globigerapsis semi-involuta zone (Upper Eocene) to the Middle part of the Globorotalia cultrata/ Globigerina nepenthes zone (Upper Miocene), in the Lindi area, Tanganyika (Blow and Banner, in Eames et al., 1962). According to the "P/N" zonation by Blow (1969), it ranges from P.16 (Upper Eocene) to within zone N.17 (Upper Miocene). (See Range Chart 1).

Globigerina sellii (Borsetti), 1959

Plate 3, figs. 3-4

1959 Globoquadrina sellii Borsetti, p. 209, pl. 13, figs. 3a-d.

1960 Globigerina clarae Bermudez, p. 1166, pl. 2, figs. 4a-d.

1962 Globigerina oligocaenica Blow and Banner, p. 88, pl. 10, figs. G and L-N.

1969 Globigerina sellii (Borsetti); Blow, p. 322, pl. 19, figs. 4-6.

1971 Globigerina sellii (Borsetti); Postuma, p. 272, 273.

1972 Globigerina sellii (Borsetti); Jenkins and Orr, p. 1090, figs. 4-6.

Remarks

Originally, Borsetti (1959), described this species as Globoquadrina sellii from the Oligocene of north Italy. Blow (1969, 1979), referred it to the genus Globigerina d'Orbigny and Globigerina d'Orbigny emend. Blow, 1979 respectively. The present writer only provisionally follows Blow (1979) with regard to the generic status of this species, since the presence of a portical-umbilical-tooth has been reported in the literature (cf. Postuma, 1971, p. 273; Jenkins, 1971).

According to Blow (1979), Globigerina sellii is the ancestor of Globigerina binaensis Koch. The latter species is distinguished from the former by the high and wide, non-perforate, apertural face.

Globigerina sellii is a very frequent species in the Nief Beds. The tests are strongly hispid, notably on the final chamber. The apertural face varies from large to very narrow. The morphologic details of the aperture are obscured, usually by secondary infilling. No portical-umbilical-tooth has been observed in these individuals.

Globigerina sellii was found together with the Dentoglobigerina tripartita group and Globigerina binaensis accompanied by a full range of intermediates. Typical forms of Globigerina sellii are closely comparable with types of Globigerina oligocaenica (= G. sellii) illustrated by Blow and Banner (in Eames et al., 1962), on plate 10, figs. L-N.

Dimensions of the figured specimens

Pl. 3, figs. 3-4.

Max. Length = 0.52 mm, 0.30

Abundance, distribution, faunal association, and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Blow (1969, 1979), gave the range of this species as from the base of zone P.19/20 to within zone N.3 (approximately middle part to the Late Oligocene). (See Range Chart 1).

Genus *Globigerinoides* Cushman, 1927, emend. Bolli, Loeblich and Tappan, 1957, emend. Blow, 1979

Genotype: *Globigerina rubra* d'Orbigny, 1839,
by original designation and monotype.

Remarks

With the exception of *Globigerinoides* (?) *higginsi*, this genus is restricted to the Neogene.

Globigerinoides obliquus oblisuus Bolli, 1957

Plate 3, figs. 5a-b

1957e	*Globigerinoides obliqua* Bolli, p. 113, pl. 25, figs. 9a-10c; Text-fig. 21, no. 5.
1962	*Globigerinoides obliquus* Bolli; Belford, p. 20, pl. 5, figs. 11-14.
1967	*Globigerinoides obliquus* Bolli; Poag and Akers, p. 171, pl. 16, figs. 16-18.
1970	*Globigerinoides obliquus obliquus* Bolli, pl. 1, figs. 18-19.
1975	*Globigerinoides obliquus* Bolli; Stainforth et al., p. 385, Fig. 8.
1979	*Globigerinoides obliquus obliquus* Bolli; Salvatorini and Cita, p. 338, pl. 8, fig. 4.

Remarks

The offshoot Globigerinoides obliquus extremus Bolli & Bermudez, is separated from Globigerinoides obliquus obliquus Bolli on the basis of its more laterally compressed final chamber (Stainforth et al., 1975).

In the Nief Beds, Globigerinoides obliquus obliquus Bolli has been identified from two samples assigned to the Late Miocene. It is comparable with the holotype illustrated by Bolli (1957e) on pl. 25, figs. 10 a-c. It differs from these illustrations in having a lower trochospire.

Dimensions of the figured specimens

Pl. 3, figs. 5 a-b.

Max. length = 0.35 mm, 0.49 (holotype = 0.50 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969) it ranges from the latest part of zone N.5 (E. Miocene) into zone N.22 (Pleistocene). It has been reported from within this range in Trinidad (Bolli, 1957e), New Zealand (Jenkins, 1971) and the West Coast of Africa (Krasheninnikov and Pflaumann, 1978). (See Range Chart 1).

Globigerinoides quadrilobatus altiaperturus Bolli, 1957

Plate 3, fig. 6.

1957e Globigerinoides triloba altiapertura Bolli, p. 113, pl. 25, figs. 7, 8; text - fig. 21, no. 3.

1962 Globigerinoides quadrilobatus altiaperturus Bolli; Blow and Banner, p. 137.

1965 Globigerinoides altiapertura Bolli; Cita, Premoli Silva and Rossi, p. 265, pl. 29, figs. 5a-c.

1971 Globigerinoides altiaperturus Bolli; Jenkins, p. 174, pl. 20, figs. 604-606.

Remarks

Globigerinoides quadrilobatus altiaperturus is distinguished from other related forms, notably Globigerinoides quadrilobatus trilobus, by the large, highly arched primary aperture and supplimentary dorsal aperture (Banner and Blow, 1965a).

In the Nief Beds, one specimen of G. quadrilobatus altiaperturus was recognized. The state of preservation, the colour, and the associated Foraminiferal assemblage, suggest its derivation from older rocks. It conforms very well with the holotype and the paratypes of this subspecies, illustrated by Bolli (1957e, pl. 25, figs. 7, 8).

Dimensions of the figured specimens

Max. length = 0.33 mm (holotype = 0.55 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

Globigerinoides quadrilobatus altiaperturus has been derived from an older stratigraphic horizon. It is recognized in a foraminiferal assemblage characteristic of zone N.9, lower Middle Miocene. (See Table 1 & 2).

Known range

According to the "P/N" zonation by Blow (1969), it ranges from near the base of zone N.5 to within the earlier part of zone N.7 (Early Miocene). Similar range has been reported from Trinidad (Bolli, 1957e), Venezuela (Blow, 1959) and in the general zonation by Postuma (1971). (See Range Chart 1).

Globigerinoides quadrilobatus immaturus Le Roy, 1939

Plate 3, figs. 7a-b

1939 Globigerinoides sacculifer (Brady) var. immatura Le Roy, p. 263, pl. 3, figs. 19-21.

1945 Globigerinoides saccullfera (Brady); Cushman and Stainforth, p. 68, pl. 13, fig. 3.

1957e Globigerinoides triloba immatura Le Roy; Bolli, p. 113, pl. 25, figs. 3a-4c; text - fig. 21, no. 2.

1960 Globigerinoides quadrilobatus immaturus Le Roy; Banner and Blow, p. 18, Fig. 1.

1960 Globigerinoides immaturus Le Roy; Bermudez, p. 1243, pl. 12, figs. 3a-c.

1975 Globigerinoides trilobus immaturus Le Roy; Rogl, Cita, Muller and Hochuli, p. 65, pl. 7, figs. 11, 12.

Remarks

This taxon was originally described as Globigerinoides sacculifer (Brady) var. immatura by Le Roy (1939). Subsequent publications have treated this form in a different manner (see references cited).

According to Banner and Blow (1960, Fig. 1; 1965a), Globigerinoides quadrilobatus immaturus Le Roy differs from Globigerinoides quadrilobatus quadrilobatus (d'Orbigny) in the rapid chamber enlargement, smaller umbilicus and tighter coiling.

The individuals from the Nief Beds characteristically show a small test, three chambers in the last convolution, a last chamber almost equal in size to the other two combined, and a coarsely pitted surface. These specimens are closely comparable with the *Globigerinoides triloba immatura* Le Roy illustrated by Bolli (1957e) on plate 25, figs. 3a-b. Some of these individuals are identical with *Globigerinoides quadrilobatus immaturus* illustrated by Belford (1962) on plate 3, figs. 1-4.

Dimensions of the figured specimens

Pl. 3, figs. 7a-b.

Max. length = 0.38 mm, 0.39.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the zonation by Postuma (1971), it ranges from the base of the *Globigerinoides trilobus* zone (Lower Miocene) to Recent. Blow (1969) gave the range from the Middle part of zone N.4 to zone N.23, (Lower Miocene to Recent). (See Range Chart 1).

Globigerinoides quadrilobatus irregularis Le Roy, 1944

Plate 3, figs. 8a-b

1944 *Globigerinoides sacculifer* (Brady) var. *irregularis* Le Roy, p. 40, pl. 3, figs. 42-43.

1959 *Globigerinoides irregularis* Le Roy; Drooger and Magné, pl. 1, fig. 12.

1960 *Globigerinoides quadrilobatus irregularis* Le Roy; Banner and Blow, p. 18, Fig. 1.

1964 *Globigerinoides trilobus irregularis* Le Roy; Reiss and Gvirtzman, pl. 92, fig. 8.

1981 *Globigerinoides quadrilobatus irregularis* Le Roy; Belford, pl. 3, figs. 1-4.

Remarks

According to Banner and Blow (1960, 1965a), *G. quadrilobatus irregularis* is derived from *Globigerinoides quadrilobatus quadrilobatus* (d'Orbigny), and gives rise to the *Globigerinoides quadrilobatus sacculifer* (Brady). It differs from the first subspecies mainly in having an asymmetrical chamber, and from the latter in the absence of the radial elongation of the last chamber. Intermediate forms between this subspecies and *Globigerinoides quadrilobatus sacculifer* are common in the samples from the Nief Beds.

Typical forms from the Nief Beds are comparable with the hypotypes from Papua, New Guinea, illustrated by Belford (1962) on plate 3, figs. 9-13. However, the illustrated specimens from the Nief Beds have less inflated chambers, notably that on plate 3, fig. 3a which shows a compressed spiral side.

Dimensions of the figured specimens

Pl. 3, figs. 8a-b.

Max. length = 0.7 mm, 0.54.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

Known range

According to Banner and Blow (1960, Fig. 1), *Globigerinoide* *quadrilobatus irregularis* Le Roy ranges from somewhere in the uppermost zone N.4, or lower part of zone N.5 (Aquitanian) to Recent. (See Range Chart 1).

Globigerinoides quadrilobatus primordius Blow & Banner, 19

Plate 3, figs. 9, 10; plate 4, fig. 1

1962 *Globigerinoides quadrilobatus primordius* Blow & Banner, p. 115, pl. 9, figs. Dd-Ff; Fig. 14 (iii-viii).

1964 *Globigerinoides trilobus primordius* Blow & Banner; Reiss and Gvirtzman, pl. 5, figs. 1a-c.

1965 *Globigerinoides quadrilobata primordia* Blow & Banner; Cita, Premoli Silva and Rossi, p. 264, pl. 29, figs. 2a-b, text-fig. 9C-C'.

1971 *Globigerinoides quadrilobatus primordius* Blow & Banner; Bronnimann and Resig, p. 1310, pl. 13, figs. 6, 9.

1971 *Globigerinoides primordius* Blow and Banner; Postuma, p. 298, 299.

1979 *Globigerinoides primordius* Blow & Banner; Poore, p. 470, pl. 11, figs. 1, 2.

Remarks

Globigerinoides quadrilobatus primordius is derived from *Globigerina praebulloides occlusa* Blow & Banner at the lowermost part of *Globorotalia kugleri* zone by the acquisition of a single spiral aperture (Blow and Banner, 1962; Keller; 1981). The individuals of *Globigerinoides quadrilobatus primordius* from the Nief Beds show a wide range of variation in their morphological features, with regard to the shape of the test, the relative size of the last chamber, and the degree of the development of a fourth chamber as viewed ventrally. Similar variation has been illustrated by Belford (1972) on plate 9, figs. 1-16. Typical forms are closely comparable with the holotype illustrated by Blow and Banner (1962) on plate 9, figs. Dd-Ff.

Globigerinoides quadrilobatus primordius was also identified from thin section. It is comparable to the figure given by Postuma (1972, p. 299).

Dimensions of the figured specimens

Pl. 3, fig. 9, pl. 4; fig. 1.

Max. Length = 0.56 mm, 0.38 (holotype = 0.41 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to Blow (1969), *Globigerinoides quadrilobatus primordius*, ranges from the lowermost of zone N.4, to the early part of zone N.5 (Earliest Miocene). Many workers have also reported this subspecies from zone N.3, Later Oligocene (cf. Belford, 1972; Poag, 1972; Stainforth et al., 1975). (See Range Chart 1).

Globigerinoides quadrilobatus quadrilobatus (d'Orbigny), 18

Plate 4 figs. 2a-b

1846 *Globigerina quadrilobata* d'Orbigny, p. 164, pl. 9, figs. 7-10.

1960 *Globigerina quadrilobata* d'Orbigny; Banner & Blow, p. 17, pl. 4, figs. 3a-b. Also given as *Globigerinoides quadrilobatus* in the explanation of the plate.

1962 Globigerinoides quadrilobatus quadrilobatus (d'Orbigny); Belford, p. 12, pl. 2, figs. 17-21.

1962 Globigerinoides quadrilobata quadrilobata (d'Orbigny); Mistretta, p. 100, pl. 8, figs. 4a-d; pl. 11, fig. 2.

1964 Globigerinoides quadrilobatus (d'Orbigny); Parker, p. 630, pl. 101, figs. 28. 32.

Remarks

Banner and Blow (1960) selected and illustrated a lectotype of Globigerinoides quadrilobatus quadrilobatus from the syntypic specimens of Globigerina quadrilobata d'Orbigny, 1946. They indicated that the original specimen on which d'Orbigny based his figures has been lost. Todd (1961), Bandy (1964b) and Jenkins (1966, 1971), considered the lectotype of Banner and Blow (1960) to be invalid, because it has supplimentary apertures as compared with their absence in d'Orbigny's original figure and description. Despite the difficulty of verifying either of these views, the lectotype of Banner and Blow is accepted here, since it has been in almost all the published literature.

In the Nief Beds, Globigerinoides quadrilobatus quadrilobatus is comparable with the lectotype illustrated by Banner and Blow (1960), on plate 4, figs. 3a-b. However, it differs in having circular dorsal supplimentary apertures as compared with the slit-like apertures of the lectotype, a more tightly coiled test and a less lobulate equitorial periphery.

Dimensions of the figured specimens

Pl. 4, figs. 2a-b.

Max. length = 0.60 mm, 0.58 (lectotype = 0.57 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known Range

According to Blow (1969), Globigerinoides quadrilobatus quadrilobatus ranges from near the top of zone N.4 to zone N.23 (Lower Miocene to the Holocene). It has been recorded from within this range in New Guinea (Belford, 1962), the deep sea drilling project, Leg 21 (Kennett, 1973), and from other parts of the world (See Range Chart 1).

Globigerinoides quadrilobatus sacculifer (Brady), 1877

Plate 4, figs. 3-4

1877 Globigerina sacculifera Brady, p. 355.

1932 Globigerinoides sacculiferus (Brady); Thalmann, pp. 293-312.

1945 Globigerinoides sacculifera (Brady); Cushman and Todd, p. 66, pl. 11, figs. 14.

1954 Globigerinoides triloba forma sacculifera (Brady); Colom, p. 215, pl. 18, figs. 49-54.

1955 Globigerinoides sacculifer (Brady); Weiss, p. 311, pl. 3, fig. 20.

1957e Globigerinoides triloba sacculifera (Brady); Bolli, p. 113 pl. 25, figs. 5a-b.

1960 Globigerinoides quadrilobatus sacculifer (Brady); Banner and Blow, p. 17 (plate explanation).

1964 Globigerinoides trilobus sacculifer (Brady); Reiss and Gvirtzman, pl. 5, figs. 10a-c.

1974 Globigerinoides trilobus (Reuss), forma sacculifera (Brady); Boltovskoy, pl. 6, figs. 1, 2.

1975 Globigerinoides quadrilobatus sacculifer (Brady); Stainforth et al., p. 307, Fig. 137.

Remarks

Globigerinoides quadrilobatus sacculifer (Brady), has a confused taxonomy. This is clearly indicated from the references cited. For detailed remarks on this subspecies, reference should be made to the publication by Blow (1959), Banner and Blow (1960, 1965a), Belford (1962), Blow and Banner (in Eames et al., 1962), Blow (1969), Parker (1962, 1967). Bé (1965) and Todd (1963, 1964).

Almost all the specimens from the Nief Beds are comparable with the lectotype (forma typica) illustrated by Banner and Blow (1960) on plate 4, figs. 1a, 1b. However, some of the specimens have radially longer final chamber than the normal forms (see specimen illustrated on plate 4, fig. 4).

Intermediate forms between *G. quadrilobatus sacculifer* and *G. quadrilobatus irregularis* which cannot be assigned with certainty to either are present in few samples.

Dimensions of the figured specimens

Pl. 4, figs. 3-4.

Max. diameter = 0.79 mm, 0.94

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), *G. quadrilobatus sacculifer* (forma typica) ranges from zone N.6 (Early Miocene), to zone N.23 (Recent). It has been reported from within this range from Trinidad (Bolli, 1957e), Venezuela (Blow, 1959), Italy (AGIP Mineraria, 1957) and New Zealand (Jenkins, 1971). (See Range Chart 1).

Globigerinoides quadrilobatus trilobus (Reuss), 1850

Plate 4, figs. 5a-c

1850 *Globigerina triloba* Reuss, p. 374, pl. 47, figs. 11a-d.

1884 *Globigerina bulloides* var. *triloba* Reuss; Brady, p. 595, pl. 79, fig. 2.

1940 *Globigerinoides triloba* (Reuss); Coryell and Rivero, p. 340.

1957 *Globigerinoides trilobus* (Reuss); AGIP Mineraria, pl. 46, fig. 6.

1957e *Globigerinoides triloba triloba* (Reuss); Bolli, p. 112, pl. 25, figs. 2a-c; text - fig. 21, no. 1.

1960 *Globigerinoides quadrilobatus trilobus* (Reuss); Banner and Blow, p. 18, Fig. 1.

1964 *Globigerinoides trilobus trilobus* (Reuss); Reiss and Gvirtzman, pl. 5, figs. 4a-5.

1975 *Globigerinoides quadrilobatus triloba* (Reuss); Stainforth et al., p. 310, Fig. 138.

1981 *Globigerinoides quadrilobatus triloba* (Reuss); Belford, pl. 3, fig. 7.

Remarks

Globigerinoides quadrilobatus trilobus (Reuss), like *G. quadrilobatus sacculifer* (Brady), has a confused taxonomy. This is indicated by the references cited.

Globigerinoides quadrilobatus trilobus has evolved from a *Globigerinoides quadrilobatus* stock by a gradual embracing by the last chamber of the rest of the test

(Blow and Banner, in Eames et al., 1962).

The Nief Beds specimens are comparable with the hypotypes of Globigerinoides quadrilobatus trilobus illustrated by Bolli (1957e) on plate 25, figs. 2a-c. Very few specimens show a low slit-like primary aperture at the base of the final chamber. These specimens resemble this subspecies illustrated by Belford (1962) on plate 3, figs. 5-8.

Dimensions of the figured specimen

Pl. 4, figs. 5a-c.

Max. length = 0.48 mm, 0.46, 0.40.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

In southern Trinidad, Globigerinoides quadrilobatus trilobus ranges from the Catapsydrax dissimilis zone to Globorotalia menardii zone, (Early to the Lower Late Miocene) (Bolli, 1957e). According to the "P/N" zonation by Blow (1969), it ranges from within the early part of zone N.6 to zone N.23 (Early Miocene to Recent). Similar range is given by Postuma (1971). (See Range Chart 1).

Globigerinoides ruber cyclostomus (Galloway & Wissler), 192

Plate 4, figs. 6a-c.

1927 Globigerina cyclostoma Galloway & Wissler, p. 42, pl. 7, figs. 8a-9c.

1962 Globigerinoides ruber cyclostomus (Galloway & Wissler); Takayanagi and Saito, p. 97, pl. 26, figs. 6a-c; text - fig. 3, no. 8a-b.

1964 Globigerinoides ruber cyclostomus (Galloway & Wissler); Reiss and Gvirtzman, p. 314 (Range Chart), pl. 93, figs. 5a-b, 8.

1969 Globigerinoides ruber cyclostomus (Galloway & Wissler); Bhatt (part), p. 32, pl. 12, fig. 4.

Remarks

According to Galloway & Wissler (1927), and Takayanago & Saito (1962), Globigerinoides ruber cyclostomus is distinguished from Globigerinoides ruber ruber in having much more compact test with quadrate equitorial profile, more regular coiling with low trochospire, less globular chambers, a larger or nearly equal sub-rectangular final chamber as compared with the combined ultimate and the penultimate chambers, and small circular aperture.

The specimens from the Nief Beds are comparable with the figure of Globigerinoides ruber cyclostomus illustrated by Takayanagi and Waito (1962) on plate 26, figs. 6a-c. It differs in having smaller circular primary aperture which is located in the intersection of the three ventral intercameral sutures, and chambers more flattened ventrally. A trace of an apertural lip is present on plate 4, fig. 6C.

Dimensions of the figured specimen

Pl. 4, figs. 6a-c.

Max. Length = 0.42 mm, 0.46, 0.49.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

Globigerinoides ruber cyclostomus is identified as a frequent species from a single sample assigned to zone N.16/N.15·(See Table 1 & 2).

Known range

Takayanagi and Saito (1962), gave the range from the Globorotalia cultrata cultrata /Globigerina nepenthes zone (lower Late Miocene) to Recent. Blow (1969, p. 324) pointed out that his concept of Globigerinoides gomitulus is based upon specimens which can be matched with G. ruber cyclostomus, and gave the range from within the later part of zone N.16 to zone N.22 (? N.23) (See Range Chart 1).

Globigerinoides sicanus de Stefani, 1950, Sensu Blow, 1956

Plate 4, figs. 7-8

1945 Globigerinoides conglobata (Brady); Cushman and Stainforth (not Brady, 1879), p. 68, pl. 13, fig. 6.

1950 Globigerinoides sicanus de Stefani, p. 9, note 4 (type figure designated as Globigerinoides conglobata of Cushman and Stainforth, 1945, p. 68, pl. 13, fig. 6.

1954 Globigerinoides bispherica Todd; Todd et al., p. 681, pl. 1, figs. 1a-c.

1955 Globigerinoides conglobatus (Brady); Weiss (not Globigerina conglobata Brady, 1879), p. 311, pl. 3, fig. 17.

1956 Globigerinoides bispherica Todd, emend. Blow, 1956; Blow, p. 62, text - fig. 1, nos. 4-8, text - fig. 2, nos. 10-11.

1959 Globigerinoides bisphericus Todd; Brooger and Batjes, pl. 1, figs. 11a-c.

1969 Globigerinoides sicanus de Stefani; Blow, p. 326, pl. 3, figs. 10, 11 (re-figured holotype).

1975 Globigerinoides sicanus de Stefani; Stainforth et al., p. 320, Fig. 144.

Remarks

Intermediate forms between Globigerinoides quadrilobatus trilobus and Globigerinoides sicanus have been recognized from the Nief Beds. These cannot be assigned with certainty to either.

The Nief Beds specimens of Globigerinoides sicanus compare closely with the hypotypic forms from the Cipero Formation illustrated by Bolli (1957e) on plate 27, figs. 1a-b. However, many specimens are recognized to show similarity with the holotype of Globigerinoides sicanus illustrated by Cushman and Stainforth (1945, as Globigerinoides conglobata) on plate 13, fig. 6. These specimens show four, very low, slit-like apertures situated along the suture between the final chamber and the rest of the text.

Dimensions of the figured specimens

Pl. 4, figs. 7-8.

Max. length = 0.51 mm, 0.57.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Blow (1969) gave the range of Globigerinoides sicanus from the base of zone N.8 to within the earlier part of zone N.9 (Late Early Miocene to the earliest part of

Middle Miocene). Similar ranges have been reported from southern Trinidad (Bolli, 1957e), and New Zealand (Jenkins, 1971). Similar forms have been recorded from higher stratigraphical levels (Boltoviskoy, 1974; Stainforth et al., 1975). (See Range Chart 1).

Subfamily *Orbulininae* Schultze, 1954, partim, emend. Blow 197

Genus *Biorbulina* Blow, 1956

Genotype: *Globigerina bilobata* d'Orbigny, 1846, by original designation.

Biorbulina bilobata (d'Orbigny), 1846

Plate 4, figs. 9-10

1846 *Globigerina bilobata* d'Orbigny, p. 164, pl. 9, figs. 11-14.

1934 *Candeina bilobata* Jedlitschka, p. 22, 24, text-figs. 8-12.

1941a *Orbulina universa* d'Orbigny var. *bispherica* Le Roy, p. 44, pl. 1, fig. 3.

1944 *Orbulina bisphaerica* Le Roy, p. 41, pl. 3, fig. 46

1951 *Orbulina bilobata* (d'Orbigny); Bronnimann, p. 135, text-fig. 3, nos. 1-2, 9-10, 17, 19; text fig. nos. 5-6, 17-1

1956 *Biorbulina bilobata* (d'Orbigny); Blow, p. 69, text-fig. 2, no. 16 (Cum. Syn.).

1960 *Globigerina bilobata* d'Orbigny; Banner and Blow, p. 2, pl. 3, fig. 9.

1962 *Orbulina universa* d'Orbigny; Belford (part), p. 6, pl. 1, figs. 5-7. Not figs. 1-4.

1967 *Orbulina spp*. Parker, p. 159, pl. 22, figs. 7, 8.

1969 *Biorbulina bilobata* (d'Orbigny); Blow, p. 334.

1971 *Orbulina bilobata* (d'Orbigny); Postuma, pp. 370-371.

1978 *Biorbulina bilobata* (d'Orbigny); Krasheninnikov and Pflaumann, p. 630, pl. 6, figs. 4, 5.

Remarks

A few specimens of Biorbulina bilobata (d'Orbigny) were recognized both amongst the matrix-free specimens and in the thin sections from the Nief Beds. They occur together with Orbulina universa in the same population. They are distinguished in having a bilobate test. The penultimate chamber varies in size from a very small pustule to one equal in size to that of the ultimate chamber. Similar variations have been illustrated by Jenkins (1960) from the Lakes Entrance Oil Shaft, Australia. Bronnimann and Resig (1971) considered the unequal chambered forms as a new subspecies which they called Orbulina universa (d'Orbigny) parkerae Bronnimann and Resig. They pointed out that it is an off shoot of Biorbulina bilobata. Here, since no stratigraphical interval separates between them, it is regarded as a variation of Biorbulina bilobata.

Biorbulina bilobata in thin section is similar to the figure illustrated by Postuma (1971, p. 371). It differs in having a thick-walled final chamber.

Dimensions of the figured specimens

Pl. 4, figs. 9-10.

Max. length = 0.65 mm, 0.4.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), it ranges from near the base of zone N.9 to zone N.23 (lowermost Middle Miocene to the Recent). A similar range is given by Postuma (1971).

Genus Orbulina d'Orbigny, emend Blow, 1956

Genotype: Orbulina universa d'Orbigny, 1839

Remarks

The first appearance of the genus Orbulina d'Orbigny serves as a world wide datum plane marking the beginning of the Middle Miocene.

Orbulina suturalis Bronnimann, 1951, emend. Blow, 1956

Plate 5, figs. 1-2.

1934 Candorbulina universa Jedlitschka, Naturf. Ver. Brunn, Verh., vo. 65, p. 21.

1944 Orbulina universa d'Orbigny; Le Roy (part), p. 41, pl. 3, fig. 45, Not fig. 44 (= O. universa).

1951 Orbulina suturalis Bronnimann (part), p. 135, text-fig. 2, nos. 1-2, 5-8, 10; text-figs. 3, nos. 3-8, 11, 13-16, 18, 20-22; text-fig. 4, nos. 2-4, 7-12, 15-16, 19-22.

1956 Orbulina suturalis Bronnimann, emend., Blow, 1956, p. 66, text-fig. 2, nos. 5-7; text-fig. 3, stage 6. (Cum. Syn.).

1975 Orbulina suturalis Bronnimann; Stainforth et al., p. 325, Fig. 147.

Remarks

In the Nief Beds, Orbulina suturalis and universa have been recognized together in the same population. The individuals of Orbulina suturalis are distinguished from the latter species by having discernable, globigerine, initial chambers, slightly protruding from the spherical surface of the enveloping last chamber. The sutural or areal secondary apertures have been obscured by matrix.

Orbulina suturalis was seen in thin section. It is similar to the figure given by Postuma (1971) on page 373. However, the initial globigerine chambers are not preserved due to the recrystalization.

Dimensions of the figured specimens

Pl. 5, figs. 1-2.

Equitorial diameter = 0.53 mm, 0.44 (holotype = 0.31 mm).

Abundance, distribution, faunal assocaition and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), *Orbulina suturalis* ranges from within the early to middle part of zone N.9 to zone N.23 (lower Middle Miocene to Recent). It has been reported from within this range from Trinidad (Bolli, 1957e) and E. Falcon, Venezuela (Blow, 1959), (See Range Chart 1).

Orbulina universa d'Orbigny, 1839

Plate 5, figs. 3-6

1839 *Orbulina universa* d'Orbigny, p. 2, pl. 1, fig. 1

1951 *Orbulina universa* d'Orbigny; Bronnimann, p. 134, Text-fig. 3, no. 12; Text - fig. 4, figs. 1, 13-14.

1956 *Orbulina universa* d'Orbigny; Blow, p. 66, Text-fig. 2, nos. 8-9.

1974 *Orbulina universa* d'Orbigny; Cifelli, p. 181, pl. 3, fig. 7.

1978 *Orbulina universa* d'Orbigny; Krasheninnikov and Pflaumann, p. 630, pl. 6, figs. 8, 9.

Remarks

Orbulina universa d'Orbigny has been treated differently by various authors with regard to its specific and generic limit. According to Bronnimann (1951), the single and the double-chambered forms of the genus *Orbulina* are separated, but related species. Blow (1956) restricted the single-chambered forms to the genus *Orbulina* d'Orbigny, and referred the double chambered forms to his new genus *Biorbulina.* He proposed two different lines of evolution for these two genera, from a common ancestor *Globigerinoides sicanus* de Stefani. According to Hofker (1969a) and Parker (1962), *O. universa* may include several species which develop the spherical final chamber, and thus denied the precise worldwide synchroneity of the *Orbulina* datum. Many authors consider *Biorbulina bilobata* to be a further growth stage of a single-chambered form, and place it in the synonym of *Orbulina universa* (cf. Belford, 1962; Parker, 1962; Rögl and Bolli, 1973; Stainforth et al., 1975). Reed (1965) suggested the retention of *Orbulina universa* as a "form species" rather than an established "genetic species" pending further investigation. The author follows Blow (1956) in his concept of *Orbulina universa*.

Orbulina universa frequently found in the Nief Beds. Normal spherical, as well as lenticular tests were recognized from these samples. Such variation has been reported by

Rögl and Bolli (1973). However, the lenticular tests almost certainly result from post depositional compression. Both types have been photographed and illustrated.

Dimensions of the figured specimens

Pl. 5, figs. 3-6.

Diameter = 0.45 mm, 0.47, 0.58, 0.56.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Many early classic papers have wrongly reported the presence of *Orbulina universa* from pre-Miocene rocks. According to the "P/N" zonation by Blow (1969), this species ranges from within the early to Middle part of zone N.9 to zone N.23 (lower Middle Miocene to Recent). A similar range is given by Postuma (1971). (See Range Chart 1).

Family *Globorotaliidae* Cushman, 1927, partim, emend. Blow, 197

Subfamily *Globorotaliinae* Cushman, 1927, partim, emend. Blow, 1979

Genus *Globorotalia* Cushman, 1927, emend. Blow, 1979

Genotype *Pulvinulina menardii* (d'Orbigny) var. *tumida* Brady, 1877, by original designation (lectotype selected by Banner and Blow, 1960)

Remarks

Globorotalia s.l., emend. Blow, 1979 is based basically on the presence of an interiomarginal, umbilical-extraumbilical aperture and trochospiral coiling throughout the ontogeny. The species with a modified final chamber (ampulla, new descriptive term defined by Blow, 1979) have been excluded from this genus.

The present writer believes the functional dorsal sutural aperture is of generic value, since it separates Globigerina and Globigerinoides. However, in order to accommodate the emended diagnosis of the Globorotaliidae, the taxon Truncorotaloides Bronnimann & Bermudez, is considered here a subgenus to the Globorotalia Cushman, emend. Blow, 1979. Based on the above diagnosis of Globorotalia s.l., the taxa Acarinina Subbotina, 1953, Globorotalia s.s. Cushman, 1927, Morozovella McGowran, 1964 and Turborotalia Cushman & Bermudez, 1949 are regarded here to be of subgeneric value.

Blow (1979) used such terms as "Muricae" and "peripheral muricocarinae" as a substitute for a "spinose wall" insofar as the spines are partially empty compared to true, solid spines. Blow (op. cit.) also used the term "functional apertures" (rimmed apertures) in contrast with the randomly scattered, non functional (non rimmed) apertures which result from a subsequent adherence of later calcified structures. He suggests that the functional apertures are indicative of cytoplasmic flow.

Many writers (cf. Bemjamini, 1980; Mancini & Oliver, 1981) elevated some of these taxa to a generic level.

Subgenus Globorotalia (Globorotalia) Cushman, 1927,
emend. Blow, 1979

Subgenotype: Pulvinulina menardii (D'Orbigny) var.
tumida Brady, 1877, by original designation.

Remarks

Globorotalia (Globorotalia) Cushman, 1927, emend. Blow, 1979, is characterized by a true peripheral carina but no muricae, no mucirocarinae and no supplimentary dorsal apertures. The primary aperture is interiomarginal umbilical-extraumbilical but not totally extraumbilical.

Truncorotalia Cushman and Bermudez and Planorotalites Morozova are regarded as synonymous with Globorotalia (Globorotalia).

Globorotalia (G) merotumida Blow and Banner, 1965

Plate 5, figs. 7a-c

1959 Globorotalia menardii miocenica Palmer; Blow (non Palmer, 1945), p. 216, pl. 19, figs. 121 a-c.

1965b Globorotalia (G) merotumida Blow & Banner; Banner and Blow, p. 1352, figs. 1a-c.

1969 Globorotalia merotumida Blow & Banner; Blow, p. 364, pl. 9, figs. 4-6.

1971 Globorotalia (Globorotalia) merotumida Blow & Banner; Bronnimann and Resig, p. 1247, pl. 30, figs. 3, 6; pl. 31, fig. 5 & 6.

1972 Globorotalia merotumida Blow & Banner; Poag, p. 510, pl. 6, figs. 11, 12.

1977 Globorotalia merotumida Blow & Banner; Wernli, p. 164, pl. 1, fig. 9.

1979 Globorotalia merotumida Blow & Banner; Cifelli and Glacon, p. 223, pl. 1, figs. 6a-c.

Remarks

Globorotalia (G) merotumida is distinguished from G (G) tumida plesiotumida Blow & Banner in being smaller, showing slower increase in the whorl height as seen from the dorsal side, a thinner carina and greater ventral convexity (Banner and Blow, 1965b). According to Berggren and Poore (1974), G. tumida plesiotumida has a more radially elongated test and a less pronounced inflation of the umbilical side resulting in less biconvexity of the test. These differences have been used to separate these two taxa in the Nief Beds specimens. However, difficulties in defining G(G) merotumida has been indicated in the literature (cf. Parker, 1967; Jenkins, 1971).

According to Blow (1969), G(G) merotumida gives rise to G(G) tumida plesiotumida in the earliest part of zone N.17. In Seram, G(G) merotumida and G(G) tumida plesiotumida have been identified from the same samples. Intermediate specimens which cannot be assigned with certainty to either of the two species were also recognized.

In the Nief Beds, G(G) merotumida has been identified from two samples. Specimens conform well with the holotype illustrated by Banner and Blow (1965b) on Fig. 1a-c. However, it differs in having a larger test and a less tumid ventral side.

Dimensions of the figured specimens

Pl. 5, figs. 7a-c

Max. diameter = 0.56 mm, 0.52, 0.63 (holotype = 0.38 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), it ranges from above the base of zone N.16 to within zone N.18 (Late Miocene). It has been reported from within this range from the western north Atlantic (Poag, 1972), the western part of the north Pacific (Krasheninnikov & Hoskins, 1973), and at DSDP, site 397 (Salvatorini and Cita, 1979).

Globorotalia (*G*) *tumida plesiotumida* Blow & Banner, 1965

Plate 5, figs. 8a-c

1965b *Globorotalia* (*G*) *tumida* (Brady) *plesiotumida* Blow & Banner; Banner and Blow, p. 1353, Fig. 2a-c.

1969 *Globorotalia* (*G*) *tumida plesiotumida* Blow & Banner; Blow; p. 371, pl. 9, figs. 7-9; pl. 47, figs. 6-8.

1972 *Globorotalia plesiotumida* Banner & Blow; Jenkins and Orr, p. 1102, pl. 30, figs. 1-3.

1975 *Globorotalia plesiotumida* Blow & Banner; Stainforth et al., p. 396, Fig. 194.

1978 *Globorotalia plesiotumida* Blow & Banner; Krasheninnikov and Pflaumann, p. 632, pl. 11, figs. 4, 5.

1979 *Globorotalia tumida plesiotumida* Blow & Banner; Salvatorini & Cita, Fig. 6 (Range Chart), pl. 12, figs. 10-14, 19.

Remarks

Globorotalia (*G*) *tumida tumida* (Brady) is distinguished from the subspecies *G*(*G*) *tumida plesiotumida* in having a much larger test, a massive carina and a higher apertural arch

(Banner and Blow, 1965b).

G(G) tumida plesiotumida is a frequent subspecies in the Nief Beds. It is similar to the holotype illustrated by Banner and Blow (1965b) on Fig. 2a-c, but has a much larger test.

Dimensions of the figured specimens

Pl. 5, figs. 8a-c.

Max. diameter = 0.77 mm, 0.67, 0.8 (holotype = 0.52 mm).

Abundance, distribution, faunal association and stratigraphical distribution in the Nief Beds

See Table 1 & 2.

Known range

G(G) tumida plesiotumida ranges from the base of zone N.17 to within the latest part of zone N.18 (Banner and Blow, 1965b; Blow, 1969). It has been reported from the Upper Miocene of the eastern equitorial Pacific, the western Pacific and the Atlantic ocean (Jenkins, and Orr, 1972; Krasheninnikov and Hoskins, 1973; Krasheninnikov and Pflaumann, 1978).

Subgenus Globorotalia (Turborotalia) Cushman & Bermudez, 1949, emend. Blow, 1979

Subgenotype: Globorotalia centralis Cushman &
Burmudez, 1934, by original designation

Remarks

This taxon was originally described by Cushman &

Bermudez (1949) as a subgenus of Globorotalia Cushman, 1927. Loeblich and Tappan (1964) elevated this taxon to generic rank based on the absence of a peripheral keel or non-porous peripheral margin, and placed "Acarinina" Subbotina in its synonym. Jenkins (1971) regarded "Turborotalia" of a subgeneric rank. He emended the diagnosis by Loeblich & Tappan (1964) to exclude the taxon "Acarinina", by the introduction of the word "Reticulate" instead of "hypsid". Blow (1979) re-defined the subgenus Globorotalia (Turborotalia) on a new basis. He stated that, true supplimentary apertures, ampullae or bullae, muricae, mucicocarinae and true carinae are absent from this subgenus. The wall texture may be with, or without pore-pits and inter-pore ridges.

Globorotalia (T) acostaensis acostaensis Blow, 1959

Plate 5, figs. 9a-c

1959 Globorotalia acostaensis Blow, p. 208, pl. 17, figs. 106a-c, 107.

1962 Globorotalia acostaensis Blow; Takayanagi and Saito, p. 75, pl. 24, figs. 2a-c.

1965 Globorotalia acostaensis Blow; Cita, Premoli Silva and Rossi, p. 225, pl. 18, fig. 6a-c; text-fig. 5a-b.

1967 Globorotalia (T) acostaensis acostaensis Blow; Banner and Blow, p. 153, pl. 3, fig. 1 (holotype refigured).

1971 Globorotalia (Turborotalia) acostaensis acostaensis Blow; Bronnimann and Resig, p. 1277, 1312, Fig. 18, pl. 3, figs. 2, 4 & 5.

1977 Globorotalia acostaensis Blow; Miles, p. 942, pl. 4, fig. 7.

1977 Globorotalia acostaensis acostaensis Blow; Wernli, p. 159, pl. 1, fig. 3.

Remarks

Globorotalia (*T*) *acostaensis* *acostaensis* may be confused with *Globorotalia* (*T*) *siakensis* Le Roy from which it is separated by its inflated chambers, more closed aperture, and a more rapdily open spire.

G(*T*) *acostaensis* *acostaensis* is a very frequent subspecies in the Nief Beds. Individuals are distinguished by having 4½ - 5 inflated chambers in the last convolution, the last slightly reduced in size compared to the others, a biconvex test with low trochospire, a lobulate equitorial periphery and a rounded axial periphery. The wall is distinicitly pitted. The sutures are depressed and radial on both the dorsal and umbilical sides. Although the apertural details are not clear, a few specimens have revealed the extended, interiomarginal, umbilical-extra-umbilical lip which covers the aperture. The specimen illustrated on plate 5, fig. 9C, shows a wide flap which covers the umbilicus.

The specimen from the Nief Beds are in accord with the diagnosis and illustration of the holotype presented by Blow (1959).

Dimensions of the figured specimens

Pl. 5, figs. 9a-c.

Max. diameter = 0.36 mm, 0.39, 0.36.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Globorotalia acostaensis acostaensis Blow, ranges from the *Globorotalia menardii menardii/Globigerina nepenthes* zone (Upper Langhian (Miocene) to the *Globigerina bulloides* zone (Upper Tortonian (Miocene)) in the Pozon Formation, Eastern Falcon, Venezuela (Blow, 1959). According to the "P/N" zonation by Blow (1969), it ranges from the base of zone N.16 (Lower Tortonian) to within zone N.21 (Lowermost Pleistocene). (See Range Chart 1).

Globorotalia (T) kugleri Bolli, 1957

Plate 6, figs. 1a-c

1957e *Globorotalia (T) kugleri* Bolli; p. 118, pl. 28, figs. 5a-b (not *Globorotalia* cf. *kugleri*, pl. 28, figs. 7a-c (= *G(T) pseudokugleri* Blow)).

1964 *Globorotalia (T) kugleri* Bolli; Reiss & Gvirtzman, p. 314, p. 94, figs. 13a-c, 14a-c, 15a-c.

1967 *Turborotalia kugleri* (Bolli); Lipps, p. 996, fig. 2.

1969 *Globorotalia (T) kugleri* Bolli; Blow, p. 350, pl. 10, figs. 1-3 (refigured holotype) and pl. 38, figs. 1-4 (topotypes here figured).

1971 *Globorotalia (T) kugleri* Bolli; Postuma, p. 324, 325.

1972 *Globorotalia (T) kugleri* Bolli; Belford, p. 13, pl. 10, figs. 6-9.

1975 *Globorotalia kugleri* Bolli; Stainforth et al., p. 289, Fig. 126.

1979 *Globorotalia kugleri* Bolli; Poore, p. 471, pl. 10, figs. 1-3.

Remarks

In view of the stratigraphical importance of *Globorotalia (T) kugleri*, Blow (1969) suggests a rigid definition for this form by separating Bolli's taxon

Globorotalia cf. kugleri which he described as Globorotalia (T) pseudokugleri Blow, and also another form which he named G(T) mendacis Blow.

G(T) mendacis Blow differs from G(T) kugleri Bolli in having a more equally biconvex test, a smaller number of less tangentially elongated chambers with less recurved intercameral sutures as viewed dorsally, and in having a more nearly closed umbilical depression.

Although the individuals of G(T) kugleri Bolli from the Nief Beds are in a state of bad preservation, they show the curved, dorsal, intercameral sutures, a strongly convex umbilical side and the flattened dorsal side. The periphery is broadly subacute as seen in axial view. These individuals are in agreement with the diagnosis and the illustration of the holotype presented by Bolli (1957e) on page 118, pl. 28, figs. 5a-b. However, the recurviture of the dorsal intercameral sutures is less marked in these individuals.

Dimensions of the figured specimens

Pl. 6, figs. 1a-c.

Max. diameter = 0.28 mm, 0.26, 0.29 (holotype = 0.3 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known Range

According to the "P/N" zonation by Blow (1969), it ranges from within zone N.3 to the top of zone N.4 (Uppermost

Oligocene - Lower Miocene). Postuma (1971), gave the range as from the base of the *Globorotalia kugleri* zone into the lowermost part of the *Globigerinoides trilobus* zone (Lowermost Miocene). According to Stainforth et al. (1975), it is a short-ranging, index species all over the world diagnostic of levels close to the Oligocene-Miocene boundary· (See Range Chart 1).

Globorotalia (*T*) *obsea* Bolli, 1957

Plate 6, figs. 2a-c

1957e *Globorotalia obesa* Bolli, p. 119, pl. 29, figs. 2a-c, 3.

1965 *Globorotalia obesa* Bolli; Bizon and Bizon, pl 248, pl. 4, figs. 6a-c.

1966 *Globorotalia obesa* Bolli; Jenkins, p. 10, pl. 2, figs. 10a-c.

1971 *Globorotalia* (*T*) *obesa* Bolli; Bronnimann and Resig, p. 13 pl. 50, figs. 7, 8; text-fig. 19.

1972 *Globorotalia* (*T*) *obesa* Bolli; Belford, p. 13, pl. 10, figs. 10-14.

1979 *Globorotalia obesa* Bolli; Salvatorini & Cita, Fig. 6 (Range Chart), pl. 9, fig. 1.

1981 *Globorotalia* (*T*) *obesa* Bolli; Belford, p. 3, pl. 5, figs. 13, 14.

Remarks

In the materials from the Nief Beds, *G*(*T*) *obesa* Bolli is characterized by its finely rugose and pitted surface, four and half globose chambers in the final convolution increasing in size fairly rapidly, and rounded axial periphery. The trochospire is usually flattened, but of lower elevation compared with final chamber. These individuals conform well with the holotype illustrated by Bolli (1957e, pl. 29, figs. 2a-c).

Dimensions of the figured specimens

Pl. 6, figs. 2a-c.

Max. diameter = 0.41 mm, 0.49, 0.38 (holotype = 0.50 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Globorotalia (T) obesa is long ranging species. According to the "P/N" zonation by Blow (1969), it ranges from within zone N.2 (P = 21) to zone N.23 (Upper Oligocene to the Lower Miocene). Postuma (1971) gave the range as from the lower part of Globigerinoides trilobus zone to the upper part of Globorotalia margaritae zone (Lower Miocene to the Lower Pliocene with questionable occurrences from the Upper Pliocene to the Recent). (See Range Chart 1).

Globorotalia (T) opima nana Bolli, 1957

Plate 6, figs. 3a-b

1957e	Globorotalia opima nana Bolli, p. 118, pl. 28, figs. 3a-c.
1969	Globorotalia (T) opima nana Bolli; Blow, p. 352, pl. 39, fig. 1.
1972	Globorotalia (T) opima nana Bolli; Belford, p. 14, pl. 11, figs. 5-9.
1975	Globorotalia opima nana Bolli; Stainforth et al., p. 297, fig. 131.

Remarks

In the Nief Beds, Globorotalia (T) opima nana was identified from two samples assigned to zone N.4/N.3 sensu

Blow (1969). This stratigraphical occurrence is regarded as higher than the upper limit of its range which is the lower part of zone N.3. Blow (1969, p. 352) considers such forms as pseudomorphs which are superfacially similar to G(T) opima nana.

The individuals of G(T) opima nana Bolli conform very well with the figures of this species illustrated by Belford (1972) on plate 11, figures 5, 6, and with the illustrations of Stainforth et al. (1975), on Fig. 299, nos. 1-3.

Dimensions of the figured specimens

Pl. 6, figs. 3a-b

Max. diameter = 0.24 mm, 0.34 (holotype = 0.3 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

G(T) opima nana is along ranging species. Its occurrence has been reported mostly through the Late Eocene and most of the Oligocene. Blow (1969) gave the range from within zone P.15 (? later part of zone P.14) to within earlier part of zone N.3 (= p.22) for "forma typica". According to this writer, higher stratigraphical occurrences such as in the upper part of zone N.3, N.4, N.5 and N.6 are regarded as pseudomorphic forms. Such records have been reported by many authors including Blow and Banner (1962) and Jenkins (1971). Belford (1972) has recognized this subspecies with a foraminiferal assemblage characteristic of zones N.4/N.3 including Globigerinoides quadrilobatus primordius Blow and Banner as in Seram. (See Range Chart 1).

Globorotalia (T) pseudokugleri Blow, 1969

Plate 6, figs. 4a-c

1957e	Globorotalia cf. kugleri Bolli, pl. 28, figs. 7a-c
1969	Globorotalia (T) pseudokugleri Blow, p. 354 and 391, pl. 10, figs. 4-6 (holotype, figures produced from Bolli, 1957), and pl. 39, figs. 5, 6 (paratypes).
1972	Globorotalia cf. pseudokugleri Blow; Jenkins and Orr, p. 1103, pl. 31, figs. 2, 3.
1972	Türborotalia pseudokugleri (Blow); Poag, p. 513, pl. 9, figs. 13, 14.
1979	Globorotalia pseudokugleri Blow; Poore, p. 471, pl. 10, fig. 6.

Remarks

Blow (1969) re-examined Globorotalia sp. cf kugleri Bolli illustrated by Bolli (1957e), and designated it the holotype of his new species Globorotalia (T) pseudokugleri Blow. It differs from G(T) kugleri in having radial intercameral sutures, inflated chambers and a rounded peripheral margin. It is distinguished from G(T) mendacis Blow, by possessing a wider umbilical depression and broadly rounded axial periphery compared to the subacute peripheral margin of G(T) mendacis Blow.

The individuals of G(T) pseudokugleri from the Nief Beds display all the morphological aspects of the holotype described and illustrated by Blow (1969). However, it differs in having a wider umbilical depression, and 7½ chambers in the last convolution compared to 7 chambers of the holotype.

Dimensions of the figured specimens

Pl. 6, figs. 4a-c.

Max. diameter = 0.36 mm, 0.38, 0.33 (holotype = 0.31 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to Blow (1969), G(T) pseudokugleri ranges from within zone N.3 (= p.22) to within about the middle part of zone N.4 (Uppermost Oligocene - Lowermost Miocene). Similar range was reported from the western north Atlantic Ocean, Leg. 11 (Poag, 1972), and the north Atlantic, Leg 49 (Poore, 1979). (See Range Chart 1).

Globorotalia (T) siakensis (Le Roy), 1939

Plate 6, figs. 5a-c, 6?

1939 Globigerina siakensis Le Roy, p. 262, pl. 4, figs. 20-22.

1957e Globorotalia mayeri Cushman & Ellisor; Bolli (not Cushman & Ellisor, 1939), p. 118, pl. 28, figs. 4a-c.

1969 Globorotalia (T) siakensis (Le Roy); Blow, p. 356, pl. 10, figs. 7-9 (holotype refigured); pl. 34, figs. 4, 5, ideotype and holotype.

1971 Globorotalia siakensis (Le Roy); Postuma, p. 358, 359.

1975 Globorotalia siakensis (Le Roy); Stainforth et al., p. 317, Fig. 143.

1977 Globorotalia siakensis (Le Roy); Berggren, p. 595, pl. 6, figs. 14-17.

1979 Globorotalia siakensis (Le Roy); Salvatorini & Cita, Fig. 6 (Range Chart), pl. 10, figs. 11-13.

Remarks

Globorotalia (T) siakensis is close to the Globorotalia (T) mayeri Cushman & Ellisor. It differs from this species in the almost radial intercameral sutures both dorsally & ventrally, relatively less closely appressed and more rapidly increasing chambers of the final convolution, flatter spiral side, narrower aperture and more open umbilicus. However, it is difficult to separate these two species in thin section.

In the Nief Beds, G(T) siakensis was identified from both the thin section and residues. The matrix free specimens conform very well with the refigured holotype illustrated by Blow (1969) on plate 10, figs. 7-9. The thin section specimens are identical with the figure illustrated by Postuma (1971) on page 359.

Dimensions of the figured specimens

Pl. 6, figs. 5a-c, 6.

Max. diameter = 0.41 mm, 0.43, 0.39, 0.26.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Blow (1969), gave the range from within the latest part of zone N.2 (= p.21) to the top of zone N.4 (Oligocene -

Miocene). A similar range is given by Postuma (1971). According to Stainforth et al. (1975), *G(T) siakensis* serves as an index for the Mid-Tertiary, ranging from Late Oligocene to Late Middle Miocene. (See Range Chart 1).

Family *Hantkeninidae* Cushman, 1927

Subfamily *Hastigerininae* Bolli, Loeblich & Tappan, 1957

Genus *Hastigerina* Thomson, 1876

Genotype: *Hastigerina murrayi* (= *Nonionina pelagica* d'Orbigny, 1839).

Hastigerina siphonifera involuta (Cushman), 1927

Plate 7, figs. 1a-b

1917 *Globigerina aequilateralis* Brady, var. *involuta* Cushman, p. 662, figures in Cushman, 1921, p. 293, figs. 11a-c.

1959 *Hastigerina aequilateralis involuta* (Cushman); Blow, p. 171, pl. 8, figs. 32a-b.

1960 *Globigerinella involuta* (Cushman); Bermudez, p. 1212, pl. 6, fig. 11; pl. 7, fig. 1.

1969 *Hastigerina (H) siphonifera involuta* (Cushman); Blow, p. 375.

1973 *Globigerinella siphonifera involuta* (Cushman); Rögl and Bolli, p. 566, pl. 3, figs. 16-18.

Remarks

Hastigerina siphonifera involuta (Cushman) is distinguished from the ancestral form, *H. siphonifera siphonifera* (d'Orbigny), 1839, in having more involute and tightly coiled chambers, and a narrower equitorial apertural arch which extends further over the dorsal sides of the tests.

The specimens from the Nief Beds are identical with the hypotypes of *Hastigerina aequilateralis involuta* (= *H. siphonifera involuta*) illustrated by Blow (1959), on pl. 8, figs. 32a-b. However, in some of these specimens, the final chamber is smaller than the penultimate. Apertural details are obscured.

Dimensions of the figured specimens

Pl. 7, figs. la-b.

Max. diameter = 0.34 mm, 0.43.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), the species ranges from within zone N.13 to within zone N.18 (Middle Miocene to the Lowermost Pliocene). (See Range Chart 1).

Family *Globoquadrinidae* Blow, 1979

Remarks

Reference is made to thb publication by Blow (1979, p. 1295) for diagnosis and remarks. He included in his new family the genera: *Dentoglobigerina* Blow, *Globigerinita*

Bronnimann, 1961, emend. Blow & Banner, 1962 (provisional generic assignations only), Globoquadrina Finlay 1947, emend. Blow, 1979, and Globorotaloides Bolli, 1957. The differences between these genera and others will be discussed briefly under each genus. Specific representatives of these genera were recognized from the Paleogene and Neogene part of the Nief Beds.

Genus Dentoglobigerina Blow, 1979

Genotype: Globigerina galavisi Bermudez, 1961, by original designation

Remarks

The characteristics which separate this genus from others are the consistency of an essentially intraumbilical primary aperture throughout the ontogeny, and the presence of a portical umbilical-tooth which is restricted laterally to the confines of the umbilicus.

Globoquadrina Finlay, emend. Blow, 1979 differs from Dentoglobigerina Blow basically in the possession of primary apertures that are interiomarginally situated, and are either asymmetrically umbilical-extraumbilical, or truely umbilical-extraumbilical in position with respect to the centre of the umbilicus in the adult stage, but is essentially intraumbilical in the juvenile.

Globorotaloides Bolli differs from Dentoglobigerina Blow and Globoquadrina Finlay, emend. Blow, 1979 in having an umbilical-extraumbilical aperture in the earlier stages of ontogeny which is followed by an essentially intraumbilical aperture in the adult stage.

Subbotina Brotzen and Pozaryska is separated from the genus *Dentoglobigerina* Blow by the possession of an asymmetrical, umbilical-extraumbilical aperture and a porticus.

Since all the species of the genus *Dentoglobigerina* Blow are characterized by portical umbilical-teeth and intraumbilical apertures which do not change throughout the ontogeny, this genus is considered here quite distinct from the genus *Globoquadrina* Finlay, emend. Blow 1979.

Dentoglobigerina altispira altispira (Cushman and Jarvis), 1936

Plate 7, figs. 2a-c, 3?

1936 *Globigerina altispira* Cushman & Jarvis, p. 5, pl. 1, figs. 13a-c, 14.

1957e *Globoquadrina altispira altispira* (Cushman & Jarvis); Bolli, p. 111, pl. 24, figs. 7a-8b.

1964 *Globoquadrina altispira* (Cushman & Jarvis); Parker, p. 631, pl. 102, figs. 1a-c.

1971 *Globoquadrina altispira* (Cushman & Jarvis); Jenkins, 164, pl. 17, figs. 516-518.

1975 *Globoquadrina altispira altispira* (Cushman & Jarvis); Stainforth et al., p. 245, Fig. 100.

1977 *Globoquadrina altispira* (Cushman & Jarvis); Berggren, pl. 2, figs. 7-9.

1978 *Globoquadrina altispira* (Cushman & Jarvis); Krasheninnikov and Pflaumann, p. 625, pl. 2, figs. 1-3.

1979 *Dentoglobigerina altispira altispira* (Cushman & Jarvis); Blow, p. 1300.

Remarks

This taxon was first described as *Globigerina altispira* by Cushman and Jarvis (1936) from the Bowden marl of Jamaica. Bolli (1957e) referred it to the genus

Globoquadrina Finlay, and described a new subspecies *"Globoquadrina" altispira globosa*. Blow (1979) referred both of these to his new genus *Dentoglobigerina*.

According to Gordon (1961) and Stainforth et al. (1975), *D. altispira altispira* arose from D. *altispira globosa* by developing a high trochospire and axially prolonged and laterally compressed chambers. Blow (1969) indicated its direct evolution from *D. altispira globularis* (Bermudez).

D. *altispira altispira* is a variable subspecies with regard to the size and the height of the trochospire. In the Nief Beds, almost all the individuals are high spired forms, although few specimens were observed with a low trochospire. Apertural details are obscured. These individuals are in accord with the description and the illustration given by Stainforth et al. (1975) on plage 245, Fig. 100, nos. 6a-c. A doubtful indentification was made from thin section. It shows some similarity with the thin section figure illustrated by Postuma (1971, p. 311).

Dimensions of the figured specimens

Pl. 7, figs. 2a-c, 3?

Max. diameter = 0.71 mm, 0.56, 0.58, 0.35 (According to Stainforth, max. diameter ranges from 0.45 - 0.75 mm).

Max. height = 0.62 mm (fig. 2b), 0.35 mm (fig. 3).

Abundance distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

D. altispira altispira was first recorded from the Pliocene of Jamaica. Later publications have recorded this subspecies from the Early Miocene through the Neogene in various parts of the world (cf. Bolli, 1957e; Blow, 1959; Jenkins, 1960; Takayanagi and Saito, 1962; Krasheninnikov and Pflaumann, 1978). According to the "P/N" zonation by Blow (1969), it ranges from within the earlier part of zone N.4 to the earlier part of zone N.20 (Miocene and Pliocene) (See Range Chart 1).

Dentoglobigerina altispira globosa (Bolli), 1957

Plate 7, figs. 4a-c

1957e	Globoquadrina altispira globosa Bolli, p. 111, pl. 24, figs. 9a-10c.
1960	Globoquadrina altispira (Cushman & Jarvis) var. globosa Bolli; Bermudez, p. 1308, pl. 12, figs. 8, 9.
1965	Globoquadrina altispira globosa Bolli; Cita, Premoli Silva and Rossi, p. 255, pl. 26, figs. 6a-c.
1979	Dentoglobigerina altispira globosa (Bolli); Blow, p. 1300.
1979	Globoquadrina altispira globosa Bolli; Salvatorini and Cita, Fig. 6, pl. 3, fig. 16.

Remarks

Dentoglobigerina altispira globosa differs from the ancestral taxon D. altispira globularis (Bermudez) in having 5-6 chambers in the last whorl (Bermudez, 1960; Blow, 1969). It is distinguished from D. altispira altispira by its globular chambers and lower trochospire (Bolli, 1957e; Blow, 1969; Stainforth et al., 1975).

D. altispira globosa is rare in the Nief Beds, and is found in the same population with D. altispira altispira. It is comparable with the description and illustration of the holotype presented by Bolli (1957e) on page 111, pl. 24, figs. 9a-c. However, it differs from the holotype in having 5 chambers in the last convolution compared to 6 of the holotype.

Dimensions of the figured specimens

Pl. 7, figs. 4 a-c.

Max. diameter = 0.73 mm, 0.68, 0.56 (holotype = 0.73 mm).

Max. height = 0.53 mm (fig. 4b).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Dentoglobigerina altispira altispira is a long ranging subspecies. According to the "P/N" zonation by Blow (1969), it ranges from zone N.3 to within zone N.19 or to within the earliest part of zone N.20 (Uppermost Oligocene to the Lower Pliocene) (See Range Chart 1).

Dentoglobigerina baroemoensis (Le Roy), 1939

Plate 7, figs. 5a-c, 6?

1939 Globigerina baroemoensis Le Roy, p. 263, pl. 6, figs. 1-2.

1969 Globoquadrina baroemoensis (Le Roy); Blow, p. 340, pl. 28, figs. 4, 8.

1973 Globoquadrina baroemoensis (Le Roy); Krasheninnikov and Hoskins, p. 125, pl. 16, figs. 1-3.

1979 Dentoglobigerina baroemoensis (Le Roy); Blow, p. 1300.

1979 Globoquadrina baroemoensis (Le Roy); Poore, p. 470, pl. 18, figs. 8-12.

Remarks

Blow (1969) indicated that D. baroemoensis gives rise to D. larmeui larmeui Akers. According to Poore (1979), this transformation is accompanied by the development of a tighter coiling, more angular chambers and extension of the apertural face deeper into the umbilicus.

The specimens from the Nief Beds are distinguished by having 3½ - 4 chambers in the final convolution, with distinct subangular umbilical shoulders, notably of the final chamber. The apertural face of the last chamber is flattened, and almost vertically oriented toward a wide umbilicus. The apertural details are obscured by adherent matrix. These individuals are in agreement with the hypotypes illustrated by Blow (1969, pl. 28, fig. 4). However, Blow's illustration show more rounded umbilical shoulders on the first three chambers.

Dimensions of the figured specimens

Pl. 7, figs. 5a-c, 6?

Max. Length = 0.71 mm, 0.72, 0.64, 0.46

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), it ranges from within the later part of zone N.2 (Upper Oligocene), to within zone N.16 (Upper Miocene) at least. (See Range Chart 1).

Dentoglobigerina larmeui larmeui (Akers), 1955

Plate 8, figs. la-c

1955 Globoquadrina larmeui Akers, p. 661, pl. 65, figs. 4A-C.

1969 Globoquadrina larmeui larmeui Akers; Blow, p. 341, pl. 28, figs. 5, 6.

1979 Dentoglobigerina larmeui larmeui (Akers); Blow, p. 1300.

Remarks

Very few specimens of D. larmeui larmeui (Akers), were identified from the Nief Beds. They occur together with Dentoglobigerina baroemoensis (Le Roy). Intermediate forms between these two taxa have also been recognized.

These individuals show some similarity with the holotype illustrated by Akers (1955, pl. 65, figs. 4a-c). They differ in having more laterally compressed chambers, a feature particularly marked in the last. The two illustrated specimens which show the dorsal and side view probably represent an intermediate form between D. baroemoensis and D. larmeui larmeui.

Dimensions of the figured specimens

Pl. 8, figs. la-c.

Max. Length = 0.45 mm, 0.43, 0.50 (holotype = 0.34 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1969), it ranges from zone N.6 to within zone N.18 (Miocene/Pliocene). (See Range Chart 1).

Dentoglobigerina praedehiscens (Blow & Banner), 1962

Plate 8, figs. 2a-c

1959 Globoquadrina robri (Bolli); Blow, p. 185, pl. 11, figs. 57 a-c (not Globigerina robri Bolli, 1957).

1962 Globoquadrina dehiscens praedehiscens Blow & Banner (in Eames et al., 1962), p. 116, pl. 15, figs. Q-S.

1963 Globoquadrina praedehiscens Blow & Banner; Saito, p. 193, pl. 55, figs. 7a-b.

1971 Globoquadrina praedehiscens Blow & Banner; Raju, p. 31, pl. 8, figs. 4a-c; pl. 9, figs. 1, 2.

1975 Globoquadrina praedehiscens Blow & Banner; Rögl, Cita, Müller and Hochuli, p. 65, pl. 8, fig. 3.

1979 Dentoglobigerina praedehiscens (Blow & Banner); Blow, p. 1305, pl. 29, figs. 3-5.

Remarks

According to Blow and Banner (in Eames et al., 1962) and Blow (1969, 1979), Dentoglobigerina praedehiscens evolved from Dentoglobigerina tripartita (Koch) and gives rise to Globoquadrina dehiscens dehiscens Chapman, Parr & Collins. The transformation from D. tripartita to the D. praedehiscens is accompanied by a closer appression and embrace of the chambers of the final convolution, and greater asymmetrical extension of the aperture towards the anterior side of the last chamber.

D. praedehiscens is distinguished from Globoquadrina dehiscens in having a circular to subcircular equitorial profile compared to the quadrate or subquadrate one of the latter species, and an essentially intraumbilical aperture in the adult stage compared with the essentially interiomarginal aperture of Globoquadrina dehiscens.

The individuals from the Nief Beds are characterized by subglobular tests with 3 embracing and appressed, subsperhical chambers in the final convolution, an almost circular equitorial profile and very weakly lobulate equitorial periphery. These characteristics are in accord with the diagnosis and the illustration of the holotype presented by Blow and Banner (in Eames et al., 1962) on page 116, pl. 15, figs. Q-S. However, the individuals from the Nief Beds have slightly more convex dorsal sides and are larger.

Dimensions of the figured specimens

Pl. 8, figs. 2a-c.

Max. diameter = 0.58 mm, 0.58, 0.58 (holotype = 0.49 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1979), D.praedehiscens (Blow & Banner) ranges from near the zone P.21/zone P.22 boundary to within zone N.6 (Late Oligocene to Earliest Miocene). (See Range Chart 1).

Dentoglobigerina sastrii (Raju), 1971

Plate 8, figs. 3a-b

1971 Globigerina sastrii Raju, p. 26, pl. 4, figs. 1a-c, 2a-c.

1972 Globigerina sastrii Raju; Belford, p. 9, pl. 7, figs. 1-8.

Remarks

Raju (1971), first described this species from the Lower Oligocene, Cauvery basin, India. Its general morphological features as well as its occurrence in the same population with Dentoglobigerina tripartita (Koch) indicate a close relation between these two species. Consequently this form is referred to the genus Dentoglobigerina Blow.

The individuals of D. sastrii Raju from the Nief Beds have a bilobate appearance, with only two chambers visible from the ventral side. The wall is postulose, particularly on the ventral side near the aperture. The equitorial profile is elliptical compared with the subcircular one of the types illustrated by Raju (1971). They conform well with the description and illustration of "Globigerina" sastrii presented by Belford (1972) on page 9, pl. 7, figs. 1-8.

Dimensions of the figured specimens

Pl. 8, figs. 3a-b.

Max. length = 0.51 mm, 0.51 (holotype = 0.64 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Belford (1972) recorded *Dentoglobigerina sastrii* from the Uppermost Oligocene, Lowermost Miocene (zone N.4/N.3) of the Nassau range, Irian Jaya. In the Nief Beds, the Foraminiferal assemblage associated with *D. sastrii* is comparable to that of the Nassu range (See Range Chart 1).

Dentoglobigerina tripartita (Koch), 1926

Plate 8, figs. 4a-c, 5, 6

1926 *Globigerina bulloides* d'Orbigny var. *tripartita* Koch, p. 746, text-fig. 21a-b.

1944 *Globigerina tripartita* (Koch); Le Roy, p. 40, pl. 3, figs. 32, 33.

1957e *Globigerina rohri* Bolli (partim), p. 109, pl. 23, figs. 1a- 2b. Not pl. 23, figs. 3a- 4b (= *Globigerina Sellii* (Borsetti)).

1962 *Globigerina tripartita tripartita* Koch; Blow and Banner (in Eames et al., 1962), p. 96, pl. 10 A-F; Fig. 18.

1963 *Globigerina rohri* Bolli; Pessagno, p. 56, pl. 3, figs. 1-2.

1971 *Globigerina tripartita rohri* Bolli; Raju, p. 27, pl. 3, figs. 2, 4a-b.

1972 *Globoquadrina tripartita* (Koch); Jenkins and Orr, p. 1095, pl. 18, figs. 1-3.

1979 *Dentoglobigerina tripartita* (Koch); Blow, p. 1310, pl. 244, figs. 5, 6.

Remarks

Dentoglobigerina tripartita (Koch) may be confused with *Dentoglobigerina venezuelana* (Hedberg). It differs from the latter species in possessing a more tightly coiled test, more laterally compressed chambers, and in having normally three chambers in the final whorl, although four chambers are occasionally present.

D. tripartita is a very frequent and characteristic species in the samples from zones N.4/N.3 (Lowermost Miocene, Uppermost Oligocene) of the Nief Beds. Almost all the specimens have large size tests, and concentrate on the 30 (B.S.M.) sieve. Two types of tests are recognized from the Nief Beds: four chambered forms, and three chambered forms with the aborted final chamber reported by Blow and Banner (1962).

D. tripartita has been identified from the washed residues and in thin sections. The solid specimens are similar to the holotype and the paratypes of "Globigerina rohri" (= D. tripartita) illustrated by Bolli (1957e) on plate 23, figs. 1a- 2b. However, most of the specimens display a higher trochospire.

The thin section specimens are comparable with the figure of Globigerina tripartita illustrated by Postuma (1971) on page 277. However, the section on plate 8, fig. 5 has flattened trochospire, while that on plate 8, fig. 6 has much smaller test.

Dimensions of the figured specimens

Pl. 8, figs. 4a-c, 5, 6.

Max. diameter = 0.85 mm, 0.98, 0.93, 0.56, 0.36.

Max. thickness = 0.53 mm, 0.36 (figs. 5, 6).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Blow (1969) gave the range from zone P.14 to zone P.3 (Uppermost Middle Eocene to the end of the Oligocene). According to Stainforth et al. (1975), it occurs regularly in the Late Eocene and Oligocene, and has been recognized also in the Early Miocene·(See Range Chart 1).

Dentoglobigerina venezuelana (Hedberg), 1937

Plate 9, figs. la-c, 2?

1937 Globigerina venezuelana Hedberg, p. 681, pl. 92, figs. 7a-b.

1947 Globoquadrina venezuelana (Hedberg); Finlay, pp. 272-275.

1975 Globigerina venezuelana Hedberg; Stainforth et al., p. 331, Fig. 151.

1979 Globoquadrina venezuelana (Hedberg); Poore, p. 470, pl. 14, figs. 4-7.

1979 Dentoglobigerina venezuelana (Hedberg); Blow, p. 1300.

Remarks

The individuals of D. venezuelana from the Nief Beds correspond very closely with the figure illustrated by Stainforth et al. (1975) on Fig. 151.

Thin section specimens are comparable with the figure of D. venezuelana illustrated by Postuma (1971, p. 279). However, the figured specimen from the Nief Beds is much smaller.

Dimensions of the figured specimen

Pl. 9, figs. 1a-c, 2?

Max. diameter = 0.66 mm, 0.68, 0.66, 0.37

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Dentoglobigerina venezuelana is a long ranging species. According to the "P/N" zonation by Blow (1969), it ranges from zone N.3 (= P.22) to within zone N.19 (Upper Oligocene to the Middle Pliocene). The same range was given by Postuma (1971). According to Stainforth et al. (1975), it ranges from the Middle Eocene to the Pliocene. (See Range Chart 1).

Genus *Globigerinita* Bronnimann, 1951, emend. Blow & Banner, 1962

Genotype: *Globigerinita naparimaensis* Bronnimann, 1951

Remarks

Loeblich and Tappan (1964, Treatise on Invertebrate Paleontology, part c) assigned *Globigerinita* Bronnimann to the subfamily *Catapsydracinae* Bolli, Loeblich & Tappan, 1957. Blow and Banner (in Eames et al., 1962) emended the diagnosis of *Globigerinita* Bronnimann, and referred all the *Globigerina*-like forms which possess true bullae and accessory apertures to this genus, and placed *Tinophodella* Loeblich & Tappan and *Catapsydrax* Bolli, Loeblich & Tappan in its synonym. They referred this genus to the subfamily Globigerininae Carpenter. Blow (1979) confirmed his previous observation (Blow, 1959) with regard to the polyphyletic origin of Globigerinita and provisionally placed it in his new family Globoquadrinidae. He indicated that future work on Catapsydrax and Tinophodella may prove that these two supraspecific taxa are valid genera.

In the present work, Globigerinita is used in the sense of Blow and Banner (in Eames et al., 1962), and provisionally referred to the family Globoquadrinidae Blow, 1979. Future work may prove that the species of Globigerinita should be assigned to the Dentoglobigerina Blow, Subbotina Brotzen & Pozaryska, Globorotaloides Bolli or other genera.

Globigerinita dissimilis ciperoensis Blow & Banner, 1962

Plate 9, figs. 3a-b

1957 Catapsydrax dissimilis (Cushman & Bermudez); Bolli, Loeblich & Tappan (part), p. 36, pl. 7, figs. 8a-c. Not pl. 7, figs. 6 & 7 (= G. dissimilis dissimilis).

1962 Globigerinita dissimilis ciperoensis Blow & Banner (in Eames et al., 1962), p. 107, pl. 14, figs. A-C.

1969 Globigerinita dissimilis ciperoensis Blow & Banner; Blow (in proceedings of the first international conference on planktonic microfossils, Geneva, 1967), p. 328, pl. 24, fig. 2.

1972 Globigerinita ciperoensis Blow & Banner; Poag, p. 516, pl. 10, figs. 5 & 6.

1979 Globigerinita ciperoensis Blow & Banner; Blow, p. 1322.

1979 Catapsydrax dissimilis ciperoensis (Blow & Banner); Poore, p. 468, pl. 15, fig. 5.

Remarks

Blow and Banner (in Eames et al., 1962) separated

Globigerinita dissimilis ciperoensis from Globigerinita dissimilis dissimilis (Cushman & Burmudez) by its possession of three or four infralaminal apertures, more coarsely perforated walls, more depressed chambers and a less lobulate periphery. Blow (1979) elevated this subspecies to specific rank and indicated that ciperoensis represents the final specialized product of the Globigerinita simulans - dissimilis riveroae - dissimilis dissimilis plexus. He used almost the same criteria that were used by Blow and Banner (op. cit.) to separate ciperoensis from dissimilis.

In the Nief Beds specimens, only the number of the infralaminal apertures can be used to separate this subspecies from Globigerinita dissimilis dissimilis. Individuals of G. dissimilis ciperoensis are comparable with the holotype illustrated by Blow and Banner (in Eames et al., 1962) on plate 14 A-C.

Dimensions of the figured specimens

Pl. 9, figs. 3a-b.

Max. diameter = 0.43 mm, 0.44 (holotype = 0.50 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1979), Globigerinita dissimilis ciperoensis ranges from near the top of zone P.18 to the top of zone N.6 (Oligocene to Early Miocene). (See Range Chart 1).

Globigerinita dissimilis dissimilis (Cushman & Bermudez), 1937

Plate 9, figs. 4a-b

1937 Globigerina dissimilis Cushman & Bermudez, p. 25, pl. 3, figs. 4-6.

1957 Catapsydrax dissimilis (Cushman & Bermudez); Bolli, Loeblich & Tappan (part), p. 36, pl. 7, figs. 6a-c (holotype refigured); pl. 7, figs. 7a-b. Not pl. 7, figs. 8a-c (= Globigerinita ciperoensis).

1957 Globigerina ("Dissimiloglobigerina") dissimilis Cushman & Bermudez; Reiss, p. 4.

1960 Globigerinita dissimilis (Cushman & Bermudez); Bermudez, p. 1262, pl. 7, figs. 4, 5.

1962 Globigerinita dissimilis dissimilis (Cushman & Bermudez); Blow and Banner (in Eames et al, 1962), p. 106, pl. 14D.

1979 Catapsydrax dissimilis dissimilis (Cushman & Bermudez); Poore, p. 468, pl. 15, fig. 4.

1979 Globigerinita dissimilis dissimilis (Cushman & Bermudez); Blow, p. 1328, pl. 241, figs. 2, 3.

Remarks

In the Nief Beds, the individuals of Globigerinita dissimilis dissimilis are distinguished by their fairly tight coiling, densly pitted surface and their wide bullae which cover the umbilicus. The wide bullae usually occur in the advanced forms of this subspecies (Blow and Banner, in Eames et al., 1962). These individuals are identical with the figure of Globigerinita dissimilis dissimilis illustrated by Blow (1979, pl. 241, fig. 2). They differ in having more embracing chambers and a less lobulate peripheral margin.

Dimensions of the figured specimens

Pl. 9, figs. 4a-b.

Max. diameter = 0.45 mm, 0.50.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation by Blow (1979), *Globigerinita dissimilis dissimilis* ranges from near the base of zone P.13 to within zone P.22 (= N.3) (Later Middle Eocene to the top of the Oligocene). (See Range Chart 1).

Globigerinita sp. cf. *dissimilis* S.L.

Plate 9, fig. 5

Remarks

Glogiberinita sp. cf. *dissimilis* S.L. is characterized by a fairly thick and pitted wall with umbilical bulla. It shows some similarity with *Globigerinita dissimilis* illustrated by Postuma (1971, p. 257).

Dimensions of the figured specimen

Max. length = 0.3 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

This form is recognized from many samples assigned to zone N.4/N.3 (Uppermost Oligocene - Lowermost Miocene). See Table 1 & 2.

Globigerinita uvula (Ehrenberg), 1861?

Plate 9, figs. 6-7

1861 Pylodexia uvula Ehrenberg, p. 276, 277, 308.

1931 ? Globigerina bradyi Wiesner, p. 133.

1962 Globigerinita uvula (Ehrenberg); Parker, p. 252, pl. 8, figs. 14-26.

1971 Globigennita uvula (Ehrenberg); Bronnimann and Resig, p. 1271, pl. 22, figs. 7, 8.

Remarks

"Globigerina" bradyi Wiesner, 1931 shows similarity with Globigerinita uvula (Ehrenberg), and is questionably included in the synonym of the latter species.

The individuals of G. uvula from the Nief Beds vary from the normal high spired form to a low spired one. Most of the specimens have a small, circular and inflated umbilical bulla. Sutural apertures are absent. The typical high spired forms are similar to the Globigerinita uvula illustrated by Bronnimann and Resig (1971) on plate 22, figs, 7, 8, but they differ in being much larger.

Dimensions of the figured specimens

Pl. 9, figs. 6-7.

Max. height = 0.45 mm, 0.45.

Max. diameter = 0.43 mm, 0.38.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

In New Zealand, G. uvula ranges from the Oligocene to the Upper Pleistocene (Jenkins, 1971). According to the "P/N" zonation given by Blow (1969), "Globigerina" bradyi (= G. uvula) ranges from zone N.4 (basal) to zone N.23 (Miocene to the Pliocene). (See Range Chart 1).

Globigerinita sp. cf. unicava unicava (Bolli, Loeblich & Tappan), 1957

Plate 9, figs. 8a-b

cf. 1972 Globigerinita unicava unicava (Bolli, Loeblich & Tappan); Belford, p. 16, pl. 12, figs. 10-12.

Remarks

Globigerinita sp. cf. unicava unicava differs from the holotype described by Bolli, Loeblich and Tappan (1957) on page 37, plate 7, figs. 9a-c in being more than twice its size. Furthermore, the bulla is larger, more circular and more inflated than in the holotype. These specimens show some similarity with Globigerinita unicava unicava from the Nassau Range, Irian Jaya , illustrated by Belford (1972) on plate 12, figs. 10-12. However, the Nief Beds specimens have smaller bullae than the specimens illustrated by Belford.

Dimensions of the figured specimens

Pl. 9, figs. 8a-b

Max. diameter = 0.68 mm, 0.70.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Genus Globoquadrina Finlay, 1947, emend. Blow, 1979

Genotype: Globorotalia dehiscens Chapman, Parr & Collins,
1934, by original designation

Remarks

Globoquadrina Finlay sensu Loeblich & Tappan (1964), includes forms which have different ontogenic stages from that of the type species Globoquadrina dehiscens dehiscens.

According to the emended diagnosis by Blow (1979), Globoquadrina Finlay includes:

"Globigerinacea and Globoquadrinidae in which the consistently trochospirally coiled tests possess adult primary apertures that are interiomarginally situated and are either asymmetrically umbilical-extraumbilical, or truely umbilical-extraumbilical in position with respect to the centre of the umbilicus; however, the apertures have an essentially intraumbilical position during some earlier stage of ontogeny. The aperture bears a portical structure which usually becomes modified to a "portical umbilica-tooth" of asymmetrically triangular shape ..... etc.". This definition of Globoquadrina will be followed in this work.

Globoquadrina dehiscens dehiscens (Chapman, Parr & Collins) 1934

Plate 9, figs. 9a-b; plate 10, fig. 1

1934 Globorotalia dehiscens Chapman, Parr & Collins, p. 569, pl. 11, figs. 36a-c.

1939 Globorotalia quadraria Cushman & Ellisor, pp. 11-12, pl. 2, figs. 5a-c.

1957e Globoquadrina dehiscens (Chapman, Parr & Collins); Bolli (part), p. 111, pl. 24, figs. 3 a-c. Not figs. 4 a-c (= Globoquadrina advena Burmudez, 1949).

1965 Globoquadrina dehiscens (Chapman, Parr & Collins); Reed, p. 87, pl. 15, figs. 10-12.

1977 Globoquadrina dehiscens (Chapman, Parr & Collins); Miles, p. 942, pl. 3, figs. 16-19.

1979 Globoquadrina dehiscens dehiscens (Chapman, Parr & Collins); Blow, p. 1353, pl. 29, fig. 1.

Remarks

Typical specimens of Globoquadrina dehiscens dehiscens were recognized from the Nief Beds. They are characterized by almost flat apertural face oriented toward a large quadrate umbilicus, a flattened spiral side, laterally compressed chambers, and the characteristic quadrate equitorial profile. Apertural details are obscured by a cement filling. These specimens are closely comparable with the figures illustrated by Bolli (1957e) on plate 24, fig. 3 a-c.

Dimensions of the figured specimens

Pl. 9, figs. 9 a-b; Pl. 10, fig. 1.

Max. length = 0.46 mm, 0.44, 0.37.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

Blow (1979) gave the range from zone N.4/N.3 to zone N.19 (Uppermost Oligocene to the Lower Pliocene). The species has been described from within the above range, from Southern Trinidad (Bolli, 1957c), Venezuela (Blow, 1959), Australia (Jenkins, 1960; Reed, 1965), France (Jenkins, 1966) and from the deep ocean cores (Miles, 1977; Krasheninnikov & Pflaumann, 1978). (See Range Chart 1).

Genus *Globorotaloides* Bolli, 1957

Genotype: *Globorotaloides variabilis* Bolli, 1957, by original designation

Globorotaloides hexagona variabilis Bolli, 1957

Plate 10, figs. 2a-c

1957e *Globorotaloides variabilis* Bolli, p. 117, pl. 27, figs. 15a-20c.

1961 *Globorotaloides variabilis* Bolli; Gordon, p. 453, pl. 2, figs. 2a-c.

1962 *Globorotaloides variabilis* Bolli; Belford, p. 29, pl. 8, figs. 12-16.

1969 *Globorotaloides hexagona variabilis* Bolli; Blow, p. 374.

Remarks

The individuals from the Nief Beds agree closely with the paratypes of *Globorotaloides hexagona variabilis* illustrated by Bolli (1957e) on plate 27, figs. 15a-b. They differ in having less recurved sutures on the dorsal side. No bullae have been observed in these specimens.

Dimensions of the figured specimens

Pl. 10, figs. 2 a-c.

Max. diameter = 0.40 mm, 0.33, 0.40 (holotype = 0.45 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation given by Blow (1969), it ranges from within zone N.8 to within zone N.18, with a doubtful occurrence in zone N.19 (Lower Miocene to the Lower Pliocene). It has been reported from within this range from Trinidad (Bolli, 1957e) and Papua New Guinea (Belford, 1962). (See Range Chart 1).

Globorotaloides suteri Bolli, 1957

Plate 10, figs. 3 a-c

1957e	*Globorotaloides suteri* Bolli, p. 117, pl. 27, figs. 9a-13b.
1962	*Globorotaloides suteri* Bolli; Asano, p. 62, pl. 23, figs. 8a-c.
1969	*Globorotaloides suteri* Bolli; Blow, p. 374.
1972	*Globorotaloides suteri* Bolli; Jenkins and Orr, p. 1106, pl. 36, figs. 10, 11, pl. 37, figs. 1-3.
1975	*Globorotaloides suteri* Bolli; Rögl, Cita, Müller and Hochuli, p. 65, pl. 9, figs. 6, 7.
1979	*Globorotaloides suteri* Bolli; Blow, p. 1358, pl. 247, figs. 9, 10.

Remarks

Bolli (1957e) and Blow (1979), have indicated that *Globorotaloides suteri* gives rise to *Globorotaloides hexagona variabilis* from which it differs in having more inflated early chambers, less curved sutures and fewer chambers. Parker (1967) and Todd (1964) have proposed their synonymity.

The individuals from the Nief Beds are identical with the paratypes illustrated by Bolli (1957e) on plate 27, figs. 10a-d. However, they differ in having axially compressed chambers in the final convolution, which may result from post depositional compression. No bullae have been observed in the material from Seram. Some of these specimens are very closely comparable with the illustration given by Asano (1962, pl. 23, figs. 8a-c).

Dimensions of the figured specimens

Pl. 10, figs. 3a-c.

Max. diameter = 0.42 mm, 0.44, 0.51 (holotype = 0.35 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Known range

According to the "P/N" zonation given by Blow (1979), it ranges from within zone P.13 to within zone N.8 (later Middle Eocene to the top of the Early Miocene approximately). It has been recorded from within this range from southern Trinidad (Bolli, 1957e), India (Raju, 1971) and the eastern equitorial pacific (Jenkins and Orr, 1972). In New Zealand, it was recorded from the Upper Eocene to the Middle Miocene (Jenkins, 1971). (See Range Chart 1).

Genus "A" and Species 1?

Plate 10, figs. 4a-b, 5

Remarks

Genus *"A"* and *species* 1? was recognized from two samples assigned to zone N.4/N.3 (Uppermost Oligocene - Lowermost Miocene).

Dimensions of the figures specimens

Pl. 10, figs. 4a-b, 5.

Max. diameter = 0.36 mm, 0.34, 0.42

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 1 & 2.

Eocene Planktonic Foraminifera of The Nief Beds

Suborder Globigerinida Blow, 1979

Superfamily Globigerinacea Carpenter, Parker and Jones, 1862

Family Globigerinidae Carpenter, Parker, and Jones, 1862,
partim, emend. Blow, 1979

Subfamily Globigerininae Carpenter, Parker and Jones, 1862,
partim, emend. Blow, 1979

Genus Globigerina d'Orbigny, 1828, emend. Blow, 1979

Genotype: Globigerina bulloides d'Orbigny, 1828

Remarks

See remarks under the genus Globigerina d'Orbigny in the section dealing with the Miocene species.

Globigerina lozanoi prolata Bolli, 1957

Plate 10, figs. 6a-c.

1954 Globigerina lozanoi Colom (partim), pl. 2, figs. 1, 3, 6, 7, 9, 13, 15, 43.

1957C Globigerina prolata Bolli, p. 72, pl. 15, figs. 24-26.

1960 Globigerina prolata Bolli; Bermudez, p. 1193.

1973 Globigerina prolata Bolli; Krasheninnikov & Hoskins, p. 12 pl. 10, figs. 2-3.

1979 Globigerina (Globigerina) lozanoi prolata Bolli; Blow, p. 856, pl. 145, fig. 1; pl. 250, fig. 10.

Remarks

The present writer has studied the figures of Globigerina lozanoi Colom illustrated by Colom (1954) on plate 2, figs. 1-48, and agrees with Blow's conclusion as to the subspecific status of prolata Bolli within the specific variation of Globigerina lozanoi S.L. Blow (1979) distinguished G. lozanoi prolata from G. lozanoi lozanoi by its fairly small umbilicus, fairly tightly coiled test, and the 4-5 chambers in the last convolution compared with at least 5 completely visible chambers in the last convolution of the latter subspecies.

The individuals from the Nief Beds have four, globular chambers in the last convolution which increase rapidly in size as added. The tests have finely pitted walls. Apertural details are obscured. These specimens match with the description and illustration of the holotype from the Upper Lizard Springs Formation of Trinidad.

Dimensions of the figured specimens

Pl. 10, figs. 6a-c.

Max. length = 0.39 mm, 0.44, 0.39 (holotype = 0.40 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Bolli (1957f) recorded Globigerina lozanoi prolata Bolli from the Globorotalia formosa formosa zone to the Globorotalia palmerae zone (Lower Eocene). It was recorded from the Lower Eocene of Italy, Syria, Cuba and the Pacific Ocean (Krasheninnikov & Hoskins, 1973). According to the "P/N" zonation by Blow (1979), it ranges from within subzone P.8a to the top of zone P.9 (later parts of the

Early Eocene). (See Range Chart 2).

Genus *Globigerinoides* Cushman, 1927, emend. Bolli, Loeblich and Tappan, 1957, emend. Blow, 1979

Genotype: *Globigerina* *rubra* d'Orbigny, 1839, by original designation and monotypy

Remarks

See remarks under the genus *Globigerinoides* Cushman, in the section dealing with the Miocene Species.

"*Globigerinoides*" (?) *higginsi* Bolli, 1957

Plate 10, fig. 7

1957f	"*Globigerinoides*" *higginsi* Bolli, p. 164, pl. 36, figs. 11a-13b.
1960	*Globigerapsis* *higginsi* (Bolli); Bermudez, p. 1250, pl. 8, figs. 5a-c.
1968	"*Globigerinoides*" *higginsi* Bolli; Samuel and Salaj, p. 140, pl. 21, fig. 5; pl. 22, fig. 1a-b.
1971	*Guembelitrioides* *higginsi* (Bolli); El-Naggar, p. 431.
1971	*Globigerina* (*Globigerina*) *higginsi* (Bolli); Jenkins, p. 149, pl. 16, figs. 469-470.
1975	*Globigerina* *higginsi* (Bolli); Stainforth et al., p. 189, Fig. 52.
1979	*Globigerinoides* (?) *higginsi* Bolli; Blow, p. 862, pl. 183, figs. 7-9; pl. 184, figs. 1-7.

Remarks

The generic status of the species *higginsi* is still controversial. Bolli (1957f) provisonally assigned this species to the genus *Globigerinoides*, because no genetic relation is apparent between this Eocene form and the Miocene main group of *Globigerinoides* species. Bermudez

(1960) assigned this species to the genus *Globigerapsis* Bolli, Loeblich and Tappan, 1957, and Jenkins (1971) to the genus *Globigerina* d'Orbigny, while El-Naggar (1971) has referred it to his new genus *Guembelitrioides*. According to Blow (1979), no difference has been found between this species, and the diagnosis of the Neogene *Globigerinoides*, and provisionally placed it in the genus *Globigerinoides* pending further investigation.

The sutural apertures of "*Globigerinoides*" *higginsi* do not seem to be a consistent character. In New Zealand, single and multiple sutural apertures have been recognized in the same population (Jenkins, 1971). In the Avedat group, the majority of specimens lack any sutural apertures (Benjamini, 1980).

The specimens from the Nief Beds are characterized by a high trochospire, loosely attached spherical chambers which increase slowly in size, and four chambers in the last convolution. The primary and the secondary apertures are obscured by matrix. The morphotypes of "*Globigerinoides*" *higginsi* from the Nief Beds match well with the holotype illustrated by Bolli (1957f). However, it differs in having a much larger final convolution compared with the rest of the test.

Dimensions of the figured specimen

Max. height = 0.48 mm.

Diameter of the last convolution = 0.38 mm. (holotype = 0.5 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Stainforth et al. (1975) gave the range as from the *Globorotalia pentacamerata* zone to the *Globigerinatheka subconglobata* zone (Early to Middle Miocene). According to the "P/N" zonation by Blow (1979), it ranges from just above the base of zone P.9 to zone P.11 with rarely occurring specimens in the earlier part of zone P.12 (Latest Early Eocene to within the Middle Eocene). (See Range Chart 2).

Family *Globorotaliidae* Cushman, 1927, partim, emend.
Blow, 1979

Subfamily *Globorotaliinae* Cushman, 1927, partim, emend.
Blow, 1979

Genus *Globorotalia* Cushman, 1927, emend. Blow, 1979

Genotype *Pulvinulina menardii* (d'Orbigny) var. *tumida* Brady, 1877, by original designation (Lectotype selected by Banner and Blow, 1960)

Remarks

See remarks under the genus *Globorotalia* Cushman in the section dealing with the Miocene species.

Subgenus *Globorotalia* (*Acarinina*) Subbotina, 1953, emend.
Blow, 1979

Subgenotype: *Acarinina acarinina* Subbotina, 1953, by
original designatio

Remarks

Globorotalia (*Acarinina*) Subbotina, 1953, emend. Blow, 1979, differs from *Globorotalia* (*Turborotalia*) Cushman & Bermudez, 1949, emend. Blow, 1979, in possessing muricae.

Globorotalia *(A)* *aspensis* (Colom), 1954

Plate 11, figs. 1a-c

1954 *Globigerina aspensis* Colom, pp. 151-154, pl. 3, figs. 1-5; pl. 4, figs. 1-3.

1957f *Globorotalia aspensis* (Colom); Bolli, p. 166, pl. 37, figs. 18a-c.

1960 *Globigerina aspensis* Colom; Bermudez, p. 1157, pl. 1, figs. 2a-c.

1968 *Turborotalia* (? *Acarinina*) *aspensis* (Colom, 1954); Samuel and Salaj, p. 162, pl. 18, figs. 4 a-c.

1979 *Globorotalia* (*Acarinina*) *aspensis* (Colom); Blow, p. 908, pl. 148, figs. 7-9; pl. 153, figs. 5-6; pl. 157, figs. 1-6; pl. 165, figs. 5-6; pl. 203, fig. 6.

Remarks

Globorotalia (*A*) *aspensis* is a frequent species in the Eocene part of the Nief Beds. The specimens are characterized by having 6-7 (occasionally 5) chambers in the final whorl, a lobulate periphery, a flat to very slightly concave dorsal surface, a wide umbilicus, radial to slightly curved sutures on the dorsal surface and radial ones on the umbilical side. The aperture is obscured by the calcareous filling of the umbilicus. These individuals show little variation from the figures given by Samuel and Salaj (1968, p. 162).

Dimensions of the figured specimens

Pl. 11, figs. 1a-c.

Max. diameter = 0.48 mm, 0.44, 0.44

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Originally G(A) aspensis (Colom) was described from the Upper Ypresian and Lower Lutetian (Eocene) of Spain. In the Navet Formation, it ranges from the Globorotalia palmerae zone to the Globigerapsis kugleri zone, Early and Middle Eocene (Bolli, 1957f). According to the "P/N" zonation given by Blow (1979), it ranges from zone P.9 to zone P.11 (Early to Middle Eocene). (See Range Chart 2).

Globorotalia (A) broedermanni Cushman & Bermudez, 1949

Plate 11, figs. 2a-c

1949 Globorotalia (Truncorotalia) brödermanni Cushman & Bermudez, p. 40, pl. 7, figs. 22-24.

1957f Globorotalia broedermanni Cushman & Bermudez; Bolli, p. 167, pl. 37, figs. 13a-c.

1960 Pseudogloborotalia broedermanni (Cushman & Bermudez); Bermudez, p. 1340, pl. 16, figs. 6a-c.

1968 Turborotalia (Acarinina) broedermanni (Cushman & Bermudez, 1949); Samuel and Salaj, p. 163, pl. 18, figs. 5a-c.

1977 Globorotalia (Truncorotalia) broedermanni Cushman & Bermudez, Cifelli and Belford, p. 103, pl. 1, figs. 10-12.

1979 Globorotalia (Acarinina) broedermanni broedermanni Cushman & Bermudez; Blow, p. 911, pl. 130, figs. 7-9; pl. 135, fig. 4; pl. 142, figs. 1-3; pl. 148, figs. 1-3; pl. 153, figs. 7, 8; pl. 179, figs. 3-5.

1980 Acarinina broedermanni (Cushman & Bermudez); Benjamini, p. 336, pl. 1, figs. 1-5.

Remarks

Bolli (1957c) described as Globorotalia broedermanni (not G. broedermanni Cushman & Bermudez, 1949) forms with a tighter coiling and small umbilicus on plate 19, figs. 13-15. These are regarded here as different from the holotype. Blow (1979) assigned Bolli's form to G(A) Lodoensis Mallory, which is regarded by him as an early member of G(A) Lodoensis - G(A) broedermanni plexus.

The individuals from the Nief Beds, resemble the holotype of G(A) broedermanni illustrated by Cushman & Bermudez (1949), and notably show the large umbilicus. However, the individuals from Seram have a finer spinose surface than the holotype (re-illustrated by Cifelli & Belford, 1977) which is papillate, and flatter dorsal side.

Dimensions of the figured specimens

Pl. 11, figs. 2a-c.

Max. diameter = 0.30 mm, 0.31, 0.30 (holotype = 0.33 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation given by Blow (1979), it ranges from subzone p.8a to zone P.11 (Early Eocene to the earlier part of the Middle Eocene). In the Slovak

Carpathian Paleogene in the vicinity of Bojinice, it ranges from the Lower Eocene through the Middle Eocene (Samuel and Salaj, 1968). (See Range Chart 2).

Globorotalia (*A*) *collactea* Finlay, 1939

Plate 11, figs. 3a-c

1939 *Globorotalia collactea* Finlay, p. 327, pl. 29, figs. 164 (holotype) - 165.

1952 *Globigerina collactea* (Finlay); Bronnimann, pp. 13-14, pl. 1, figs. 13-15.

1965a *Truncorotaloides collactea* (Finlay); Jenkins, p. 843, figs. 1-27.

1975 *Truncorotaloides collactea* (Finlay); McKeel and Lipps, p. 258, pl. 2, figs. 6a-c.

1977 *Truncorotaloides collactea* (Finlay); Poore and Brabb, p. 269, pl. 5, figs. 5-7.

1979 *Globorotalia* (*A*) *collactea* Finlay; Blow, p. 919, pl. 172, figs. 7-9; pl. 194, figs. 1-4.

Remarks

Jenkins (1965a) provided a detailed account of the morphological variations of *G*(*A*) *collactea* in the type population, and assigned it to the genus *Truncorotaloides* Bronnimann & Bermudez. He pointed out that most specimens do not appear to have small sutural openings on the spiral side. Although Mckeel and Lipps (1975) placed this species in the genus *Truncorotaloides*, they noted that "due to the extreme rareness of supplimentary apertures, and the presence of a spinose wall, the genus "*Acarinina*" Subbotina, may be more suitable assignment for this species". The individuals from the Nief Beds are not well enough preserved to show the presence or otherwise of supplimentary apertures. However, they show the rounded to subangular axial periphery and the fine papillated surface. The published literature on this species indicates a non-rimmed and randomly distributed supplimentary apertures which result from late stage calcification. Therefore, this species is assigned here to the subgenus Acarinina Subbotina.

Globorotalia (A) collactea is similar to the Truncorotaloides rohri Bronnimann & Bermudez. According to Jenkins (1965a), the first species is distinguished from the latter in being smaller, less spinose, in having smaller sutural apertures on the spiral side, a more compact test and dextral coiling (in contrast to the sinistral coiling of Truncorotaloides rohri).

The individuals of Globorotalia (A) collactea from the Nief Beds have five chambers, slightly elongated in the final whorl. The peripheral margin is rounded and weakly lobulate. The spiral side is slightly convex and lacks any supplimentary apertures. The wall surface is covered by a fine papillae, and the umbilicus is small pit, partially filled with sediment. The above diagnosis is within the range of variations of the type specimens as presented by Jenkins (1965a). The specimens from Seram agree very closely with the figures of G(A) collactea illustrated by Bronnimann (1952) on plate 1, figs. 13-15.

Dimensions of the figured specimens

Pl. 11, figs. 3a-c

Max. diameter = 0.35 mm, 0.29, 0.31

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979), it ranges from possibly the later part of zone P.9, but typically from zone P.10 to zone P.14 (essentially Middle Eocene). (See Range Chart 2).

Globorotalia (A) primitiva (Finlay), 1947

Plate 11, figs. 4a-c, 5a-c

1947 Globoquadrina primitiva Finlay, p. 291, pl. 8, figs. 129-134.

1952 Globigerina primitiva (Finlay); Bronnimann, pp. 11-12, pl. 1, figs. 10-12.

1962 Globorotalia (Acarinina) primitiva (Finlay); Hillebrandt, pp. 141-142, pl. 14, figs. 2a-b; 4a-c.

1963 Turborotalia primitiva (Finlay); Gohrbandt, pp. 67-68, pl. 1, figs. 19-21.

1965b Pseudogloboquadrina primitiva (Finlay); Jenkins, p. 1124, Fig. 9, nos. 81-86.

1968 Turborotalia (Acarinina) primitiva (Finlay, 1947); Samuel and Salaj, p. 171, pl. 15, figs. 14a-c; pl. 16, figs. 1a-b.

1968 Globorotalia (Acarinina) primitiva (Finlay) 1947; Wille, p. 238, pl. 6, fig. 6.

1973 Acarinina primitiva (Finlay); Krasheninnikov and Hoskins, p. 116, pl. 3, figs. 4-6.

1979 Globorotalia (Acarinina) primitiva (Finlay); Blow, p. 949, pl. 143, figs. 6-9; pl. 294, figs. 1-4.

Remarks

Globorotalia (A) primitiva is common in two samples. In dorsal view, specimens show closely appressed and embracing chambers which are longer tangentially than radially broad. The tests are muricate, although the pustules differ in their intensity from fine to coarse as was observed by Jenkins (1971) in his material. The aperture is interiomarginal umbilical-extraumbilical in position as indicated from plate 11, figs. 4a-c. The peripheral margin is subangular but not disjunct. These individuals are identical with the description and illustrations of G(A) primitiva presented by Bronniman (1952) on page 11, plate 1, figs. 10-12. However, Bronnimann's illustrations show a stronger muricate wall and more appressed and embracing chambers.

Dimensions of the figured specimens

Pl. 11, figs. 4a-c, 5a-c

Max. length = 0.31 mm, 0.42, 0.42, 0.32, 0.36, 0.36 (holotype = 0.31 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Globorotalia (A) primitiva has been reported from the Paleocene and Eocene in various parts of the world (Bronnimann, 1952; Bolli, 1957c; Hornibrook, 1961; Jenkins, 1971; Krasheninnikov and Hoskins, 1973; Samuel and Salaj, 1968). According to Stainforth et al. (1975), the normal range of this species is from Late Paleocene up to and through the Middle Eocene. Blow (1979) gave the range from within zone

P.8 (subzone P.8a) to zone P.13 (Early to Middle Eocene). The differences in the ranges are certainly due to the different concepts of this species by various authors (See Range Chart 2).

Subgenus Globorotalia (Morozovella) McGowran, 1964 emend Blow, 1979

Subgenotype: Pulvinulina velascoensis Cushman, 1925, by original designation

Remarks

Globorotalia (Morozovella) McGowran, 1964, emend. Blow, 1979, differs from Globorotalia (Globorotalia) Cushman, 1927, emend. Blow, 1979 mainly in having a muricocarinae compared with the imperforate peripheral part (true carina) of the latter subgenus.

Globorotalia (M) aequa Cushman & Renz, 1942

Plate 12, figs. 1a-c, 2

1942 Globorotalia crassata var. aequa Cushman & Renz, p. 12, pl. 3, fig. 3.

1946 Globorotalia lacerti Cushman & Renz, p. 47, pl. 8, figs. 11, 12.

1957c Globorotalia aequa Cushman & Renz; Bolli, p. 74, pl. 17, figs. 1-3; pl. 18, figs. 13-15.

1960 Pseudogloborotalia aequa (Cushman & Renz); Bermudez, p. 1336, pl. 16, fig. 4.

1962 Globorotalia (Turborotalia) aequa Cushman & Renz; Hillebrandt, pp. 133-134, pl. 13, figs. 1a-4.

1966 Globorotalia aequa aequa Cushman & Renz 1942; Belford, p. 13, pl. 2, figs. 13-18.

1968 Truncorotaloides (Morozovella) aequus (Cushman & Renz; McGowran, pl. 1, figs. 3-7.

1971 Globorotalia (Morozovella) aequa aequa Cushman & Renz; Jenkins, p. 100, pl. 7, figs. 167-171.

1972 Morozovella aequa (Cushman & Renz); Vincent and Brun, pl. 1, fig. 4.

1979 Globorotalia (M) aequa aequa Cushman & Renz; Blow, p. 975, pl. 96, figs. 4-9; pl. 99, fig. 5; pl. 102, figs. 6, 9-10; pl. 103, fig. 1; pl. 18, figs. 8-10, pl. 210, figs. 1-6; pl. 211, figs. 1-5.

1979 Globorotalia (M) aequa Lacerti Cushman & Renz; Blow, p. 977, pl. 138, figs. 1-3.

1981 Morozovella aequa (Cushman & Renz); Mancini and Oliver, p. 216, pl. 4, figs. 1-3.

Remarks

Globorotalia (M) aequa was first described by Cushman and Renz (1942) from the Soldado Formation of Trinidad as a variety of Globorotalia crassata (Cushman). Virtually all the subsequent workers, have regarded these two as a separate species because of the differences in their morpholoty and their stratigraphical ranges.

According to Bolli (1957c) and Jenkins (1971), G(M) aequa gives rise to the similar species G(M) rex Martin (= G(M) subbotinae Morozova). The latter differs from the former mainly in its more robust test and thicker keel. Bolli (op. cit.) indicated the evolution of G(M) aequa from G(M) angulata (white), from which it is distinguished mainly by having fewer chambers, which increase in size more rapdily. According to Blow (1979), G(M) aequa aequa Cushman & Renz gives rise to G(M) aequa Lacerti Cushman & Renz. He separated the latter from the former by its more relaxed coiling-mode which resulted in broadening the test, compared with the subrectangular one of G(M) aequa.

In the Nief Beds, G(M) aequa has been identified both amongst free specimens, and in the thin sections. The solid specimens are characterized by a plano;convex test, a periphery with mucricocarina and a wall covered by muricae; there are 4 chambers in the final whorl, increasing gradually in size as added; the last, forming about $\frac{1}{3}$ of the test as seen ventrally, and $\frac{1}{4}$ as seen dorsally. They are identical with the holotype of Globorotalia lacerti (= G(M) aequa lacerti) illustrated by Cushman and Renz (1946) on plate 8, figs. 11, 12. The thin section specimens are similar to the figures illustrated by Postuma (1971) on page 169. However, no muricocarinae have been observed in these specimens. According to Blow (1979), the development of the muricocarinae is variable according to the stratigraphical position of the specimens studied.

Dimensions of the figured specimens

Pl. 12, figs. 1a-c, 2.

Max. diameter = 0.41 mm, 0.43, 0.48, 0.32.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Stainforth et al. (1975), gave the range from the lowermost part of the Globorotalia pseudomenardii zone to the middle part of the Globorotalia subbotinae zone (Late Paleocene to the Early Eocene). According to the "P/N" zonation given by Blow (1979), the combined ranges of G(M) aequa aequa and G(M) aequa lacerti, is from zone P.3 (Lower Thanetian s.l) to the top of zone P.8 (Early Eocene). It has been reported from within this range from Trinidad

(Bolli, 1957c; Loeblich & Tappan, 1957a), the Gulf and Atlantic Coastal Plain, U.S.A. (Loeblich & Tappan, 1957b) and the other parts of the world. (See Range Chart 2).

Globorotalia (Morozovella) aragonensis Nuttall, 1930

Plate 12, figs. 3a-c

1930 Globorotalia aragonensis Nuttall, p. 288, pl. 24, figs. 6-8, 10, 11.

1949 Globorotalia (Truncorotalia) aragonensis Nuttall; Cushman and Bermudez, pp. 38-39, pl. 7, figs. 13-15.

1957c Globorotalia aragonensis Nuttall; Bolli, p. 75, pl. 18, figs. 7-9.

1960 Pseudogloborotalia aragonensis (Nuttall); Bermudez, p. 1338, pl. 16, figs. 5a-c.

1964 Globorotalia aragonensis Nuttall; Luterbacher, p. 696, figs. 121-126.

1968 Globorotalia aragonensis aragonensis Nuttall; Samuel and Salaj, p. 148, pl. 11, figs. 5a-c.

1968 Globorotalia (Truncorotalia) aragonensis aragonensis Nuttall; Wille, p. 242, pl. 7, fig. 1.

1975 Globorotalia aragonensis Nuttall; Stainforth et al., p. 168, Fig. 35.

1977 Globorotalia aragonensis Nuttall; Cifelli and Belford, p. 102, pl. 1, figs. 7-9.

1979 Globorotalia (M) aragonensis Nuttall; Blow, p. 990, pl. 134, fig. 6; pl. 141, figs. 1, 2, 4-9; pl. 146; figs. 1, 2; pl. 147, figs. 5-7; pl. 152, figs. 1-5; pl. 164, figs. 6-9; pl. 167, figs. 6-9; pl. 226, fig. 6; pl. 227, figs. 1-6; pl. 228, figs. 1-6.

1980 Morozovella aragonensis aragonensis (Nuttall); Benjamini, p. 350, pl. 3, figs. 10-15, 17.

Remarks

Globorotalia (M) aragonensis Nuttall (1930) was first described from the Aragon and Chicontepel Formations, Tampico embayment, Mexico, without the designation of a holotype. Cifelli and Belford (1977) presented a complete description of their newly selected lectotype without any indication of its code number. Blow (1979), selected the specimen registered as Cushman Collection no. 59500 as lectotype of G(M) aragonensis.

G(M) aragonensis Nuttall is more likely to be misidentified with the Paleocene species G(M) velascoensis Cushman. The former is distinguished from the latter in having a smaller number of chambers in the last convolution, a smaller umbilicus and a more elevated dorsal side.

The specimens from Seram have robust, circular and plano-convex tests and 6-7 chambers in the last whorl which increase in size slowly as they are added. The tests are muricate with peripheral muricocarina. The chambers on the umbilical side are tightly grouped around a deep and narrow umbilicus. The dorsal sutures are pseudolimbate and oblique to the periphery.

The individuals of G(M) aragonensis from the Nief Beds are close to the description and illustration of this species presented by Bolli (1957c) on page 75, pl. 18, figs. 7-9.

Dimensions of the figured specimens

Pl. 12, figs. 3a-c.

Max. diameter = 0.48 mm, 0.65, 0.56 (average diameter of the types = 0.60 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

This cosmopolitan species has been reported from the Lower and Middle Eocene in various parts of the world (Nuttall, 1930; Luterbacher, 1964; Bolli, 1957f; Pessagno, 1961; Bandy, 1964a; Samuel & Salaj, 1968). According to Bolli (1966), G(M) aragonensis ranges from the lower part of Globorotalia formosa formosa to the upper part of the Globigerapsis kugleri zone (Lower and Middle Eocene). Stainforth et al. (1975), gave the range from the Globorotalia formosa formosa to the Globigerinatheka subconglobata zone (Early to Middle Eocene). According to the "P/N" zonation by Blow (1979), it ranges from the base of subzone P.8b to Zone N.11 (Early Eocene to about the earlier third of the Middle Eocene). (See Range Chart 2).

Globorotalia (M) formosa formosa Bolli, 1957

Plate 12, figs. 4a-c, 5

1957c Globorotalia formosa formosa Bolli, p. 76, pl. 18, figs. 1-3.

1960 Pseudogloborotalia formosa (Bolli); Bermudez, p. 1343.

1964 Globorotalis formosa formosa Bolli; Luterbacher, p. 694, figs. 118-120.

1970a Globorotalia formosa formosa Bolli; Samanta, p. 624, pl. 97, figs. 15, 16.

1971 Globorotalia formosa Bolli; Postuma, p. 190, 191.

1975 Globorotalia formosa formosa Bolli; Stainforth et al., p. 184, Fig. 48.

1979 Globorotalia (Morozovella) formosa Bolli; Blow, p. 1000, pl. 127, figs. 3, 4; pl. 134, figs. 7, 8; pl. 138, figs. 9, 10; pl. 224, figs. 3, 4.

1980 Morozovella formosa formosa (Bolli); Benjamini, p. 350, pl. 3, figs. 3, 8, 9.

Remarks

Bolli (1957c), re-evaluated the morphotypes from the Upper Lizard Springs Formation (Bolli, 1952), described by him as *Globorotalia velascoensis* (Cushman), and assigned them to his two new subspecies *Globorotalia formosa formosa* and *Globorotalia formosa gracilis*. Samanta (1970a) distinguished *G. formosa formosa* from *Globorotalia velascoensis* (Cushman) by its more lobulate periphery, (usually) fewer chambers in the last whorl, thinner peripheral keel and unornamented umbilical ends of the chambers. According to Blow (1979), the chambers of the final whorl of *G*(*M*) *formosa formosa*, as seen dorsally, are usually a little longer tangentially than broad radially, compared to the equidimentional chambers of *G*(*M*)*velascoensis* (Cushman). Luterbacher (1964) regarded *G*(*M*) *formosa formosa* Bolli as related to the *G. velascoensis* group, which includes forms with multichambered and highly ornamented tests.

According to Stainforth et al. (1975) and Blow (1979), *G*(*M*) *formosa formosa* Bolli arose from *G*(*M*) *formosa gracilis* (= *G*(*M*) *subbotinae gracilis* according to Blow, 1979). The morphogenesis is an overall increase in test size concomitant with an increasing number of chambers in the last convolution of the test.

The specimens from the Nief Beds are characterized by a plano-convex test, covered by muricae with peripheral test microcarinae, 6-7 chambers in the last convolution, and intercameral sutures which are pseudolimbate and curved as seen dorsally. The umbilicus is well defined, narrow and deep. The sutures on the umbilical side are incised and radial.

The general morphological features of specimens from the Nief Beds are comparable with the diagnosis and description presented by Bolli (1957c) on page 76, pl. 18, figs. 1-3.

G(M) formosa formosa Bolli, has also been identified in thin section. It is comparable with the figure given by Postuma (1971) on page 191. However, the individuals from the Nief Beds seem to have stronger muricae.

Dimensions of the figured specimens

Pl. 12, figs. 4a-c, 5.

Max. diameter = 0.7 mm, 0.7, 0.68, 0.52 (holotype = 0.65 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Globorotalia (M) formosa formosa Bolli has been reported from the Lower Eocene of various parts of the world. In the Lizard Springs Formation, Trinidad, it ranges from the G. formosa formosa to the G. aragonensis zone (Lower Eocene (Bolli, 1957c)). According to Postuma (1971), it ranges throughout his G. formosa - aragonensis zone (Lower Eocene). Stainforth et al. (1975), indicated that it extends from within the Globorotalia subbotinae zone to within the Globorotalia aragonensis zone (Early Eocene). According to "P/N" zonation given by Blow (1979), it ranges from the base of zone P.8 (subzone P.8a) to the top of the subzone P.8b (Early Eocene). (See Range Chart 2).

Globorotalia (*M*) *formosa gracilis* Bolli, 1957

Plate 12, figs. 6a-c

1957c *Globorotalia formosa gracilis* Bolli, p. 75, pl. 18, figs. 4-6.

1960 *Pseudogloborotalia formosa* Bolli, var. *gracilis* (Bolli); Bermudez, p. 1344.

1964 *Globorotalia formosa gracilis* Bolli; Luterbacher, p. 692, figs. 115, 117.

1968 *Globorotalia* (*Truncorotalia*) *formosa gracilis* Bolli; Wille, p. 244, pl. 7, fig. 7.

1970a *Globorotalia formosa gracilis* Bolli; Samanta, p. 625, pl. 97, figs. 13, 14.

1971a *Morozovella gracilis* (Bolli); Berggren, pp. 57-77, pl. 5, figs. 7, 8.

1971 *Globorotalia* (*Morozovella*) *gracilis* Bolli; Jenkins, p. 105, pl. 9, figs. 202-204.

1971 *Globorotalia gracilis* Bolli; Postuma, p. 192, 193.

1973 *Globorotalia formosa gracilis* Bolli; Krasheninnikov and Hoskins, p. 117, pl. 21, figs. 7-9.

1975 *Globorotalia formosa gracilis* Bolli; Stainforth et al., p. 184, fig. 49.

1979 *Globorotalia* (*Morozova*) *subbotinae gracilis* Bolli; Blow, p. 1021, pl. 111, figs. 9, 10; pl. 112, fig. 1; pl. 115, figs. 7-10; pl. 120, figs. 1-9; pl. 121, figs. 1-8; pl. 223, figs. 3, 4; pl. 249, figs. 8, 9.

1980 *Morozovella formosa gracilis* (Bolli); Benjamini, p. 350, pl. 3, figs. 2, 5, 7.

Remarks

Originally, Bolli (1957c) described *G*(*M*) *formosa gracilis* from the Upper Lizard Springs Formation, Trinidad. He pointed out that *G. formosa gracilis* evolved from *G*(*M*) *aequa* Cushman & Renz. The former species differs from the latter in possessing a distinct peripheral keel and more chambers in the last whorl.

Globorotalia (M) acuta Toulmin differs from G(M) formosa gracilis in having a wider umbilicus and ornamented umbilical ends of the chambers.

The individuals of G(M) formosa gracilis from the Nief Beds are in agreement with the diagnosis and illustration of the holotype presented by Bolli (1957c) on plage 75, pl. 18, figs. 4-6. However, Bolli's illustration reveals five chambers in the last convolution, whereas the individuals from Seram have 4.5 to 5.

Dimensions of the figured specimens

Pl. 12, figs. 6a-c

Max. diameter = 0.52 mm, 0.47, 0.44 (holotype = 0.50 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Globorotalia (M) formosa gracilis has been reported from the Lower Eocene of various parts of the world. It was recorded from the Lower Eocene of Trinidad (Bolli, 1957c), New Zealand (Jenkins, 1971), the West Carpathian (Samuel et al., 1972), Iraq (Khassab, 1972) and other localities. In the Gubbio section of Central Italy, it ranges from the Lower Globorotalia aequa zone (? Uppermost Paleocene) to the lower part of the Globorotalia aragonensis zone (Lower Eocene), in the sense of Luterbacher (1964). Stainforth et al. (1975) gave the range from the lowermost of the Globorotalia subbotinae zone to the end of the *Globorotalia formosa formosa* zone (Early Eocene). According to the "P/N" zonation given by Blow (1979), it ranges from the later part of zone P.6 to subzone P.8b (latest Paleocene to Early Eocene). (See Range Chart 2).

Globorotalia (*M*) *lehneri* Cushman & Jarvis, 1929

Plate 13, figs. 1a-c, 2?

1929 *Globorotalia lehneri* Cushman & Jarvis, p. 17, pl. 3, figs. 16a-c.

1949 *Globorotalia lehneri* Cushman & Jarvis; Cushman and Bermudez, p. 32, pl. 6, figs. 7-9.

1957f *Globorotalia lehneri* Cushman & Jarvis; Bolli, p. 169, pl. 38, figs. 9a-13.

1960 *Pseudogloborotalia lehneri* (Cushman & Jarvis); Bermudez, p. 1345, pl. 16, fig. 9.

1968 *Globorotalia lehneri* Cushman & Jarvis; McGowran, pl. 2, fig. 5.

1969 *Globorotalia* (*G.*) *lehneri* Cushman & Jarvis; Blow, p. 363, pl. 50, fig. 1.

1970c *Globorotalia lehneri* Cushman & Jarvis; Samanta, p. 203, pl. 3, figs. 13-14.

1971 *Globorotalia lehneri* Cushman & Jarvis; Postuma, p. 198, 199.

1975 *Globorotalia lehneri* Cushman & Jarvis; Stainforth et al., p. 198, fig. 6.

1977 *Morozovella lehneri* (Cushman & Jarvis); Poore and Brabb, p. 263, pl. 8, figs. 14-15.

1979 *Globorotalia* (*M*) *lehneri* Cushman & Jarvis; Blow, p. 1002, pl. 50, fig. 1; pl. 188, figs. 1-10; pl. 251, figs. 3, 4.

Remarks

The original illustration of the holotype of *Globorotalia lehneri* Cushman & Jarvis, exhibits radially elongated and strongly lobulate chambers of the final whorl. Cushman and Bermudez (1949), in their illustration of *G*. *Iehneri* from Cuba, have shown a form with a strongly indented peripheral margin, with the chambers of the final convolution less produced than in the holotype. Blow (1969, 1979) and Stainforth et al. (1975), emphasized the radial elongation of the chambers of the final convolution as characteristic feature of this species. However, Bolli (1957f, pl. 38, figs. 9-10, 12-13) and Stainforth et al. (1975, Fig. 60, nos. 1-6, 8), illustrated forms without such radial elongation. Blow (1979, p. 1002) excluded these forms from *G*(*M*) *Iehneri*.

Although the figured specimens from the Nief Beds do not exhibit the radially elongated chambers, they show the axially compressed and biconvex test, with a lobulate and slightly indented periphery. Probably these individuals represent primitive forms of *G*(*M*) *Iehneri*, or even an intermediate between this species and *G*(*M*) *spinulosa* Cushman. They are similar to the forms of *G*(*M*) *Ienheri* illustrated by Stainforth et al. (1975) on Fig. 60, nos. 6, 8.

According to Bolli (1957f), Blow (1969, 1979) and Stainforth et al. (1975), *G*(*M*) *spinulosa* Cushman gives rise to *G*(*M*) *Iehneri*. The latter is separated from the former by its biconvex and compressed test compared to the umbilicoconvex test of *G*(*M*) *spinulosa*, and the radial elongation of the chambers of *G*(*M*) *Iehneri*.

A doubtful identification of *G*(*M*) *Iehneri* was also made in thin sections. It is almost similar in general morphological features to the illustration by Postuma (1971, p. 199). However, the specimens from the Nief Beds has a flattened dorsal side compared to the slightly convex side of Postuma's illustration. This may be due to the subaxial orientation of the section.

Dimensions of the figured specimens

Pl. 13, figs. 1a-c, 2?

Max. diameter = 0.36 mm, 0.36, 0.44, 0.31

Max. thickness = 0.08 mm (fig. 1b), 0.11 (fig. 2).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Globorotalia (M) lenheri has been reported from the Middle Eocene of Trinidad (Cushman & Jarvis, 1929; Bolli, 1957f), Puerto Rico (Pessagno, 1961), Italy (Premoli Silva & Palmieri, 1962), India (Samanta, 1969, 1970C), Western Pacific Ocean (Krashenninikov & Hoskins, 1973) and other parts of the world. Stainforth et al. (1975), gave the range from the Globigerinatheka subconglobata zone to the Truncorotaloides rohri zone (Middle Eocene). According to the "P/N" zonation by Blow (1979), it ranges from the later part of zone P.11 to zone P.13 (Middle Eocene). (See Range Chart 2).

Globorotalia (M) spinulosa Cushman

Plate 13, figs. 3a-c, 4

1927a Globorotalia spinulosa Cushman, p. 114, pl. 23, figs. 4a-c.

1949 Globorotalia (Truncorotalia) spinulosa Cushman; Cushman and Bermudez, p. 40, 41, pl. 8, figs. 1-3.

1953 *Globorotalia spinulosa* Cushman; Beckmann, p. 397, Text- fig. 23; pl. 26, fig. 13.

1957f *Globorotalia spinulosa* Cushman; Bolli, p. 168, pl. 38, figs. 6a- 7c.

1960 *Pseudogloborotalia spinulosa* (Cushman); Bermudez, pp. 1347 - 1348, pl. 17, figs. 2a-b.

1969 *Globorotalia* (*G*) *spinulosa* (Cushman); Blow, p. 370, pl. 50, figs. 2-5.

1970 *Globorotalia spinulosa* Cushman; Bauman, p. 1195, pl. 1, figs. 10 a-c.

1971 *Globorotalia spinulosa* Cushman; Postuma, p. 212, 213.

1975 *Globorotalia spinulosa* Cushman; Stainforth et al., p. 230, Fig. 88.

1979 *Globorotalia* (*M*) *spinulosa spinulosa* Cushman; Blow, p. 1013, pl. 182, figs. 1-4; pl. 185, figs. 1-4; pl. 197, figs. 1-6; pl. 229, figs. 1-4.

1979 *Globorotalia* (*M*) *spinulosa coronata* Blow, p. 1016, pl. 50, fig. 5; pl. 168, figs. 1-8; pl. 229, figs. 5, 6; pl. 230, figs. 1-6.

1960 *Morozovella spinulosa* (Cushman) s.s.; Benjamini, p. 350, pl. 3, figs. 18-22.

Remarks

Globorotalia (*M*) *spinulosa* was first described by Cushman (1927), from the "Upper Eocene" Alazan Clay, Mexico. According to Blow (1979), Cushman's specimens are derived probably from the Guayabal Formation of Middle Eocene age.

Blow (1979) described a new subspecies *G*(*M*) *spinulosa coronata*, he changing the central form to *G*(*M*) *spinulosa spinulosa*. The former differs from the latter mainly in having a more widely open umbilicus surrounded by ornamented umbilical shoulders. In the Nief Beds, *G*(*M*) *spinulosa* Cushman is characterized by an almost flat to slightly convex spiral side, strongly convex ventral side, 4 to 5 chambers in the last convolution which increase slowly in size. The test is covered by muricae and has a peripheral *muricocarina*. Sutures on the spiral side are curved and depressed but radial on the umbilical side. The aperture seems to be covered by a narrow lip. The umbilicus is surrounded by a sharp umbilical shoulders without any ornamentation. It is similar to the *G(M) spinulosa spinulosa* Cushman, illustrated by Blow (1979) on plate 182, figs. 1-4. However, the specimens from the Nief Beds show finer muricae.

A single, badly preserved thin section specimen (pl. 13, fig. 4), has been identified from sample (63-3). It is comparable to the figure illustrated by Beckmann (1953, p. 397, fig. 23). It differs from Beckmann's illustration in having a flatter dorsal side.

Dimensions of the figured specimens

Pl. 13, figs. 3a-c, 4.

Max. diameter = 0.51 mm, 0.52, 0.57, 0.7.

Max. thickness = 0.17 mm (fig. 3b), 0.37 (fig. 4).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the general zonation by Postuma (1971), *G(M) spinulosa* extends from the base of the *Globorotalia bullbrooki* zone to the top of the *Orbulinoides beckmanni* zone (Middle Eocene). It ranges from approximately the *Globorotalia aragonensis* zone through the *Truncorotaloides* rohri zone, Late Early Eocene and Middle Eocene (Stainforth et al., 1975). According to Blow (1979), it extends from the earlier parts of zone P.10 to the top of zone P.14 (Middle Eocene), but may include the extreme basal part of the Late Eocene. (See Range Chart 2).

Globorotalia (M) subbotinae Morozova, 1939

Plate 13, fig. 5 a-c.

1939 Globorotalia subbotinae Morozova, pp. 80-81, pl. 2, figs. 16-17.

1943 Globorotalia rex Martin, p. 117, pl. 8, fig. 2.

1957a Globorotalia rex Martin; Loeblich and Tappan, p. 195, pl. 60, figs. 1a-c.

1960 Pseudogloborotalia rex (Martin); Bermudez, p. 1346.

1963 Truncorotalia cf. rex (Martin); Gohrbandt, p. 64, pl. 6, figs. 1-3.

1964 Globorotalia subbotinae Morozova; Luterbacher, pp. 676-679, Figs. 85-90.

1968 Globorotalia (Truborotalia) rex Martin; Wille, p. 264, pl. 8, figs. 1, 2.

1971 Globorotalia (Morozovella) aequa rex Martin; Jenkins, p. 101, pl. 7, figs. 180-182.

1975 Globorotalia subbotinae Morozova; Stainforth et al., p. 230, Fig. 89.

1979 Globorotalia subbotina subbotinae Morozova; Blow, p. 1018, pl. 102, figs. 1-5; pl. 111, figs. 6-8; pl. 115, figs. 3-5; pl. 119, figs. 4-10; pl. 127, figs. 6-7; pl. 133, fig. 8; pl. 218, figs. 1-6; pl. 219, figs. 1-6; pl. 220, figs. 1-6; pl. 221, figs. 1-7; pl. 222, figs. 1-6.

1981 Morozovella subbotinae (Morozova); Mancini and Oliver, p. 218, pl. 5, figs. 4-6.

Remarks

No morphological difference has been found between G(M) rex Martin and G(M) subbotinae Morozova as indicated from the illustrations of these two species in the published literature. Consequently, G(M) subbotinae Morozova is regarded here as the senior snynonym. The synonymization of these two morphotypes has been suggested by Luterbacher (1964), Berggren (1968), Stainforth et al. (1975), Blow (1979) and Mancini and Oliver (1981).

The individuals of G(M) subbotinae Morozova from the Nief Beds are characterized by robust and coarsely muricate tests with thick peripheral muricocarinae, and four chambers in the final convolution that are tangentially longer than radially broad. These specimens conform with the figures of G(M) rex illustrated by Bolli (1957c) on page 75, pl. 18, figs. 10-12.

Dimensions of the figured specimens

Pl. 13, figs. 5a-c.

Max. diameter = 0.54 mm, 0.54, 0.56.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Stainforth et al. (1975) gave the range from within the G. velascoensis zone to within the G. aragonensis zone (Late Paleocene and Early Eocene). According to the "P/N" zonation by Blow (1979), it ranges from P.6 to zone P.8 (Late Paleocene to Early Eocene). (See Range Chart 2).

Subgenus Globorotalia (Truncorotaloides) Bronniman & Bermudez, 1953, emend. Blow, 1979

Subgenotype: Truncorotaloides rohri Bronnimann & Bermudez, 1953, by original designation

Remarks

See remarks under the genus Globorotalia Cushman in the section dealing with the Miocene species.

Globorotalia (Truncorotaloides) rohri Bronnimann & Bermudez, 1953

Plate 13, figs. 6a-c.

1953 Truncorotaloides rohri Bronnimann & Bermudez, pp. 818-819, pl. 87, figs. 7-9.

Remarks

In the Nief Beds, Globorotalia (T) rohri is common in two samples. It is distinguished by having five chambers in the last convolution, the last showing a slightly disjunct peripheral part as seen in dorsal view. The surface is finely papillated. The dorsal sutural apertures are not preserved. These specimens seem to represent intermediate forms between G(T) rohri Bronnimann & Bermudez and G(T) rohri "var. piparoensis" Bronnimann & Bermudez, as illustrated by these authors on plate 87, figs. 4-9.

Dimensions of the figured specimens

Pl. 13, figs. 6a-c

Max. length = 0.47 mm, 0.39, 0.42.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Stainforth et al. (1975) gave the range from the Hanktenina aragonensis zone to the Truncorotaloides rohri zone (Middle Eocene). According to Blow (1979), T. rohri rohri ranges from zone P.12 to zone P.14, possibly into the basal part of zone P.15 (Later Middle Eocene to the earliest part of the Late Eocene). However, if T. rohri "var. guaracaraensis" and T. "var. piparoensis" included within G(T) rohri s.l., the latter range will be extended down to the lowermost zone P.11. (See Range Chart 2).

Globorotalia (Truncorotaloides) topilensis (Cushman), 1925?

Plate 14, figs. 1a-b.

1925a	Globigerina topilensis Cushman, p. 7, pl. 1, figs. 9a-c.
1957f	Truncorotaloides topilensis (Cushman); Bolli, p. 170, pl. 39, figs. 13-16b.
1960	Pseudogloborotalia topilensis (Cushman); Bermudez, p. 1348, p. 16, fig. 12.
1964	Globigerinoides topilensis (Cushman); Copeland, p. 285, pl 33, figs. 4a-c.
1968	Truncorotaloides topilensis (Cushman); Samuel and Salaj, p. 177, pl. 19, figs. 4a-c; test - fig. 46.
1970	Truncorotaloides topilensis (Cushman); Soldaini, p. 73, pl. 3, figs. 2a-c.
1979	Globorotalia (Truncorotaloides) topilensis topilensis (Cushman); Blow, p. 1042, pl. 193, figs. 1-9; pl. 207, figs. 3, 4; pl. 51, figs. 1-3.

Remarks

Very badly preserved, and primitive forms of Globorotalia (Truncorotaloides) topilensis? have been identified from the Nief Beds. These individuals differ from the normal forms of G(T) topilensis (Cushman) in having subangular peripheral margins, less disjunct chambers of the final convolution and finer papillated walls. Secondary sutural apertures are difficult to discern due to the bad preservation.

The individuals of G(T) topilensis? from the Nief Beds, are more or less similar to the figures illustrated by Samuel and Salaj (1968) and Soldaini (1970) from the Slovak Carpathian Paleogene and the Eocene of Hungary respectively.

Dimensions of the figured specimens

Pl. 14, figs. la-b.

Max. length = 0.44 mm, 0.42

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(T) topilensis (Cushman), has been widely reported from the Middle Eocene in various parts of the world. Stainforth et al. (1975), gave the range throughout the Middle Eocene except the topmost part of the Truncorotaloides rohri zone. According to the "P/N" zonation given by Blow (1979), the species extends from within zone P.12 to the earlier part of zone P.14 (essentially Late Middle Eocene). (See Range Chart 2).

Subgenus *Globorotalia* (*Turborotalia*) Cushman & Bermudez, 1949, emend. Blow, 1979

Subgenotype: *Globorotalia centralis* Cushman & Bermudez, 1934, by original designation

Remarks

See remarks under the subgenus *Globorotalia* (*Turborotalia*) Cushman & Bermudez in the section dealing with the Miocene species.

Globorotalia (*Turborotalia*) *centralis* Cushman & Bermudez, 1937

Plate 14, figs. 2a-c, 3

1937 *Globorotalia centralis* Cushman & Bermudez, p. 26, pl. 2, figs. 62-65.

1949 *Globorotalia* (*Turborotalia*) *centralis* Cushman & Bermudez, pp. 44-45, pl. 8, figs. 19-21.

1953 *Acarinina centralis* (Cushman & Bermudez); Subbotina, pp. 237-239, pl. 25, figs. 7a-9c.

1957f *Globorotalia centralis* Cushman & Bermudez; Bolli, p. 169, pl. 39, figs. 1a-4.

1962 *Globorotalia* (*Turborotalia*) *centralis* Cushman & Bermudez; Blow and Banner (in Eames et al., 1962), p. 117, pl. 12, figs. K-M; pl. 16, fig. L; pl. 17, figs. B, G; Fig. 12c, d.

1968 *Turborotalia* (*Turborotalia*) *centralis* (Cushman & Bermudez); Samuel and Salaj, p. 159, pl. 20, figs. 2a-c.

1968 *Turborotalia centralis* (Cushman & Bermudez); Srinivasan, p. 145, pl. 14, figs. 8, 9.

1970 *Globorotalia cerroazulensis pomeroli* Toumarkine & Bolli, p. 140, pl. 1, figs. 10-18.

1977 *Globorotalia centralis* Cushman & Bermudez; Cifelli & Belford, p. 104, pl. 1, figs. 16-18.

1979 *Globorotalia* (*Turborotalia*) *centralis* Cushman & Bermudez; Blow, p. 1052, pl. 36, figs. 1-2; pl. 137, fig. 9; pl. 190, figs. 1-5; pl. 261, figs. 7-9.

Remarks

Toumarkine and Bolli (1970) have constructed their *Globorotalia cerroazulensis frontosa* (Subbotina) - *Globorotalia cerroazulensis cunialensis* Toumarkine & Bolli lineage. According to this hypothesis, *Globorotalia cerroazulensis pomeroli* Toumarkine & Bolli has been derived from *Globorotalia cerroazulensis frontosa* and gives rise to *Globorotalia cerroazulensis cerroazulensis* (Cole). In their systematic description, Toumarkine and Bolli (op. cit.) placed *G*(*T*) *centralis* in the synonymy of G(T) *cerroazulensis cerroazulensis* (Cole). The present writer has compared the members of the evolutionary plexus illustrated by Toumarkine and Bolli (1970) on plate 1, with the refigured holotype of *G*(*T*) *centralis* illustrated by Bolli, Loeblich and Tappan (1957) on plate 10, figs. 4a-c, and concluded that the gross morphological aspect of *G*. *cerroazulensis pomeroli* Toumarkine & Bolli matches those of *G*(*T*) *centralis*. The thin section illustrations of *G*(*T*) *centralis* and *G*(*T*) *cerroazulensis* from the Nief Beds (see pl. 14, figs. 3, 4) reveal without any doubt, the differences between these two species in the wall structure, wall texture and the angularity of the peripheral margin. These two species are regarded here as a separate taxa. Moreover, *G*(*T*) *cerroazulensis pomeroli* is considered a junior synonym of *G*(*T*) *centralis*. These conclusions are in agreement with the view of Blow (1979).

G(*T*) *centralis* has been identified from the solid specimens as well as the thin section from Seram. The matrix free specimens seem to fall within the range of variation of *G*(*T*) *cerroazulensis pomeroli* which is regarded here as a junior synonym of *G*(*T*) *centralis*. The section of this species is comparable with the figure illustrated by Blow and Banner (in Eames et al., 1962) on plate 16, fig. L. It differs basically in having a narrower umbilicus.

Dimensions of the figured specimens

Pl. 14, figs. 2a-c, 3.

Max. diameter = 0.48 mm, 0.40, 0.36, 0.7 (holotype = 0.45 - 0.55).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Globorotalia (*T*) *centralis* Cushman & Bermudez, has been reported from the Middle and Upper Eocene in many countries of Europe, Asia, Africa, America, Australia, New Zealand as well as from the deep sea cores. According to the "P/N" zonation by Blow (1969, 1979), it ranges from the earlier part of zone P.11 to the top of zone P.17 (early Middle Eocene to the top of the Late Eocene). (See Range Chart 2).

Globorotalia (*T*) *cerroazulensis* (Cole), 1928

Plate 14, fig. 4

1928 *Globigerina cerro-azulensis* Cole, p. 217, pl. 32, figs. 11-13.

1928 *Globorotalia cocoaensis* Cushman, p. 75, pl. 10, figs. 3a-c.

1949 *Globorotalia* (*T*) *cerroazulensis* (Cole); Cushman and Bermudez, pp. 42-43, pl. 8, figs. 10-12.

1962 *Globorotalia* (*T*) *cerroazulensis* (Cole); Blow and Banner (in Eames et al., 1962), p. 118, pl. 12, figs. D-F; pl. 16, fig. M; Figs. 12d, e.

1968 *Globorotalia cerroazulensis* (Cole); McGowran, pp. 179-198, pl. 3, fig. 2.

1970 *Globorotalia cerroazulensis cerroazulensis* (Cole); Toumarkine and Bolli, p. 144, pl. 1, figs. 19-24.

1970 *Globorotalia cerroazulensis cocoaensis* Cushman; Toumarkine and Bolli, p. 144, pl. 1, figs. 28-33.

1971 *Globorotalia cerroazulensis* (Cole); Postuma, p. 184, 185.

1979 *Globorotalia (Turborotalia) cerroazulensis* (Cole); Blow, p. 1054, pl. 36, figs. 3, 4; pl. 242, figs. 1-7.

Remarks

Cushman and Bermudez (1949), distinguished *Globorotalia (T) cerroazulensis* (Cole), from *Globorotalia* (*T*) *cocoaensis* Cushman by its larger and more robust test, and more inflated ventral side. Blow (1979) emphasized the more flattened dorsal surface of *G*(*T*) *cocoaensis* Cushman. These differences are considered within the range of variation of *G*(*T*) *cerroazulensis* (Cole). Therefore, *G*(*T*) *cocoaensis* is regarded as a junior synonym of the latter. Concerning the validity of *G*(*T*) *cerroazulensis corroazulensis* (Cole) and *G*(*T*) *cerroazulensis cocoaensis* Cushman as presented by Toumarkine and Bolli (1970), reference is made to the lengthy and detailed argument by Blow (1979, pp. 1055-1058). The paragraph dealing with *G*(*T*) *centralis* should be referred to for the relevant remarks on *G*(*T*) *cerroazulensis*.

In the Nief Beds, *G*(*T*) *cerroazulensis* (Cole) has been identified in thin section. The species is distinguished by its smooth surface, flattened spiral side, the dorso-ventral compression of the chambers, and the angular peripheral margin without a true carina. It conforms well with the figure of *Globorotalia cerroazulensis* (Cole) illustrated by McGowran (1968) on plate 3, fig. 2, and Postuma (1971) on page 185. However, it differs from these forms in having more dorso-ventrally compressed chambers. The completely closed aperture of the illustrated specimen is related to the orientation of the section.

Dimensions of the figured specimen

Max. diameter = 0.42 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(T) cerroazulensis (Cole), has been widely reported from the Upper Eocene in various parts of the world (Bolli, 1957f; Blow and Banner (in Eames et al., 1962); Samuel and Salaj, 1968; Blow, 1969; Samanta, 1969, 1970b; Bauman, 1970; Postuma, 1971). According to the "P/N" zonation by Blow (1979), it extends from within the later part of zone P.14 emended, to the earlier part of zone P.17 (Late Eocene). (See Range Chart 2).

Family Globigerapsidae Blow, 1979

Genus Muricoglobigerina Blow, 1979

Genotype: Globigerina soldadoensis Bronnimann, 195

Remarks

Muricoglobigerina Blow differs from Globigerina d'Orbigny emend. Blow, 1979 in having a muricate wall surface. According to Blow (1979, Fig. 62), these two genera represent two different lines of evolution. Muricoglobigerina Blow differs from Globorotalia Cushman, in having an interiomarginal, intraumbilical primary aperture. It differs from Globigerapsis Bolli, Loeblich & Tappan, emend. Blow, 1979, in lacking true dorsal, supplimentary apertures. The occasional presence of sutural dorsal apertures are not considered true supplimentary or accessory apertures (Blow, 1979, p. 119). These supplimentary apertures are due to the interference by the muricae at the plane of junction of successively added chambers.

Muricoglobigerina gravelli (Bronnimann), 1952

Plate 14, figs. 5a-c, Plate 16, fig. 6

1952 Globigerina gravelli Bronnimann, p. 160, pl. 1, figs. 16-18.

1971 Globigerina gravelli Bronnimann; Postuma, p. 150, 151.

1972 Turborotalia (Acarinina) gravelli (Bronnimann); Samuel, Borza and Köhler, p. 184, pl. 68, figs. 3a, b.

1973 Acarinina gravelli (Bronnimann); Krashennikov and Hoskins.

1979 Muricoglobigerina esnehensis (Nakkady); Blow, p. 1127, pl. 109, figs. 1-7.

Remarks

Loeblich and Tappan (1957a) proposed the synonymisation of Muricoglobigerina mckannai (White), 1928, Muricoglobigerina esnehensis (Nakkady), 1950 and Muricoglobigerina gravelli (Bronnimann), 1952. Blow (1979) investigated some of the primary types of these species deposited in the British Museum (Natural History), London, and in the U.S. National

Museum, Washington. He concluded that *M. mckannai* and *M. gravelli* are taxonomically distinct species, and confirmed Loeblich and Tappan's view in the synonymity of *M. esnehensis* and *M. gravelli* with the first species as the prior taxon. This conclusion is accepted here. However, the name "gravelli" is provisionally used in this thesis.

M. gravelli differs from *M. mckannai* in having a lobulate outline, a less tight coiling mode, more inflated chambers, more concave initial part, and consistently radial dorsal intercameral sutures against the posteriorly recurved and incised sutures of *M. mckannai* (Krasheninnikov & Hoskins, 1973; Blow, 1979).

The matrix free specimens of *M. gravelli* from the Nief Beds are in agreement with the diagnosis and the illustrations of this species presented by Bronnimann (1952, p. 160, pl. 1, figs. 16-18). However, the specimens from Seram show a higher elevation and convexity of the test, with a finer muricate wall.

M. gravelli was also identified from thin section. It shows similarity with *M. gravelli* illustrated by Postuma (1971) on page 151.

Dimensions of the figured specimens

Pl. 14, figs. 5a-c; pl. 16, fig. 6.

Max. diameter = 0.63 mm, 0.40, 0.52, 0.34

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation given by Blow (1979), the species (as *M. esnehensis*) extends from zone P.5 to the end of zone P.8 (Upper Paleocene to the Lower Eocene). (See Range Chart 2).

Muricoglobigerina soldadoensis soldadoensis (Bronnimann), 1952

Plate 14, figs. 6a-c.

1952 *Globigerina soldadoensis* Bronnimann, p. 9, pl. 1, figs. 1-9.

1957f *Globigerina soldadoensis* Bronnimann; Bolli, p. 162, pl. 35, figs. 9a-c.

1962 *Globorotalia (Acarinina) soldadoensis* (Bronnimann); Hillebrandt pp. 142-143, pl. 14, figs. 5a-c; 6a-c.

1968 *Turborotalia (Acarinina) soldadoensis* (Bronnimann, 1952); Samuel and Salaj, p. 173, pl. 15, figs. 3a-c.

1971a *Acarinina soldadoensis* (Bronnimann); Berggren, pp. 57-65, pl. 5, figs. 1-3.

1972 *Turborotalia (Acarinina) soldadoensis soldadoensis* (Bronnimann); Samuel, Borza and Köhler, p. 189, pl. 68, figs. 4a-c.

1979 *Muricoglobigerina soldadoensis soldadoensis* (Bronnimann); Blow, p. 1120, pl. 98, figs. 1-3; pl. 107, figs. 1-5; pl. 109, fig. 8; pl. 110, fig. 1; pl. 124, figs. 1, 3, 5; pl. 131, figs. 1-3, 6; pl. 235, fig. 6.

Remarks

The individuals of *Muricoglobigerina soldadoensis soldadoensis* (Bronnimann) from the Nief Beds are characterized by low trochoid tests with almost flat dorsal sides, lobulate peripheries, four chambers (occasionally five) in the final convolution, fine muricate walls and wide umbilici. Apertural details are obscured by umbilical infill. These individuals are identical, judged by the figures and description, with the holotype of *M. soldadoensis* illustrated by Bronnimann (1952), on page 7 & 9, pl. 1, figs. 1-9.

Dimensions of the figured specimens

Pl. 14, figs. 6a-c.

Max. diameter = 0.45 mm, 0.43, 0.49.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

M. soldadoensis soldadoensis (Bronnimann) is known from the Upper Paleocene and Lower Eocene from many parts of the world (Bronnimann, 1952; Bolli, 1957f; Hornibrook, 1958; Pessagno, 1960; El-Naggar, 1966; Samuel and Salaj, 1968; Jenkins, 1971). According to the "P/N" zonation by Blow (1979), it extends from the base of zone P.5 to within the earlier part of zone P.9 (Later Paleocene to nearly to the top of the Early Eocene). (See Range Chart 2).

Ex Interc *Muricoglobigerina gravelli* (Bronnimann) and *Muricoglobigerina soldadoensis soldadoensis* (Bronnimann)

Plate 15, figs. 1a-c.

1957c Ex Interc "*Globigerina*" *gravelli* Bronnimann and *Globigerin* *soldadoensis* Bronnimann; Bolli, pl. 16, figs. 10-12.

Remarks

Intermediate forms between *Muricoglobigerina gravelli* and *Muricoglobigerina soldadoensis* sensu Bolli (1957c) were identified from two samples. These forms occur together, and in the same samples with M. gravelli and M. soldadoensis.

Dimensions of the figured specimens

Pl. 15, figs. 1a-c.

Max. diameter = 0.37 mm, 0.33, 0.35.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Muricoglobigerina soldadoensis angulosa Bolli, 1957

Plate 15, figs. 2a-c

1957c Globigerina soldadoensis angulosa Bolli, p. 71, pl. 16, figs. 4-6.

1960 Globigerina soldadoensis var. angulosa Bolli; Bermudez, p. 1200.

1963 Globigerina soldadoensis angulosa Bolli; Coltro, pl. 15, figs. 2a-c.

1972 Turborotalia (Acarinina) soldadoensis angulosa (Bolli, 1957); Samuel, Borza and Köhler, p. 190, pl. 68, figs. 5a-c.

1979 Muricoglobigerina soldadoensis angulosa (Bolli); Blow, p. 1122, pl. 109, fig. 9; pl. 131, figs. 4, 5.

1980 Acarinina soldadoensis (Bronnimann); Benjamini (part), p. 340, pl. 2, figs. 5, 7. Not figs. 6, 8.

Remarks

Muricoglobigerina soldadoensis angulosa (Bolli) is distinguished from Muricoglobigerina soldadoensis soldadoensis (Bronnimann) in having more angular chambers in the final convolution, and a more restricted stratigraphical range.

In the Nief Beds, two distinct populations of M.

soldadoensis angulosa have been recognized. The individuals of the population in sample C.C.76 have a cream colour, a very fine spinose or muricate wall and less angular chambers than the individuals of the other population. They are similar to the hypotypic forms from the Navet Formation illustrated by Bolli (1957f). The other types are represented by the population in sample (60-1). These individuals are characterized by a dark brown colour, a more spinose surface and more angular chambers. These conform with the description and illustration of the holotype from the Upper Lizard Springs Formation. The differences between these two populations either have an environmental significance or may be related to the state of preservation.

Dimensions of the figured specimens

Pl. 15, figs. 2a-c.

Length = 0.54 mm, 0.44, 0.62.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979), it ranges from the later part of zone P.6 to within the earliest part of zone P.9 (Latest Paleocene to nearly to the top of the Early Eocene). It has been reported from the Upper Paleocene and Lower Eocene in Trinidad (Bolli, 1957c, f) and West Carpathians (Samuel et al. 1972). (See Range Chart 2).

Family Hantkeninidae Cushman, 1927

Subfamily Hantkenininae Cushman, 1927

Genus Hantkenina Cushman, 1925

Genotype: Hantkenina alabamensis Cushman, 1925

Hantkenina sp. cf. mexicana Cushman, 1924

Plate 15, fig. 3

cf. 1959 Hantkenina mexicana Cushman; AGIP Mineraria, pl. 127.

Remarks

A single specimen of Hantkenina sp. cf. mexicana was identified from thin section. It is similar to the thin section figure of this species illustrated by AGIP Mineraria (1959) on plate 127.

Dimensions of the figured specimen

Total length = 0.49 mm.

The length of the tubulospine = 0.15 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Subfamily Hastigerininae Bolli, Loeblich & Tappan, 1957

Genus Pseudohastigerina Banner & Blow, 1959

Genotype: Nonion micrus Cole, 1927, by original designation.

Remarks

The genus Globanomalina Haque (1956, in Berggren et al., 1967, p. 297) was first defined to include forms whose chambers were arranged in a low trochospire. Loeblich and Tappan (1964, p. C.665) indicated that the type species of Globanomalina Haque is involute in both sides. They redescribed it to include planispiral to slightly asymmetrical forms, and considered Pseudohastigerina Banner & Blow to be synonymous with Haque's genus. Berggren, Olsson, Reyment (1967) have carefully re-examined the paratypes of Globanomalina Haque in the British Museum (Natural History), and confirmed the presence of a very low trochospire in these specimens. They pointed out that the bad preservation of these paratypes may have misled Loeblich and Tappan to interpret this genus as being planispiral. Consequently, Berggren, Olsson and Reyment (op. cit.) have used Pseudohastigerina Banner & Blow for the Paleogene planispiral forms instead of Globanomalina. In the light of the above discussion, the present author considers Pseudohastigerina Banner & Blow as a valid genus for the Paleogene planispiral forms, and regards Globanomalina Haque as a junior synonym of Globorotalia Cushman.

Blow (1979, p. 1179) distinguished Pseudohastigerina from the Hastigerina, siphonifera - group, in not having raised inter-pore ridges, and from Hastigerina pelagica d'Orbigny in not having a tri-radiate spines. The species of Pseudohastigerina are restricted to the Paleogene, whereas those of Hastigerina are confined to the Neogene.

Pseudohastigerina micra (Cole), 1927

Plate 15, fig. 4

1927 Nonion micrus Cole, p. 22, pl. 15, fig. 12.

1932 Nonion danvillensis Howe & Wallace, p. 51, pl. 9, figs. 3a-b.

1937a Globigerinella micra (Cole); Glaessner, p. 30, pl. 1, figs. 4a-b.

1940 Nonion iota Finlay, p. 456, pl. 65, figs. 108-110.

1957f Hastigerina micra (Cole); Bolli, p. 161, pl. 35, figs. 1a-2b.

1959 Pseudohastigerina micra (Cole); Banner and Blow, pp. 19-20, pl. 3, figs. 6a-b.

1968 Globanomalina micra (Cole); Samuel and Salaj, p. 180, pl. 20, figs. 5a-b; test - fig. 49 A-B.

1970 Pseudohastigerina micra (Cole); Cordey, Berggren and Olsson, pp. 235-242, text-fig. 5, nos. 27-32.

1975 Pseudohastigerina micra (Cole); Stainforth et al., p. 207, Fig. 68.

1979 Pseudohastigerina danvillensis (Howe & Wallace); Blow, p. 1181, pl. 159, figs. 6, 7; pl. 161, figs. 2-7; pl. 166, figs. 2-10; pl. 253, figs. 10-12.

1979 Pseudohastigerina micra (Cole); Blow, p. 1185, pl. 166, fig. 11; pl. 198, figs. 8, 9; pl. 253, figs. 1-9.

Remarks

Contradicting views have been found in the literature concerning the link between P. danvillensis (Howe & Wallace) and P. micra (Cole). According to Barker (in Berggren, 1960, p. 86), P. danvillensis differs from P. micra in its slightly larger size, its 7 to 7½ chambers in the last whorl compared to 6 to 6½ of P. micra, and its more compressed test with an almost blunt keel on the periphery of the last chambers on some specimens, compared to the rounded to subrounded axial periphery of P. micra. Berggren (1960) supported this view and regarded these two taxa as separate species. In a later publication (Cordey, Berggren and Olsson, 1970), indicated that P. danvillensis is a junior synonym of P. micra. Blow (1979) regarded these two taxa as separate species and have a different origin. However, the writer considers P. danvillensis and P. micra to be synonymous.

In the Nief Beds, a single specimen of P. micra was identified in a thin section. It differs from the diagnosis and illustration of this species, as presented by Postuma (1971), in having a strongly compressed final chamber with an acute axial periphery. This specimen seems to fall within the range of P. danvillensis sensu Berggren (1960) and Blow (1979).

Dimension of the figured specimen

Max. length = 0.3 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979), the combined ranges of P. danvillensis and P. micra is from zone P.8 (subzone P.8b) to the upper part of zone P.17 (Early to Late Eocene). (See Range Chart 2).

Family Eoglobigerinidae Blow, 1979

Genus Subbotina Brotzen & Pozaryska, 1961 emend. Loeblich and Tappan, 1964, emend. Blow, 1979

Genotype: "Globigerina" triloculinoides Plummer, 1926,
by original designation

Remarks

Subbotina Brotzen & Pozaryska, 1961, emend. Blow, 1969, differs from Globigerina d'Orbigny, 1826, emend. Blow, 1979 in the possession of a portical structure, and from Globorotalia Cushman, 1927, emend. Blow, 1979 in the possession of an asymmetrically umbilical-extraumbilical aperture (new descriptive term, Blow, 1979, p. 489).

The introduction of such terms as "asymmetrically umbilical-extraumbilical aperture" by Blow (1979) will remove the confusion in the diagnosis of Subbotina, Globorotalia, and Turborotalia Cushman & Bermudez as defined by Loeblich and Tappan (1964, p. 668).

The basic diagnostic features of the genus Subbotina, namely the "funnel-shaped" pore pits indicated by Brotzen and Pozaryska (1961, p. 160); the reticulate and pitted surface mentioned by Loeblich & Tappan (1964, p. 673); the "asymmetrically umbilical-extraumbilical" aperture and the portical structure indicated by Blow (1979, p. 1245) have been observed in all the species of the genus Subbotina recognized from the Nief Beds. Since the "asymmetrical umbilical-extraumbilical" aperture and the porticus give a distinctive status to this genus, the emendation of Blow (1979) is preferably followed here.

Subbotina sp. cf. eocaenica (Terquem), 1882

Plate 15, fig. 5

1882 Globigerina eocaenica Terquem, p. 86, pl. 9, fig. 4.

1957f *Globigerina boweri* Bolli, p. 163, pl. 36, figs. 2a-b.

Remarks

A single specimen of *Subbotina sp.* cf. *eocaenica* (Terquem) has been identified from the Nief Beds. It is similar to the *Globigerina boweri* Bolli, illustrated by Bolli (1957f) on plate 36, figs. 2a-b which is regarded as *Subbotina eocaenica*? (Terquem) by Blow (1979, p. 1260). However, the details of the apertural system, the dorsal side and the side view are obscured, and the assignment of the Nief Beds specimens to *S. eocaenica* (Terquem) is tentative.

Dimensions of the figured specimen

Max. length = 0.18 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Subbotina sp. cf. *frontosa boweri* (Bolli), 1957

Plate 15, figs. 6a-b

1957f *Globigerina boweri* Bolli, p. 163, pl. 36, figs. 1a-1b.

Remarks

Very badly preserved specimens of *Subbotina sp.* cf. *frontosa boweri* (Bolli) were recognized from the Nief Beds. The bad preservation did not permit a detailed study of these forms, especially the features related to the aperture.

However, these forms are roughly similar to the figures of "Globigerina" boweri illustrated by Bolli (1957f) on plate 36, figs. 1a-b.

Dimensions of the figured specimens

Pl. 15, figs. 6a-b

Max. length = 0.2 mm, 0.16.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Subbotina linaperta (Finlay), 1939

Plate 15, figs. 7a-c, 8

1939 Globigerina linaperta Finlay, p. 125, pl. 13, figs. 54-57.

1958 Globigerina linaperta Finlay; Hornibrook, p. 33, pl. 1, figs. 19-21 (holotype re-drawn).

1960a Globigerina linaperta Finlay; Bolli and Cita, p. 371, pl. 33, figs. 2a-c.

1968 Subbotina linaperta (Finlay); Srinivasan, p. 149, pl. 16, figs. 7, 10, 11.

1971 Globigerina (Subbotina) linaperta Finlay; Jenkins, p. 162, pl. 18, figs. 551-554.

1975 Subbotina linaperta (Finlay); Mckeel and Lipps, p. 62, pl. 3, figs. 4a-c.

1979 Subbotina linaperta (Finlay); Blow, p. 1276, pl. 91, fig. 8; pl. 124, fig. 9; pl. 158; fig. 8, pl. 160, figs. 6-8; pl. 177, figs. 4-6; pl. 240, figs. 5, 6.

Remarks

Subbotina linaperta (Finlay) is similar to Subbotina triloculinodies (Plummer) in exhibiting a wide range of variation and gradation within its population in any one locality. It shows considerably variability concerning the size of the last chamber compared to the rest of the test, the pitting of the surface, the degree of the convexity of the spiral side, the position of the aperture and the peripheral compression of the chambers. 3 to 3½ chambers of the final convolution has been recorded by Mckeel and Lipps (1972). The final chamber shows variation from smaller, equal to even larger than the preceeding chambers (Bronnimann, 1952). According to Finlay (1939), Bronnimann (1952) and Jenkins and Orr (1972), the compressed peripheral margin is a characteristic feature of the chambers of the final volution.

Subbotina linaperta (Finlay) is closely related to *Subbotina triloculinoides* (Plummer), and considered by many writers to be derived from this Paleocene species (Bolli, 1957c; Loeblich and Tappan, 1957a; Bronnimann, 1952; Samanta, 1969; Srinivasan, 1968). According to Bronnimann (1952), and Samuel, Borza & Köhler, (1972), *S. linaperta* is distinguished from *S. triloculinoides* (Plummer) by its larger size, more compressed peripheral portion of the chambers, the finer perforations, the larger umbilicus, the almost equitorial position of the aperture, less distinct flaring lip (porticus) protecting the aperture and wider stratigraphic range. The materials from the Nief Beds indicate that the size of the test cannot be used to differentiate between *S. linaperta* and *S. triloculinoides* Differentiation of these two species is mainly based on the compression of the peripheral part of the chambers, and to less extent on the coarsenss of the pitting and the nature of the aperture.

Subbotina linaperta (Finlay) was recognized from the Nief Beds as matrix free specimens. Their state of preservation is not satisfactory. The tests consist of 3 to 3½ chambers in the final volution. The final chamber constitutes slightly less than half the total size of the test. The peripheral compression of the final chambers, and the flat dorsal surface are characteristic features of these specimens. The walls are finely pitted. Although the apertural details are almost completely obscured, traces of the asymmetrical umbilica-extraumbilical aperture and the porticus can be observed. These specimens are comparable with the figures illustrated by Bolli and Cita (1960a) on plate 33, figs. 2a-c.

A related form was identified in the thin sections. It is similar to the *Subbotina sp.* aff. *S. linaperta* illustrated by McGowran (1968) on plate 3, figs. 16.

Dimensions of the figured specimens

Pl. 15, figs. 7a-c, 8.

Max. length = 0.33 mm, 0.43, 0.32, 0.23 (holotype = 0.44).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Subbotina linaperta (Finlay) is a long ranging species. It has been reported from the Paleocene and Eocene in various parts of the world. According to the "P/N" zonation given by Blow (1979), it ranges from zone P.4 (Paleocene) to zone P.16 (Late Eocene). (See Range Chart 2).

Subbotina triangularis triangularis (White), 1928

Plate 16, figs. 1a-c

1928 Globigerina triangularis White, pp. 195-196, pl. 28, figs. 1a-b.

1957C Globigerina triangularis White; Bolli, p. 71, pl. 15, figs. 12-14.

1964 Globigerina triangularis White; Barr and Berggren, p. 128, pl. 1, figs. 1a-4c.

1979 Subbotina triangularis triangularis (White); Blow, p. 1281, pl. 91, figs. 7, 9; pl. 98, fig. 6; pl. 107, figs. 8, 9.

Remarks

Subbotina triangularis triangularis (White) is closely related and similar to Subbotina triloculinoides (Plummer). It differs from the last species in having a more triangular test, a higher trochospire, and a smaller and more flattened last chamber. According to Blow (1979), the aperture and its associated porticus is almost confined to the limits of the umbilical depression and does not extend significantly towards the anterior side of the last chamber as in Subbotina triloculinoides (Plummer). Bolli (1957c), Samuel et al. (1972) and Blow (1979) proposed the derivation of Subbotina triangularis triangularis from Subbotina triloculinoides. According to Blow (1979), this evolution involves a relaxation of the coiling mode, more lateral restriction of the apertural system especially toward the anterior, a less rapid rate of chamber enlargement and the development of a broader porticus. Transitional forms between these two species have been recognized from the Nief Beds.

The individuals of Subbotin triangularis triangularis from the Nief Beds are rather variable. The trochospire varies from low to moderately high, and the final chamber from flattened to slightly inflated. Some of the specimens deviate from the usual triangular shape to approach a form similar to Subbotina triloculinoides (Plummer). The number of chambers in the final whorl varies from 3 to 3½. The walls are pitted. The aperture is asymmetrical umbilica-extraumbilical, and extends from the middle part of the umbilicus towards the anterior side of the final chamber. It is covered by a porticus, slightly wider in the middle part.

Typical forms of Subbotina triangularis triangularis from the Nief Beds are similar in general way to the figures of this species illustrated by Bolli (1957c) on plate 15, figs. 12-14, and to the illustration by Blow (1979) on plate 91, fig. 7, and plate 107, fig. 8. However, they differ from the diagnosis and illustration by Blow (1979) in having a longer and low arched apertural opening. The photographed umbilical view of this species from the Nief Beds (pl. 16, fig. 1c) probably represents an intermediate form between Subbotina triangularis triangularis and Subbotina triloculinoides.

Dimensions of the figured specimens

Pl. 16, figs. 1a-c.

Max. length = 0.43 mm., 0.39, 0.44.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979), it ranges from zone P.2 to zone P.8 (Earlier Paleocene to within the Early Eocene). (See Range Chart 2).

Family Globoquadrinidae Blow, 1979

Genus Dentoglobigerina Blow, 1979

Genotype: "Globigerina" galavisi Bermudez, 1961,
by original designation

Remarks

See remarks under the Family Globoquadrinidae Blow and the Genus Dentoglobigerina Blow in the section dealing with the Miocene species.

Dentoglobigerina pseudovenezuelana (Blow & Banner), 1962

Plate 16, figs. 2a-c

1957c Globigerina yeguaensis Weinzierl & Applin; Bolli (part), pl. 35, figs. 14a-c.

1962 Globigerina yeguaensis pseudovenezuelana Blow & Banner (in Eames et al., 1962), p. 100, pl. 11, figs. J-L (holotype), figs. N-O (paratypes).

1963 Globigerina yeguaensis pseudovenezuelana Blow & Banner; Eckert, p. 1060, pl. 5, figs. 4a-d.

1979 Dentoglobigerina pseudovenezuelana (Blow & Banner); Blow, p. 1307, pl. 19, figs. 1, 2; pl. 244, figs. 5, 6.

Remarks

"Globigerina" yeguaensis illustrated by Bolli (1957f) on plate 34, figs. 14a-c has four appressed chambers in the last convolution and a semicircular profile. This form is referred here to Dentoglobigerina pseudovenezuelana.

The Nief Beds specimen are characterized by 3½ to 4 chambers in the last convolution. The aperture is a low arch within the umbilicus. No portical umbilical tooth has been recognized in these specimens, probably due to its fragile nature. The walls are ornamented with fine perforations. The figured specimens are similar to the paratypes illustrated by Blow and Banner (in Eames et al. 1962) on plate 11, figs. J-L. However, they differ basically in having 4 chambers in the last convolution compared to 3½ of the paratypes.

Dimensions of the figured specimens

Pl. 16, figs. 2a-c.

Max. length = 0.37 mm, 0.36, 0.43

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979) it ranges from within zone P.13 to near the top of zone P.19/P.20 (later part of the Middle Eocene to about the Middle part of the Oligocene). (See Range Chart 2).

Dentoglobigerina yeguaensis (Weinzierl & Applin), 1929

Plate 16, figs. 3a-c.

1929 Globigerina yeguaensis Weinzierl & Applin, p. 408, pl. 43, figs. 1a-b.

1963 Globigerina yeguaensis yeguaensis Weinzierl & Applin; Eckert, p. 1060, pl. 4, figs. 4a-d, 5a-c.

1963 Globigerina yeguaensis Weinzierl & Applin; Coltro, pl. 14, figs. 8a-c.

1970c Globigerina yeguaensis Weinzierl & Applin; Samanta, p. 192, pl. 1, figs. 15-17.

1979 Dentoglobigerina yeguaensis (Weinzierl & Applin); Blow, p. 1313, pl. 3, figs. 12-14 (holotype redrawn).

Remarks

According to Blow (1979, p. 1314), Dentoglobigerina yeguaensis (Weinzierl & Applin) developed from the Dentoglobigerina galavisi (Bermudez) and gives rise to Dentoglobigerina pseudovenezuelana (Blow & Banner). Blow (op. cit.) separated D. yeguaensis from D. galavisi by its having a slower rate of chamber enlargement in the last convolution, more appressed and longer tangentially than broad radially as compared to the more nearly equidimensional of galavisi. On this basis, the specimens from the Nief Beds are referred to the D. yeguaensis. The forms described as Globigerina yeguaensis by Bolli (1957f) on plate 35, figs. 15a-c, and Blow and Banner (in Eames et al., 1962) on plate 13 H-M, have almost equidimensional and less appressed chambers as compared to the holotype of D. yeguaensis. These forms seem to belong in D. galavisi (Bermudez).

D. pseudovenezuelana is separated from D. yeguaensis in having more appressed and embracing chambers in the last convolution, a less lobulate periphery and a generally more circular outline.

D. yeguaensis (Weinzierl & Applin) has been identified amongst matrix free specimens from the Nief Beds. The main diagnostic features are the almost equal sizes of the chambers in the last convolution, tangentially longer than radially broad. These specimens agree with the holotype of this species refigured by Blow (1969) on plate 3, figs. 12-14. However, they differ in having less appressed chambers in the final convolution and, in this respect, are closer to *D. galavisi*.

Dimensions of the figured specimens

Pl. 16, figs. 3a-c.

Max. length = 0.34 mm., 0.33, 0.34.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

D. yeguaensis was originally described from the subsurface Yegua Formation (Middle Eocene) of Texas (Weinzierl and Applin, 1929). According to Blow (1979), its occurrence is not significant outside the interval from zone P.12 to zone P.14 (Later Middle Eocene to ? basal part of the Late Eocene). Other reported occurrences are from the Lower Eocene, Oligocene and Lower Miocene. The differences in the ranges are due to the different concepts of this species by various authors. (See Range Chart 2).

Dentoglobigerina sp. cf. *yeguaensis* (Weinzierl & Applin), 192

Plate 16, fig. 4

1971 *Globigerina yeguaensis* Weinzierl & Applin; Postuma, p. 162, 163.

Remarks

Dentoglobigerina sp. cf. yeguaensis was identified from thin section. It is similar to the D. yeguaensis Weinzierl & Applin illustrated by Postuma (1971, p. 163). However, it differs in having a thinner wall and in the details of the initial chambers.

Dimensions of the figured specimen

Max. length = 0.39 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Genus Globigerinita Bronnimann, 1951, emend. Blow & Banner, 1962

Genotype: Globigerinita naparimaensis Bronnimann, 1951

Remarks

See remarks under the genus Globigerinita Bronnimann in the section dealing with the Miocene species.

Globigerinita turgida (Finlay), 1939?

Plate 16, figs. 5a-c

1939 Globigerina linaperta Finlay var. turgida Finlay, p. 125 (no figures).

1952 Globigerina turgida Finlay; Bronnimann, pp. 167-168. pl. 3, figs. 1-3.

1961 Globigerina turgida Finlay; Pessagno, p. 354, pl. 2, figs. 3-5.

1964 Globorotaloides turgida (Finlay); Jenkins, pp. 117-121, pl. 8, nos. 13a-c.

1972 *Globorotaloides turgida* (Finlay); Mckeel and Lipps, p. 85, pl. 1, figs. 4a-c.

1979 *Globigerinita turgida* (Finlay); Blow, p. 1348, pl. 79, figs. 6, 7.

Remarks

Finlay (1939) first described this species as *Globigerina linaperta* var. *turgida* without giving any figures. Bronnimann (1952) and subsequent workers considered this taxon as a distinct species. Jenkins (1964), re-described and, for the first time figured the holotype. In his paper, Jenkins (op. cit.) studied the ontogeny and noticed three stages of development, vis: *Globorotalia*, *Globigerina* and *Globigerinita*, and referred it to the genus *Globorotaloides* Bolli. Blow (1979) referred the species to the genus *Globigerinita* Bronnimann, 1951, emend. Blow and Banner, 1962, and proposed a *subbotinid* ancestor. In this thesis, *turgida* Finlay is provisionally placed in the genus *Globigerinita* since the holotype possesses bulla.

In the Nief Beds, *Globigerinita turgida* is distinguished by having a high trochospire, inflated chambers and a finely pitted wall. No bullae have been observed in these individuals. These specimens conform closely with the figure of *Globigerinita turgida* illustrated by Pessagno (1961) on plate 2, figs. 3-5.

Dimensions of the figured specimens

Pl. 16, figs. 5a-c

Max. diameter = 0.44 mm., 0.41, 0.48 (holotype = 0.65 mm).

Max. thickness = 0.32 mm (fig. 5b).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation given by Blow, (1979), it ranges from the base of zone P.10 to within the earlier part of zone P.12, Middle Eocene. He indicated a possible occurrence in the later part of zone P.12. (See Range Chart 2).

Paleocene Planktonic Foraminifera of The Nief Beds

Suborder Globigerinida Blow, 1979

Superfamily Globigerinacea Carpenter, Parker and Jones, 1862

Family Globorotaliidae Cushman, 1927, partim, emend. Blow, 1979

Subfamily Globorotaliinae Cushman, 1927, partim, emend. Blow, 1979

Genus Globorotalia Cushman, 1927, emend. Blow, 1979

Genotype Pulvinulina menardii (d'Orbigny) var. tumida Brady, 1877, by original designation (lectotype selected by Banner and Blow, 1960)

Remarks

See remarks under the genus Globorotalia Cushman in the section dealing with the Miocene species.

Subgenus Globorotalia (Acarinina) Subbotina, 1953, emend. Blow, 1979

Subgenotype: Acarinina acarinina Subbotina, 1953, by original designation.

Remarks

See remarks under the subgenus Globorotalia (Acarinina) Subbotin in the section dealing with the Eocene species.

Globorotalia (A) uncinata Bolli, 1957?

Plate 16, fig. 7; pl. 17, fig. 1

1957c Globorotalia uncinata Bolli, p. 74, pl. 17, figs. 13-15.

1960 Globorotalia uncinata Bolli; Hay, p. 72.

1964 Globorotalia uncinata Bolli; Luterbacher, p. 655, Figs. 30, 31.

1966 Globorotalia uncinata uncinata Bolli; El-Naggar, p. 240, pl. 18, figs. 1a-c; pl. 19, figs. 2a-c.

1971 Globorotalia uncinata Bolli; Postuma, p. 216, 217.

1978 Globorotalia uncinata Bolli; Toumarkine, p. 692 (Range Chart), pl. 1, fig. 16.

Remarks

According to Blow (1979), Globorotalia (A) uncinata uncinata (= G(A) praecursoria praecursoria Morozova sensu Blow, 1979), arose from the whole Pseudobulloides - inconstans plexus, rather than G(T) pseudobulloides as indicated by Bolli (1957c). According to Blow (op. cit.), this evolution occurs by the dorsal flattening of the chamber surfaces, the acquisition of recurved dorsal intercameral sutures and the spread of the muricae over the test. In primitive forms, the muricae are restricted to the initial chambers.

In the Nief Beds, a single, solid specimen of G(A) uncinata has been recognized. It is distinguished by 6½ chambers in the last volution, recurved intercameral sutures of the dorsal side in the earlier part of the last convolution, a pitted surface and slightly convex spiral side. Little can be seen from the ventral side owing to poor preservation, and the identification is tentative. However, it differs from the normal forms of this species in having a slightly convex spiral side, and a flattened final chamber of the last convolution. Typically, G(A) uncinata is characterized by dorsal flattening, notably in the earlier chambers of the last whorl which are succeeded by later inflated chambers.

Two specimens of G(A) uncinata were identified from the thin section. They are comparable to the thin section figure illustrated by Postuma (1971, p. 217). However, they differ in having less spinose surface, smaller umbilici and shorter lengths relative to the thickness as compared to Postuma's illustration.

Dimensions of the figured specimens

Pl. 16, figs. 7; pl. 17, fig. 1.
Max. diameter = 0.21 mm, 0.30 (holotype = 0.35 mm)
Max. diameter = 0.22 mm. (pl. 17, fig. 1).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Globorotalia (*A*) *uncinata* has been reported from the Paleocene in many parts of the world. Postuma (1971), gave the range throughout the *Globorotalia uncinata* zone and the lower part of the *Globorotalia angulata* zone, Paleocene. According to the "P/N" zonation by Blow (1979), it ranges from the base of zone P.2 to zone P.3 (early part of the Paleocene). (See Range Chart 2).

Subgenus *Globorotalia* (*Globorotalia*) Cushman, 1927, emend. Blow, 1979

Subgenotype: *Pulvinulina menardii* (d'Orbigny) var. *tumida*
Brady, 1877, by original designation

Remarks

See remarks under the subgenus *Globorotalia* (*Globorotalia*)

Cushman, 1927, emend. Blow, 1979, in the section dealing with the Miocene species.

Globorotalia (Globorotalia) ehrenbergi Bolli, 1957

Plate 17, figs. 2-4

1957c	Globorotalia ehrenbergi Bolli, p. 77, pl. 20, figs. 18-20.
1960a	Globorotalia ehrenbergi Bolli; Bolli and Cita, p. 382, pl. 35, figs. 4a-c.
1968	Planorotalites chapmani ehrenbergi (Bolli); McGowran, p. 196, pl. 4, fig. 12.
1971	Globorotalia ehrenbergi Bolli; Postuma, p. 188, 189.
1972	Planorotalites ehrenbergi (Bolli) & gr. ehrenbergi (Bolli); Vincent and Brun, pl. 1, figs. 5, 6.
1979	Globorotalia (Globorotalia) ehrenbergi Bolli; Blow, p. 888.

Remarks

Formerly, Globorotalia (G) ehrenbergi Bolli was included within Globorotalia membranacea (Ehrenberg) by various authors. Later, Bolli (1957c) described this form as a separate species. Bolli and Cita (1960a: in Berggren, 1962, p. 94) recognized that Globorotalia membrancea (Ehrenberg) comprises three species; Globorotalia ehrenbergi, Globorotalia pseudomenardii and Globorotalia compressa.

Globorotalia (G) ehrenberg is regarded as an intermediate stage within the G(T) compressa - G(G) pseudomenardii gens (Bolli, 1957C; Berggren, 1962; El-Naggar, 1966; Postuma, 1971; Samuel et al., 1972). According to Blow (1979, p. 888), G(G) pseudomenardii Bolli was derived from the plexus of forms referable to Globorotalia (T) haunsbergensis Gohrbandt, and that G(G) ehrenbergi represents the partially carinate, intermediate forms.

Globorotalia (T) chapmani Parr is similar to Globorotalia (G) ehrenbergi Bolli, but may be distinguished in having a concave early portion to the trochospire, and a perforate peripheral margin throughout the last convolution.

G(G) ehrenbergi has been identified only from the thin section in the Nief Beds. It is distinguished by the compressed chambers, the acute peripheral margin, the smooth surface and the slightly convex spiral side. Three sections were photographed and illustrated. The section on plate 17, fig. 2, shows a faint keel, which is usually present in the ultimate, or the ultimate and the penultimate chambers. This section, as well as the section on plate 17, fig. 4, shows some similarity with the figure illustrated by McGowran (1968) on plate 4, fig. 12. However, they differ slightly in the convexity of the spiral side, the shape of the chambers and the degree of the peripheral angularity. G(G) ehrenbergi as illustrated on plate 17, fig. 3, agrees well with the figure illustrated by Postuma (1971, page 189).

Dimensions of the figured specimens

Pl. 17, figs. 2-4.

Max. length = 0.48 mm, 0.29, 0.26 (holotype = 0.28).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(G) ehrenbergi has been reported from the Paleocene of Trinidad (Bolli, 1957c), Italy (Bolli and Cita, 1960a), Egypt (Said and Sabry, 1964), Iraq (Kassab, 1972) and West Carpathian (Samuel et al., 1972). According to the "P/N" zonation by Blow (1979), it ranges from the base of zone P.3 to zone P.4 (earlier to middle parts of the Paleocene). (See Range Chart 2).

Globorotalia (Globorotalia) pseudomenardii Bolli, 1957

Plate 17, figs. 5, 6

1957c	Globorotalia pseudomenardii Bolli, p. 77, pl. 20, figs. 14-17.
1962	Globorotalia (Globorotalia) pseudomenardii Bolli; Hillebrandt, pp. 126-127, pl. 12, figs. 5a-c; 6a-b.
1966	Globorotalia pseudomenardii Bolli; Belford, p. 10, pl. 1, figs. 13-23.
1968	Planorotalites pseudomenardii (Bolli); McGowran, pl. 4, figs. 5-9.
1971	Globorotalia (Planorotalites) pseudomenardii; Jenkins, p. 109, pl. 9, figs. 207-220.
1975	Globorotalia pseudomenardii Bolli; Stainforth et al., p. 217, Fig. 77.
1979	Globorotalia (Globorotalia) pseudomenardii Bolli; Blow, p. 892, pl. 89 figs. 1-5; pl. 94, figs. 1-5; pl. 105, figs. 3, 7-10; pl. 108, figs. 4-7; pl. 111, figs. 1-4; pl. 112, figs. 2, 3, 9, 10.

Remarks

Very few thin section specimens of Globorotalia (G) pseudomenardii were identified from the Paleocene part of the Nief Beds. It is distinguished by its biconvex test, compressed chambers and a faint keel. The figures illustrated on plate 17, figs. 5, 6 are similar to the illustrations by McGowran (1968) on plate 4. The flattening of the dorsal side is owing to the subaxial orientation of the sections which passes through the side of the trochospire.

Dimensions of the figured specimens

Pl. 17, figs. 5-6.

Max. diameter = 0.25 mm, 0.35 (holotype = 0.34).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(G) pseudomenardii has been reported widely from the Paleocene (Gartner & Hay, 1962; Berggren, 1965a; Bolli, 1957c; Bolli & Cita, 1960a; Jenkins, 1971; Krasheninnikov & Hoskins, 1973). According to the "P/N" zonation given by Blow (1979), the species ranges from the base of zone P.4 to within zone P.7 (Middle Paleocene to within the basal Early Eocene for the total group). (See Range Chart 2).

Globorotalia (Globorotalia) pusilla laevigata Bolli, 1957

Plate 17, fig. 7

1957c Globorotalia pusilla laevigata Bolli, p. 78, pl. 20, figs. 5-7.

1960 Globorotalia pusilla Bolli, var. laevigata Bolli; Bermudez, p. 1301.

1962 Globorotalia (?Globorotalia) pusilla laevigata Bolli; Hillebrandt, pp. 128-129, pl. 2, figs. 17 a,b.

1965 Globorotalia pusilla laevigata Bolli; McGowran, p. 63, pl. 6, fig. 4.

1971 Globorotalia (Planorotalites) laevigata Bolli; Jenkins, p. 108, pl. 10, figs. 247-249.

1971 Globorotalia laevigata Bolli; Postuma, p. 196, 197.

1973 Globorotalia laevigata Bolli; Krasheninnikov & Hoskins, p. 115, pl. 23, figs. 4-6.

Remarks

Globorotalia (G) pusilla laevigata Bolli is distinguished from Globorotalia (G) pusilla pusilla Bolli by its more circular outline, more acute axial periphery with a faint keel in the ultimate and the penultimate chambers, and by its spiral sutures not being depressed (Bolli, 1957c; Samanta, 1970a).

Blow (1979) regarded G(G) pusilla laevigata Bolli a junior synonym of G(G) albeari Cushman & Bermudez. The original illustrations by Cushman and Bermudez (1949) are hand drawings and hardly adequate for sure taxonomic differentiation. However, comparison of the description and illustrations of the holotypes of these two taxa, have revealed the similarity between them. Provisionally, the name G(G) pusilla Bolli is used in this thesis pending further investigation.

G(G) pusilla laevigata Bolli has been identified in thin sections. The test is biconvex, compressed, with low trochospire. A faint keel is present on one side of the section, while the other side is less angular. These specimens resemble the figure of G. laevigata illustrated by Postuma (1971, p. 197). However, Postuma's illustration shows a thicker and more nodose wall.

Dimensions of the figured specimens

Max. diameter = 0.21 mm (holotype = 0.28 mm)

Max. thickness = 0.11 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

The majority of published papers have reported *G*(*G*) *pusilla laevigata* from the Paleocene. Very few workers have extended the range into the Lower Eocene (cf. Jenkins, 1971; Said & Sabry, 1964). According to the "P/N" zonation given by Blow (1979), the subspecies ranges probably from the latest part of zone P.3, to the end of zone P.6 and possibly into the earlier part of zone P.7, essentially it ranges through the middle to later parts of the Paleocene, but may occur in earliest Early Eocene horizons. (See Range Chart 2).

Subgenus *Globorotalia* (*Morozovella*) McGowran, 1964 emend. Blow, 1979

Subgenotype: *Pulvinulina velascoensis* Cushman, 1925,
by original designation

Remarks

See remarks under the Subgenus *Globorotalia* (*Morozovella*) McGowran, 1964, emend. Blow, 1979, in the section dealing with the Eocene species.

Globorotalia (*M*) *aequa* Cushman & Renz, 1942

Plate 12, figs. 1a-c, 2

Remarks

See remarks under *G*(*M*) *aequa* Cushman & Renz in the section dealing with the Eocene species.

Globorotalia (*M*) *angulata angulata* (White), 1928

Plate 17, figs. 8a-c, 9

1928 *Globigerina angulata* White, pp. 191-192, pl. 27, figs. 13a-c.

1957c *Globorotalia angulata* (White); Bolli, p. 74, pl. 17, figs. 7-9.

1961 *Globorotalia* (*Truncorotalia*) *angulata* (White); Leonov and Alimarina, pl. 5, figs. 2a-c, 7a-c.

1963 *Truncorotalia angulata angulata* (White); Gohrbandt, p. 57, pl. 4, figs. 4-6.

1968 *Truncorotaloides* (*Morozovella*) *angulatus* (White); McGowran, pl. 1, figs. 13-18.

1971 *Globorotalia* (*Morozovella*) *angulata* (White); Jenkins, p. 102, pl. 8, figs. 183-185.

1972 *Morozovella angulata* (White); Vincent & Brunn, pl. 1, fig. 9.

1975 *Globorotalia angulata* (White); Stainforth et al., p. 167, Fig. 34.

1979 *Globorotalia* (*Morozovella*) *angulata angulata* (White); Blow, p. 984, pl. 86, fig. 9; pl. 87; fig. 1.

Remarks

Published accounts of *G*(*M*) *angulata* (White), indicate its morphological variability. According to Luterbacher (1964), the variable characters are the number of chambers in the last whorl, the size of the last chamber and the distribution of the spinosity.

G(M) angulata angulata has been identified from both the matrix free specimens and in the thin sections. The matrix free specimens are characterized by 4-5 chambers in the last whorl, the last chamber is smaller than the penultimate, the surface of the test is muricate, and the peripheral muricae are concentrated and fused to form a peripheral muricocarina. The tests are plano-convex with small umbilici. These specimens are in a close agreement with the figures given by Bolli (1957C, pl. 17, figs. 7-9). However, the individuals from the Nief Beds have coarser muricae and smaller final chambers as seen umbilically.

The thin section specimens are similar to the figures given by Vincent and Brunn (1972, pl. 1, fig. 9).

Dimensions of the figured specimens

Pl. 17, figs. 8a-c, 9

Max. diameter = 0.39 mm., 0.48, 0.38, 0.25 (holotype = 0.35).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Published accounts have indicated that G(M) angulata angulata (White) is a reliable index for the Paleocene. Postuma (1971), gave the range as throughout the Globorotalia angulata zone, with questionable occurrences in the upper part of the Globorotalia uncinata zone (Paleocene). According to Bolli (1966), the species ranges from the

G. angulata to the G. pusilla pusilla zone (Paleocene). The species was recorded from within the upper Lower Paleocene to the Upper Paleocene of Italy (Bolli and Cita, 1960a), Egypt (Said and Sabry, 1964; El-Naggar, 1966), West Florida (Applin and Jackson, 1964), the West Coast of Africa (Toumarkine, 1978) and Iraq (Kassab, 1972). According to Blow (1979), G(G) angulata ranges from the base of zone P.3 throughout zone P.4 and into the earlier parts of zone P.5, i.e. Earlier Paleocene through the later, Lower Thanetian to the Lower Londinian. (See Range Chart 2).

Globorotalia (M) angulata conicotruncana Subbotina, 1947

Plate 17, figs. 10a-c

1947 Globorotalia conicotruncana Subbotina, p. 115, pl. 4, figs. 11-13.

1957c Globorotalia angulata abundocamerata Bolli, p. 74, pl. 17, figs. 4-6.

1960 Pseudogloborotalia angulata (White), var. abundocamerata (Bolli); Bermudez, p. 1338.

1963 Truncorotalia angulata abundocamerata (Bolli); Gohrbandt, p. 58, pl. 4, figs. 7-9.

1964 Globorotalia conicotruncana Subbotina; Luterbacher, p. 660, figs. 40-42, 46-51.

1971 Globorotalia abundocamerata Bolli; Postuma, p. 166, 167.

1975 Globorotalia conicotruncana Subbotina; Stainforth et al., p. 178, fig. 44.

1979 Globorotalia (Morozovella) angulata conicotruncana Subbotina; Blow, p. 986, pl. 87, fig. 3.

Remarks

There is no significant difference between the type figures of G. angulata abundocamerata Bolli, and G. conicotruncana Subbotina, and the former is regarded here to be a junior synonym of the latter.

In the Nief Beds, G(M) angulata conicotruncana has been identified from one sample. Individuals are characterized by a plano-convex tests and 6-8 chambers in the last convolution, increasing slowly in size as added. Their surfaces are covered by muricae, which concentrate in the peripheral parts to form a peripheral muricocarinae. The umbilici are small and surrounded by the umbilical shoulders of the chambers. The intercameral sutures are almost radial between the last 3 chambers but are arcuate between the initial chambers of the final whorl. Specimens closely resemble Globorotalia conicotruncana as illustrated by Luterbacher (1964, Fig. 46a).

Dimensions of the figured specimens

Pl. 17, figs. 10a-c.

Max. diameter = 0.58 mm., 0.53, 0.51.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Stainforth et al. (1975) gave the range as from within G. angulata zone to within the G. pseudomenardii zone (Middle to Late Paleocene). According to the "P/N" zonation given by Blow (1979) G(M) angulata conicotruncana ranges from about the middle part of zone P.3 to zone P.4, but may extend into the earlier part of zone P.5, Paleocene. (See Range Chart 2).

Globorotalia (*Morozovella*) *velascoensis* (Cushman), 1925

Plate 17, fig. 11; Plate 18, figs. 1a-b

1925b *Pulvinulina velascoensis* Cushman, p. 19, pl. 3, figs. 5a-c.

1927b *Globorotalia velascoensis* (Cushman), p. 169, pl. 27, figs. 7-9.

1949 *Globorotalia* (*Turborotalia*) *velascoensis* (Cushman); Cushman & Bermudez, p. 41, pl. 8, figs. 4-6.

1956 *Truncorotalia velascoensis* (Cushman); Said and Kenawy, p. 152, pl. 6, fig. 4.

1957a *Globorotalia velascoensis* (Cushman); Loeblich and Tappan, p. 196, pl. 64, figs. 1, 2.

1960 *Pseudogloborotalia velascoensis* (Cushman); Bermudez, p. 1349, pl. 16, figs. 11a-b.

1962 *Globorotalia* (*Turborotalia*) *velascoensis velascoensis* (Cushman); Hillebrandt, p. 139, pl. 13, figs. 16-21.

1964 *Globorotalia velascoensis* (Cushman); Luterbacher, p. 681, figs. 92-94, 98-99.

1966 *Globorotalia velascoensis velascoensis* (Cushman); El-Naggar, p. 246, pl. 20, figs. 3a-d; pl. 21, fig. 3.

1968 *Truncorotaloides* (*Morozovella*) *Velascoensis* (Cushman); Mc Gowran, pl. 2, fig. 1.

1971 *Globorotalia* (*Morozovella*) *velascoensis* (Cushman); Jenkins, p. 107, pl. 9, figs. 214-216.

1975 *Globorotalia velascoensis* (Cushman); Stainforth et al., p. 240, Fig. 97.

1978 *Morzovella velascoensis* (Cushman); Hofker, p. 70, pl. 8, fig. 8.

1979 *Globorotalia velascoensis velascoensis* (Cushman); Blow, p. 1027, pl. 92, fig. 7; pl. 94, figs. 6-9; pl. 95, figs. 1, 2; pl. 99, figs. 3, 4; pl. 216, figs. 1-8; pl. 217, figs. 1-6.

Remarks

Globorotalia (M) velascoensis is a variable species. Variations in this species as noted from the published literature are in: the size of the test, the number of chambers in the final whorl, the width of the umbilicus and the intensity of the murication.

In the Nief Beds, G(M) velascoensis (Cushman) has been recognized from the matrix free specimens and in thin section. The free specimens are characterized by their plano-convex tests with a slightly concave spiral side surrounding a slightly elevated central part, and 6-7 chambers in the last volution. Sutures on the ventral side are almost radial, and curved, pseudolimbate on the dorsal side. The equitorial periphery is subcircular and lobulate with a peripheral muricocarina. The wall is covered by muricae and the umbilical chamber tips are covered by a partially fused conglomeration of muricae, notably in the early chambers (see pl. 18, fig. 1b). These specimens are in accord with the diagnosis and illustration of G(M) velascoensis shown by Bolli (1957c, p. 76, pl. 20, figs. 1-3). However, the limbate nature of the spiral sutures is not clear in the individuals from Seram owing to the bad preservation. The thin section specimens are similar to the figures illustrated by McGowran (1968), on plate 2, fig. 1.

Dimensions of the figured specimens

Pl. 17, fig. 11; pl. 18, 1a-b.

Max. diameter = 0.55 mm, 0.59, 0.44 (holotype = 0.65 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(M) velascoensis is known from the Upper Paleocene of many parts of the world. A Late Paleocene range (G. pseudomenardii and G. velascoensis zones) was given by Stainforth et al. (1975). According to the "P/N" zonation by Blow (1979), it ranges from zone P.4 to zone P.6 (Middle to Late Paleocene). (See Range Chart 2).

Subgenus Globorotalia (Turborotalia) Cushman & Bermudez, 1949, emend. Blow, 1979

Subgenotype: Globorotalia centralis Cushman & Bermudez, 1937
by original designation.

Remarks

See remarks under Globorotalia (Turborotalia) Cushman & Bermudez in the section dealing with the Miocene species.

Globorotalia (T) chapmani parr, 1938

Plate 18, fig. 2.

1938 Globorotalia chapmani Parr, p. 87.

1964 Globorotalia chapmani Parr; McGowran, p. 85, pl. 1, figs. 1-9.

1967 Globorotalia chapmani Parr; Berggren, Olsson and Reyment, p. 277, pl. 1, figs. 1-6; text-fig. 1; text-fig. 3, figs. 1a-c; text-fig. 4, figs. 1a-c.

1968 Planorotalites chapmani (Parr); McGowran, pl. 4, figs. 13-18, 21.

1979 Globorotalia (T) chapmani Parr; Blow, p. 1059, pl. 106, fig. 1; pl. 116, figs. 1-5 (sensu Berggren, Olsson and Reyment, 1967).

Remarks

Globorotalia (G) elongata Glaessner differs from Globorotalia (T) chapmani Parr basically in having a biconvex test, a peripheral carina and truely limbate intercameral sutures for some of the later chambers. Accordingly, some of the forms of G(G) elongata, illustrated by Bolli, (1957c) and Loeblich & Tappan (1957a) are referred here to G(T) chapmani. Furthermore, the paratyoes of Globorotalia troelseni Loeblich & Tappan, have the same diagnosis as G(T) chapmani and regarded here to be synonymous with the latter.

In the Nief Beds, G(T) chapmani, Parr, has been identified from one sample in which it is rare. It is characterized by its compressed chambers lacking carinae, and compressed spiral side. The last characteristic is used for the separation of this species from G(G) ehrenbergi Bolli. G(T) chapmani from the Nief Beds conforms very well with the figure illustrated by McGowran (1968) on plate 4, no. 13.

Dimensions of the figured specimen

Max. diameter = 0.37 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979), *G*(*T*) *chapmani* ranges from the base of zone P.5 to the top of zone P.7 (Later Paleocene to basal Early Eocene). (See Range Chart 2).

Globorotalia (*T*) *compressa* (Plummer), 1926

Plate 18, figs. 3a-b, 4, 5

1926 *Globigerina compressa* Plummer, p. 135, pl. 8, fig. 8.

1952 *Globorotalia compressa* (Plummer); Bronnimann, p. 25, pl. 2, figs. 19-24.

1957c *Globorotalia compressa* (Plummer); Bolli, p. 77, pl. 20, figs. 21-23.

1962 *Globorotalia* (*T*) *compressa* (Plummer); Berggren, p. 94, pl. 14, figs. 5a-c; text-figs. 13, nos. 1-6.

1962 *Globorotalia* (*Globorotalia*) *compressa* (Plummer); Hillebrandt, pp. 125-126, pl. 12, figs. 1a-c.

1963 *Globigerina compressa* Plummer; Bronnimann & Rigassi, pl. 19, figs. 4a-c.

1968 *Planorotalites compressus* (Plummer); McGowran, pl. 4, nos. 10-11.

1975 *Globorotalia compressa* (Plummer); Stainforth et al., p. 178, fig. 43.

1979 *Globorotalia* (*Turborotalia*) *compressa compressa* (Plummer); Blow, p. 1062, pl. 75, figs. 10 & 11; pl. 78, figs. 5-10; pl. 233, figs. 1-3; pl. 248, figs. 1-3; pl. 254, figs. 1-3; pl. 257, figs. 5-7.

Remarks

Globorotalia (*T*) *compressa* (Plummer) is distinguished from *Globorotalia* (*T*) *pseudobulloides* (Plummer) by its smaller test, compressed chambers and more finely perforated wall (Loeblich and Tappan, 1957a; Berggren, 1962).

Since *G*(*T*) *haunsbergensis* Gohrbandt and *G*(*T*) *compressa* (Plummer) are linked by intermediate forms which are difficult to assign to either, and since no distinction can be made between these two species in thin section, G(T) haunsbergensis is provisionally and subspecifically referred to G(T) compressa s.l. (See Blow, 1979, pp. 1062-1075).

G(T) compressa (Plummer) has been identified from the solid specimens as well as the thin section from the Nief Beds. The specimens display a rounded peripheral margin. Furthermore, the matrix free specimens are characterized by a lax coiling mode and rapidly enlarging chambers in the final convolution. The latter characteristic is well illustrated on the figures and diagnosis of G(T) haunsbergensis presented by Blow (1979, p. 1075, pl. 88, figs. 6, 8, 9). A similar form was illustrated by Stainforth et al. (1975) on Fig. 43, no. 6a as Globorotalia compressa (Plummer).

Two thin section specimens of G(T) compressa have been photographed and illustrated. These show the range of variation within the population of this species. The specimen on pl. 18, fig. 4, is comparable with the figure of Globorotalia compressa illustrated by Postuma (1971, p. 187). The specimen on plate 18, fig. 5 is similar to the figure of "planorotalites compressus" (Plummer) illustrated by McGowran (1968, pl. 4, fig. 10). However, it differs in having a lower trochospire which may be related to the orientation of the section.

Dimensions of the figured specimens

Pl. 18, figs. 3a-b, 4, 5.

Max. diameter = 0.37 mm, 0.35, 0.24, 0.29 (holotype = 0.28).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to the "P/N" zonation by Blow (1979), Globorotalia compressa s.l. ranges from the upper part of zone P.α to the lower part of zone P.4 (Lower Danian s.l. to the Middle Thanetian s.l.). However, G(T) compressa compressa alone ranges from the lower part of zone P.1b to the lowermost part of zone P.4 (lowermost part of the Danian s.s. to the Middle Thanetian s.s.). According to this zonation G(T) haunsbergensis ranges from the middle part of zone P.2 to the upper part of zone P.4. (See Range Chart 2).

Globorotalia (T) sp. cf. inconstans (Subbotina), 1953

Plate 18, fig. 6

cf. 1972 Morozovella inconstans (Subbotina); Vincent and Brun, pl. 2, fig. 10.

Remarks

Globorotalia (T) sp. cf. inconstans (Subbotina) has been identified from thin section from the Nief Beds. The main diagnostic characteristics of this form are the flattened dorsal surface and the inflated, almost smooth chambers. The diagnosis conforms with the figure of the thin section illustrated by Vincent and Brun (1972, pl. 2, fig. 10). However, it differs from Vincent's illustration in having thinner walls, a smaller umbilicus and a less spinose surface.

Dimensions of the figured specimen

Max. diameter = 0.32 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Globorotalia (T) pseudobulloides (Plummer), 1926

Plate 18, figs. 7a-c, 8

1926 Globigerina pseudobulloides Plummer, pp. 133-134, pl. 8, figs. 9a-c.

1957c Globorotalia pseudobulloides (Plummer); Bolli, p. 73, pl. 17, figs. 19-21.

1960a Globigerina pseudobulloides Plummer; Hofker, p. 77, text - figs. 17-20, 22, 23, 36-38.

1962 Globorotalia (Turborotalia) pseudobulloides, Berggren p. 88, pl. 14, figs. 3a-4c; text-fig. 12, nos. 1a-7b.

1963 Globigerina pseudobulloides pseudobulloides Plummer; Gohrbandt, p. 44, pl. 1, figs. 7-9.

1966 Globorotalia pseudobulloides (Plummer); El-Naggar, p. 224, pl. 18, figs. 3a-c.

1968 Subbotina pseudobulloides (Plummer); McGowran, pl. 3, figs. 17, 18.

1971a Subbotina pseudobulloides (Plummer); Berggren, pl. 4, figs. 3-5.

1971 Globorotalia pseudobulloides (Plummer); Postuma, p. 202, 203.

1978 Globorotalia pseudobulloides (Plummer); Toumarkine, pp. 679-721, pl. 1, figs. 1, 2.

1979 Globorotalia (T) pseudobulloides (Plummer); Blow, p. 1096, pl. 69, figs. 2, 3; pl. 71, figs. 4, 5; pl. 75, figs. 2, 3; pl. 248, figs. 6-8; pl. 255, figs. 1-6.

Remarks

Blow (1979, p. 1100) considered G(T) pseudobulloides as the ancestral form of G(T) quadrilocula Blow, 1979

(= *G*. *quadrata* (White) of Bolli, 1957c, pl. 17, figs. 22-24, non White, 1928). El-Naggar (1966, p. 227 and text-fig. 15) indicated the possibility of muitidirectional evolution in *G*(*T*) *pseudobulloides*, leading to *G*(*T*) *compressa* (Plummer), *G*. *imitata* Subbotina, *G*. *quadrata* (White) and *G*(*T*) *trinidadensis* Bolli. Transitional forms between *G*(*T*) *pseudobulloides* and *G*(*T*) *trinidadensis* occur in the samples from the Nief Beds.

Typical forms of *G*(*T*) *pseudobulloides*, both from solid specimens and thin sections, have been photographed and illustrated. They are distinguished by their low trochospire tests, their 4½ subglobular chambers in the last volution, gradually increasing in size, their ultimate chambers which are slightly larger than the penultimate ones, their subquadrate to slightly elongate peripheral test profiles and lobulate peripheries. The apertural system is completely obscured owing to adherent matrix. These specimens are comparable with the figures given by Loeblich and Tappan (1957a, pl. 41, figs. 1a-b). The thin section of this species closely resembles the illustration given by Postuma (1971, p. 203).

Dimensions of the figured specimens

Pl. 18, figs. 7a-c, 8.

Max. diameter = 0.7 mm, 0.6, 0.59, 0.48.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(T) pseudobulloides has been recorded from within the Lower to Middle Paleocene in Texas (Plummer, 1926; Loeblich and Tappan, 1957b), Trinidad (Bolli, 1957c), Denmark (Troelsen, 1957; Berggren, 1962; Hofker, 1960a), Italy (Bolli & Cita, 1960a), Puerto Rico (Pessagno, 1960), the Central Carpathians of East Slovakia (Samuel et al., 1968; Samuel et al., 1972), Egypt (El-Naggar, 1966) and England (Haynes, 1955). It has been recorded throughout most of the Paleocene in Belgium (Moorkens, 1970) and India (Samanta, 1970a). According to the "P/N" zonation given by Blow (1979), the species ranges from the base of zone P.1 to near the top of zone P.3. He also stated that some very rarely occurring specimens, not fully typical of G. pseudobulloides, appear to occur within the latest parts of zone P.3 and doubtfully within the earlier part of zone P.4 (Early to approximately Middle Paleocene). (See Range Chart 2).

Globorotalia (T) trinidadensis Bolli, 1957

Plate 18, figs. 9a-b, 10?

1957c	Globorotalia trinidadensis Bolli, p. 73, pl. 16, figs. 19-22. Not fig. 23.
1963	Globigerina trinidadensis (Bolli); Gohrbandt, pp. 45-46, pl. 1, figs. 13-15.
1964	Globorotalia trinidadensis Bolli; Luterbacher, pp. 651-652, Figs. 26-29.
1968	Turborotalia (Acarinina) trinidadensis (Bolli, 1957); Samuel and Salaj, p. 174, pl. 13, figs. 1a-c, 2.
1978	Subbotina trinidadensis Bolli; Hofker (part), p. 61, pl. 4, figs. 10, 15, 16; pl. 5, figs. 1-14; pl. 6, figs. 1-12; pl. 7, figs. 12-21.
1978	Globorotalia trinidadensis Bolli; Toumarkine, p. 692, (Range Chart), pl. 1, figs. 9-11.

Remarks

Globorotalia (T) trinidadensis is similar to the Globorotalia (T) inconstans (Subbotina) from which it differs in having more chambers in the last volution, a more flattened or even depressed spiral side and a smoother surface. Blow (1979) followed Leonov and Alimarina (1961, in Blow, 1979) in considering G(T) trinidadensis a junior synonym of G(T) inconstans.

G(T) trinidadensis has been identified both amongst the matrix free specimens and in thin section. The free specimens are characterized by a faint rugose surface, a flat to slightly depressed spiral side, usually five chambers in the volution increasing gradually in size, and the almost equal sizes of the ultimate and penultimate chambers. They are similar to the holotype illustrated by Bolli (1957C, pl. 16, fig. 19). However, the individuals from the Nief Beds have less incised dorsal and ventral sutures. This may be related to the state of preservation. Thin section specimens are comparable with the figure given by Hofker (1978, pl. 7, fig. 12). However, it differs from the holotype in having a very small test.

Dimensions of the figured specimens

Pl. 18, figs. 9a-b, 10.

Max. diameter = 0.41 mm., 0.34, 0.19 (type specimens 0.40 - 0.41).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

G(T) trinidadensis is a widespread species in the Danian and Montian. According to Bolli (1966), it ranges from the Globorotalia trinidadensis zone to the middle part of the Globorotalia uncinata zone (Lower and Middle Paleocene). Blow (1979), gave the range of G(T) inconstans (= G(T) trinidadensis sensu Blow, 1979) as from the base of subzone P.1b to the top of zone P.2 (Danian to ? basal Thanetian s.l., Paleocene). This range is similar to the total recorded ranges by various authors. (See Range Chart 2).

Ex Interc. G(T) trinidadensis/inconstans plexus and G(A) uncinata Bolli

Plate 19, figs. 1a-c

1957c Ex Interc Globorotalia uncinata Bolli and Globorotalia pseudobulloides Plummer; Bolli, pl. 17, figs. 16-18.

Remarks

Ex Interc G(T) trinidadensis/inconstans plexus and G(A) uncinata has been recognized from the Nief Beds. Slightly recurved intercameral sutures have been observed in the initial part of the last convolution. This form is similar to Ex Interc G. uncinata and G. pseudobulloides illustrated by Bolli (1957c, pl. 17, figs. 16-18).

According to Berggren (1965b), Bolli's form is related to G(T) inconstans (Subbotina), while Hofker (1978) and Blow (1979) referred it to G(A) praecursoria praecursoria (Morozova) (= G(A) uncinata uncinata Bolli sensu Blow, 1979).

Dimensions of the figured specimens

Pl. 19, figs. 1a-c

Max. diameter = 0.18 mm, 0.14, 0.18

Abundance, distribution, faunal association, and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Family Globigerapsidae Blow, 1979

Genus Muricoglobigerina Blow, 1979

Genotype: Globigerina soldadoensis Bronnimann, 195

Remarks

See remarks under the genus Muricoglobigerina Blow, in the section dealing with the Eocene species.

Muricoglobigerina mckannai (White), 1928?

Plate 19, fig. 2

1928 Globigerina mckannai White, p. 194, pl. 27, figs. 16a-c.

1957c Globorotalia mckannai (White); Bolli, p. 79, pl. 19, figs. 16-18.

1960 Globigerina mckannai White; Berggren, p. 68.

1962 Globorotalia mckannai (White); Gartner and Hay, p. 564.

1966 Globigerina mckannai White; Belford, p. 9.

1967 Acarinina mckannai (White); Gohrbandt, p. 72, pl. 1, figs. 16-18, 22-27.

1968 Truncorotaloides (Acarinina) mckannai (White); McGowran, pl. 3, figs. 7-10.

1971 Globorotalia (Acarinina) mckannai (White); Jenkins, p. 82.

1971 Globorotalia mckannai (White); Postuma, p. 200, 201.

1979 Muricoglobigerina mckannai (White); Blow, p. 1129, pl. 93, fig. 5.

Remarks

In the Nief Beds, Muricoglobigerina mckannai (White)? was identified from the thin section only. Two forms of the species have been recognized. Some, with small tests and low trochospires, are very badly preserved, and are not illustrated here. They agree with the illustration of the thin section given by McGowran (1968, pl. 3, fig. 7) and Postuma (1971, p. 201). The other specimens (pl. 19, fig. 2), exhibit a large test with high trochospire. These are similar to the figure illustrated by McGowran (1968) on plate 3, figs. 8-10. Similar variations in the size and the height of the test have been recorded by Gohrbandt (1963, 1967).

Dimensions of the figured specimens

Diameter = 0.65 mm (holotype = 0.40 mm)
Height = 0.5 mm (holotype = 0.3 mm)
Thickness of the wall = 0.05 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

According to Berggren (1971b), Muricoglobigerina mckannai is restricted to the Upper Paleocene. Postuma (1971), has reported its occurrence in the Globorotalia pseudomenardii zone, Upper Paleocene. According to the "P/N" zonation by Blow (1979), it ranges from P.4 to the end of P.5 (Upper Paleocene). (See Range Chart 2).

Family Eoglobigerinidae Blow, 1979

Genus Eoglobigerina Morozova, 1959, emend. Blow, 1979

Genotype: Globigerina (Eoglobigerina) eobulloides
Morozova, 1959, by original designation.

Remarks

Originally, Morozova (1959) described this taxon as a subgenus of Globigerina d'Orbigny. Loeblich and Tappan (1964), placed it in the synonymy of Globorotaloides Bolli, 1957. Blow (1979), emended the diagnosis of Eoglobigerina, elevating it to generic level and this is followed here.

Eoglobigerina Morozova, emend. Blow, 1979 is separated from Globigerina d'Orbigny, emend. Blow, 1979 in having asymmetrical umbilica-extraumbilical apertures and a weakly developed porticus. It differs from Globorotaloides Bolli mainly in having a primary aperture which does not show any change of position during ontogeny, and the consistent abscence of bullae. The writer could not find any clear cut difference between this genus and Subbotina Brotzen & Pozarysk, 1961, emend. Loeblich and Tappan, 1964, emend. Blow, 1979. According to Blow (1979), Eoglobigerina differs from the latter genus in having weak porticus, less asymmetrica anterior extension of the apertural system and a small sized test. On this basis, Eoglobigerina is regarded as a primitive taxon restricted to the earlier horizons of the Paleogene period, and gives rise to forms included in the genus Subbotina Brotzen & Pozaryska, emend. Blow, 1979.

Eoglobigerina aff. spiralis (Bolli), 1957

Plate 19, fig. 3

1957c Globigerina spiralis Bolli, p. 70, pl. 16, figs. 16-18.

1979 Eoglobigerina spiralis (Bolli); Blow, p. 1222, pl. 79, figs. 5-9.

Remarks

Muricoglobigerina aquiensis (Loeblich & Tappan), shows a morphological similarity to Eoglobigerina spiralis (Bolli). The first species differs from the latter in having fewer chambers, a smaller test, a somewhat lower trochospire and more strongly developed surface ornamentation (Berggren, 1960).

Eoglobigerina aff. spiralis in the Nief Beds is identified from a crushed residue and in thin section. The matrix free specimens are very badly preserved, and are not illustrated here. They are similar to "Globigerina" spiralis illustrated by Bolli (1957C, pl. 16, figs. 16-18). The thin section specimen from the Nief Beds is comparable with the figure of "Globigerina" aqueinsis Loeblich & Tappan illustrated by Samuel, Borza and Köhler (1972, pl. 62, fig. 13), but it differs in being larger in size.

Dimensions of the figured specimen

Max. diameter = 0.39 mm (holotype = 0.28)

Max. height = 0.31 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

In Trinidad, Eoglobigerina spiralis is restricted to the Globorotalia uncinata zone, Lower Paleocene (Bolli, 1957c). According to the "P/N" zonation by Blow (1979), it ranges from the base of zone P.2 to within the earlier part of zone P.3 (Later Danian s.l. to Early Thanetian s.l.). (See Range Chart 2).

Genus Subbotina Brotzen & Pozaryska, 1961, emend. Loeblich and Tappan, 1964, emend. Blow, 1979

Genotype: "Globigerina" triloculinoides Plummer, 1926, by original designation

Remarks

See remarks under the genus Subbotina Brotzen & Pozaryska, in the section dealing with the Eocene species.

Subbotina Linaperta (Finlay), 1939

Plate 15, figs. 7a-c, 8

Remarks

See remarks under Subbotina linaperta (Finlay) in the section dealing with the Eocene species.

Subbotina triangularis triangularis (White), 1928

Plate 16, figs. 1a-c

Remarks

See remarks under the genus Subbotina triangularis triangularis (White) in the section dealing with the Eocene species.

Subbotina triloculinoides (Plummer), 1926

Plate 19, figs. 4a-c, 5

1926	Globigerina triloculinoides Plummer, pp. 134-135, pl. 8, figs. 10a-c.
1957	Globigerina triloculinoides Plummer; Troelsen, p. 129, pl. 30, fig. 4.
1966	Subbotina triloculinoides (Plummer); Belford, p. 7, pl. 1, figs. 1-5.
1968	Subbotina triloculinoides (Plummer); McGowran, pl. 3, fig. 13.
1970	Globigerina triloculinoides Plummer; Moorkens, p. 860, pl. 4, figs. 1a-d, figs. 3a-b.
1978	Globigerina triloculinoides Plummer; Toumarkine, pp. 679-721, pl. 1, figs. 3-5.
1979	Subbotina triloculinoides triloculinoides (Plummer); Blow, p. 1287.

Remarks

Subbotina triloculinoides (Plummer) exhibits a wide range of variation and graduation within its population at any locality. This results in uncertainty, conflicting views and disagreement concerning the specific limit of this species (cf. Bronnimann, 1952; Loeblich & Tppan, 1957a; Berggren, 1964; El-Naggar, 1966; Samanta, 1970a; Jenkins, 1971).

Subbotina triloculinoides (Plummer) is very close to the Subbotina linaperta (Finlay). The former differs from the latter mostly in having a smaller tests and inflated chambers. In the Nief Beds, the size of the test is not a reliable criterion for the separation of these two species.

The individuals of Subbotina triloculinoides (Plummer) from the Nief Beds have been recognized both amongst the matrix free specimens and in thin sections. The matrix free specimens have 3 to 3½ globular inflated chambers in the final convolution, rapidly increasing in size, and the final chamber occupies half the size of the test. These chambers have a tripartite appearance as seen from the umbilical side. The wall surface is pitted with a funnel-shaped pores. The aperture is asymmetrical umbilica-extraumbilical type covered by a porticus (sensu Blow, 1979). These specimens are in accord with the diagnosis and illustration of "Globigerina" triloculinoides described by Postuma (1971, p. 160, 161). The thin section specimens conform with the figure of Subbotina triloculinoides illustrated by McGowran (1968, pl. 3, fig. 13) although it is much smaller.

Dimensions of the figured specimens

Pl. 19, figs. 4a-c, 5.

Max. length = 0.35 mm, 0.41, 0.43, 0.30.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Subbotina triloculinoides is known from the Paleocene of many parts of the world. Very few workers have extended the range into the Lower Eocene (cf. Jenkins, 1971; Boersma, 1977). According to the "P/N" zonation by Blow (1979), it ranges from the later part of zone P.1 (subzone P.1b) to the top of zone P.6 (Danian to the Londinian). (See Range Chart 2).

Subbotina velascoensis Cushman, 1925

Plate 19, figs. 6a-c

1925b	*Globigerina velascoensis* Cushman, p. 19, pl. 3, fig. 6.
1957C	*Globigerina velascoensis* Cushman; Bolli, p. 71, pl. 15, figs. 9-11.
1960a	*Globigerina velascoensis* Cushman; Bolli & Cita, p. 374, pl. 34, figs. 8a-c.
1964	*Globigerina velascoensis* Cushman; Applin and Jackson, p. 66, pl. 3, figs. 3, 4.
1966	*Globigerina velascoensis* Cushman; El-Naggar, p. 183, pl. 16, figs. 3a-d.
1967	*Globigerina velascoensis* Cushman; Gohrbandt, pl. 1, figs. 34-39.
1979	*Subbotina velascoensis* (Cushman) sensu Bolli, 1957; Blow, p. 1292, pl. 98, fig. 9.

Remarks

Subbotina velascoensis (Cushman) somewhat resembles *Subbotina triloculinoides* (Plummer). According to Applin and Jackson (1964), and Gohrbandt (1967), the laterally compressed chambers and the compact test are the main morphological features distinguishing the former from the latter.

The individuals of *Subbotina velascoensis* from the Nief Beds are characterized by a compact and quadrate equitorial profile of the test, and a strong radial compression and appression of the later chambers. They agree closely with "*Globigerina*" *velascoensis* as illustrated by Bolli and Cita (1960a, pl. 34, figs. 8a-c).

Dimensions of the figured specimens

Pl. 19, figs. 6a-c

Max. length = 0.31 mm, 0.32, 0.38.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 3 & 4.

Known range

Subbotina velascoensis has been reported widely from the Upper Paleocene in many parts of the world. According to the "P/N" zonation by Blow (1979), it ranges from zone P.4 to the top of zone P.6 (mainly later parts of the Paleocene). (See Range Chart 2).

Upper Cretaceous Planktonic Foraminifera of The Nief Beds

Suborder *Rotaliina* Delage & Herouard, 1896

Superfamily *Globigerinacea* Carpenter, Parker & Jones, 1862

Family *Abathomphalidae* Pessagno, 1967

Genus *Globotruncanella* Reiss, 1957, emend. Pessagno, 1967

Genotype: *Globortuncana citae* Bolli, 1951 (= *Globotruncana havanensis* Voorwijk, 1937)

Globotruncanella havanensis (Voorwijk), 1937

Plate 19, figs. 7-9

1937 *Globotruncana havanensis* Voorwijk, p. 195, pl. 1, figs. 25, 26, 29.

1951 *Globotruncana citae* Bolli, p. 197, pl. 35, figs. 4-6.

1955 *Globotruncana citae* Bolli; Gandolfi, p. 51, pl. 3, figs. 11a-c.

1956 *Rugotruncana havanensis* (Voorwijk); Bronnimann and Brown, p. 552, pl. 22, figs. 4-6; pl. 24, fig. 10.

1956b *Marginotruncana citae* (Bolli); Hofker, p. 334, text - fig. 25.

1957 *Globotruncana (Globotruncana) citae* Bolli; Edgell, p. 111, pl. 1, figs. 13-15.

1960 *Globotruncana (Rugotruncana) havanensis* Voorwijk; Pessagno p. 103.

1962a *Praeglobotruncana havanensis* (Voorwijk); Berggren, pp. 26-30, pl. 7, figs. 1a-c.

1963 *Globotruncanella havanensis* (Voorwijk); Bronnimann and Rigassi, pl. 17, fig. 2.

1963 *Globotruncanella havanensis* (Voorwijk); Bronnimann and Rigassi, pl. 17, fig. 2.

1963 *Globotruncanella havanensis* (Voorwijk); Hinte, pp. 94-96, pl. 10, fig. 3, pl. 11, figs. 4-5; pl. 12, fig. 1.

1966 *Globotruncana havanensis* Voorwijk; Douglas and Sliter, p. 111, pl. 1, figs. 9-10.

1967 Globotruncanella havanensis (Voorwijk); Pessagno, p. 373, pl. 84, figs. 1-3.

1968 Praeglobotruncana havanensis (Voorwijk); Barr, p. 314, pl. 37, figs. 1-2.

1969 Globotruncanella havanensis (Voorwijk); Douglas, p. 190, pl. 10, fig. 3.

1979 Globotruncanella havanensis (Voorwijk); Wonders, p. 191, pl. 10, fig. 2.

Remarks

Comparison of the holotype of "Globotruncana" citae illustrated by Bolli (1951, pl. 35, figs. 4-6), and the holotype of "Globotruncana" havanensis (Voorwijk), re-illustrated by Hinte (1963, pl. 12, figs. 1a-c), reveals the similarity between these two forms, thus "Globotruncana" citae Bolli is regarded here as a junior synonym.

The generic status of Globotruncanella havanensis is a subject of arguments among different authors. Originally the holotype was assigned to the genus Globotruncana Cushman. Since then, it has been referred to the genera Rugotruncana Bronnimann & Brown, Marginotruncana Hofker, Praeglobotruncana Bermudez, and Globotruncanella Reiss. Reference is made to the paper by Berggren (1962) for an adequate review of the taxanomic status of this species. The present author has studied the former genera, and found that the few characteristics which can be seen in thin section are in accord with the general diagnosis of the genus Globotruncanella Reiss, emended Pessagno, 1967.

Globotruncanella havanensis has been recognized in thin section. The specimens from the Nief Beds are characterized by a small test covered by a fine scattered short spines, convex spiral side, convave umbilical side and compressed chambers in the final volution. They conform well with the figure given by Bronnimann and Brown (1955, pl. 24, fig. 10) and Wonders (1979, pl. 10, fig. 2). The illustrated specimen on plate 19, fig. 9, shows a weakly developed keel on one side of the section. It shows similarity with the related form "Loeblichella" coarctata (Bolli) illustrated by Ice and McNulty (1980, pl. 5, fig. 9). Since there are no precise criteria to separate these two species in thin section, this specimen is provisinallly placed in Globotruncanella havanensis (Voorwijk).

Dimensions of the figured specimens

Pl. 19, figs. 7-9.

Max. diameter = 0.21 mm, 0.17, 0.35.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncanella havanensis (Voorwijk) has been reported from the Campanian and Maestrichtian of various parts of the world. However, most of the recorded occurrences are from the Maestrichtian. Globotruncanella havanensis was recorded from the Lower Campanian to the end of Maestrichtian in Trinidad (Bolli, 1957b), the Central Apennines (Wonders, 1979) and in the general zonation by Postuma (1971). The species was recorded from the Maestrichtian of Tunisia (Dalbiez, 1955), Australia (Edgell, 1957; Wright & Apthorpe, 1976), Puerto Rico (Pessagno, 1960), the southwestern Carpathian (Neagu, 1968), northern California (Douglas, 1969) and West Aquitaine, France (Dupeuble, 1969). According to Pessagno (1967), Globotruncanella havanensis was recorded from the Maestrichtian of Denmark, Germany Holland and Russia. (See Range Chart 3).

Family Globotruncanidae Brotzen, 1942

Genus Rugoglobigerina Bronnimann, 1952

Genotype: "Globigerina" rugosa Plummer, 1927, by original designation

Rugoglobigerina rotundata Bronnimann, 1952?

Plate 20, fig. 1

1952 Rugoglobigerina rugosa rotundata Bronnimann, pp. 34-36, pl. 4, figs. 7-9; text-figs. 15a-f, 16a-c.

1955 Kuglerina rotundata (Bronnimann); Bronnimann and Brown, p. 557.

1955 Globotruncana (Rugoglobigerina) rotundata rotundata (Bronnimann); Gandolfi, p. 70, pl. 7, figs. 2a-c.

1967 Rugoglobigerina rugosa rotundata Bronnimann; Bandy, p. 22, test-fig. 10, no. 5.

1967 Rugoglobigerina rotundata Bronnimann; Pessagno, pp. 365-366, pl. 65, figs. 1-4; pl. 68, figs. 1-3.

1971 Rugoglobigerina rotundata Bronnimann; Postuma, pp. 88-89.

1978 Rugoglobigerina rotundata Bronnimann; Hofker, pl. 1, fig. 17.

Remarks

The few sections of Rugoglobigerina rotundata Bronnimann? from the Nief Beds, show a globular test, low spired initial chambers with flattened tops, a small umbilicus and globular ornamented chambers with a slight axial elongation. They are comparable with the figure given by Postuma (1971, p. 89). However, the figured specimen differs from the holotype in having a much smaller size. It is probably a young specimen.

Dimensions of the figured specimen

Max. diameter = 0.17 mm (holotype = 0.5 mm).

Max. thickness = 0.13 mm (holotype = 0.37 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

All the reliable references indicate the stratigraphical range of Rugoglobigerina rotundata Bronnimann to be from middle to terminal Maestrichtian. According to the zonation by Postuma (1971), it ranges throughout Globotruncana gansseri zone and Globotruncana mayaroensis zone (Middle & Upper Maestrichtian). Neagu's (1968) reference is the only one from the Lower Maestrichtian. (See Range Chart 3).

Rugoglobigerina rugosa (Plummer), 1927

Plate 20, fig. 2

1927 Globigerina rugosa Plummer, p. 38, pl. 2, fig. 10.

1952 Rugoglobigerina rugosa rugosa (Plummer); Brönnimann, p. 28, text-figs. 11, 12, 13.

1955 Globotruncana (Rugoglobigerina) rugosa rugosa (Plummer); Gandolfi, p. 72, pl. 7, figs. 6a-c.

1962 Rugoglobigerina rugosa (Plummer); Berggren, p. 71, pl. 11, figs. 1-5; text-figs. 8, nos. 1-5.

1964 Rugoglobigerina rugosa (Plummer); Olsson, p. 173, pl. 7, figs. 2-5 (see syn.).

1967 Rugoglobigerina rugosa (Plummer); Pessagno, p. 366, pl. 75, figs. 2-3; pl. 101, figs. 8-9 (see syn.).

1969 Rugoglobigerina rugosa (Plummer); Douglas, p. 175, pl. 6, figs. 1-2.

1971 Rugoglobigerina rugosa (Plummer); Postuma, p. 90, 91.

1973 Rugoglobigerina rugosa (Plummer); Smith and Pessagno, p. 58, pl. 25, figs. 1-4 (see syn.)

Remarks

The published records on this species reveal a wide range of variation in the number of chambers in the final whorl, the density of the surface rugosity and the convexity of the spiral side. This is in part related to the concept of each author of this species.

Olsson (1964) stated that "Rugoglobigerina rugosa (Plummer) appears to be the central stock from which several species of the genus Rugoglobigerina Bronnimann have evolved". Bronnimann (1952), Bandy (1967) and Douglas (1969) indicated the evolution of Rugoglobigerina rotundata Bronnimann from Rugoglobigerina rugosa (Plummer).

Reference is made to the papers by Berggren (1962), Pessagno (1967) and Smith & Pessagno (1973) for a detailed discussion of this species.

Rugoglobigerina rugosa was recognized in thin section from the Nief Beds. The main diagnosis as seen in thin section is the low trochospire of the test, the surface rugosity, the globular chambers and the wide umbilicus. This diagnosis, as well as the axial profile are in accord with that given by Postuma (1971, p. 91).

Dimensions of the figured specimen

Max. length = 0.4 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Rugoglobigerina rugosa has been reported from the Campanian and Maestrichtian of various parts of the world. Bandy (1967), Postuma (1971) and Smith & Pessagno (1973) gave the range as from Upper Lower Campanian to the end of Maestrichtian. Takayanagi (1965) quoted many authors who reported this species from rocks as old as Turonian. (See Range Chart 3).

Rugoglobigerina sp. cf. *scotti* (Bronnimann), 1952

Plate 20, fig. 3

1952 *Trinitella scotti* Bronnimann, p. 57, pl. 4, figs. 4-6, text fig. 30.

1971 *Rugoglobigerina scotti* (Bronnimann); Postuma, p. 92, 93.

Remarks

One specimen of *Rugoglobigerina sp.* cf. *scotti* was recognized from the Nief Beds. The general axial profile is similar to that shown by Postuma (1971, p. 93), notably the flattening of the dorsal side. It differs from all other described forms in the small size of the test, thin and almost smooth wall, small umbilicus and short test relative to its thickness.

Dimensions of the figured specimen

Max. diameter = 0.12 mm (holotype = 0.4 mm).

Thickness = 0.06 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Genus *Globotruncana* Cushman, 1926

Genotype: *Pulvinulina arca* Cushman, 1926, by original designation

Remarks

Loeblich and Tappan (1964) placed *Marginotruncana* Hofker, 1956, in the synonym of *Globotruncana* Cushman. Pessagno (1967) emended the genus *Marginotruncana* Hofker, and indicated that it is not a junior synonym of *Globotruncana*, but is a distinct and valid genus. He states that *Marginotruncana* differs from *Globotruncana* in (1) having a primary aperture which is extraumbilical-umbilical in position; (2) lacking a true tegilla with intralamminal supplementary apertures; (3) having a much shallower and wider umbilicus.

Since all the species from the Upper Cretaceous of the Nief Beds were identified from thin sections, only the third criterion can be used. Consequently, all the species were assigned to *Globotruncana*.

Globortruncana arca (Cushman), 1926

Plate 20, fig. 4

1926 *Pulvinulina arca* Cushman, p. 23, pl. 3, figs. la-c.

1927a *Globotruncana arca* (Cushman), p. 91, pl. 19, fig. 11.

1955 *Globotruncana (Globotruncana) arca* (Cushman); Dalbiez, p. 164, text - figs. 5a-c.

1955 *Globotruncana arca arca* (Cushman); Gandolfi, p. 63, pl. 5, figs. 2a-4c.

1962 *Globotruncana (Globotruncana) arca* (Cushman); Berggren, p. 49, pl. 9, figs. 1a-2c. (Cum. syn.).

1965 *Globotruncana arca* (Cushman); Takayanagi, p. 209, pl. 22, figs. 6a-c; pl. 23, figs. 1a-2c.

1966 *Globotruncana arca* (Cushman); El-Naggar, p. 83, pl. 1, figs. 1a-2.

1967 *Globotruncana arca* (Cushman); Pessagno, p. 321, pl. 79, figs. 5-8; pl. 90, figs. 6-8; pl. 96, figs. 7, 8, 17 (cum. syn.)

1969 *Globotruncana arca* (Cushman); Dupeuble, p. 155, pl. 2, figs. 4, 5; pl. 3, figs. 7, 9.

1971 *Globotruncana arca* (Cushman); Postuma, p. 18, 19.

1974 *Globotruncana arca* (Cushman); Saito and Donk, p. 165, pl. 1, figs. 1-2.

Remarks

According to Pessagno (1967), the origin of *Globotruncana arca* is speculative and needs further investigation. He suggested three alternatives: derivation of *Globotruncana arca* from *Globotruncana fornicata* Plummer (most likely), from *Globotruncana lapparenti* stock or from *Globotruncana stuartiformis* Dalbiez (least likely). Bolli (1951) suggested its derivation from *Globotruncana mariei* Banner & Blow (= *Globotruncana cretacea* Cushman) in the Lower Maestrichtian.

The individuals of *Globotruncana arca* from the Nief Beds were identified in thin section. Typical forms are characterized by their broadly convex spiral sides, and their two widely separated keels and the peripheral band between them which slope toward the umbilicus. They are comparable with the figure illustrated by Postuma (1971) on page 19. Two variations of this species were also recognized, depending on the convexity of the dorsal side and the spacing between the keels. These are similar to the figures given by Dupeuble (1969, pl. 2, fig. 4d; pl. 3, fig. 9d) and Pessagno (1967, pl. 96, fig. 8). Only the typical form was photographed and illustrated.

Dimensions of the figured specimen

Max. diameter = 0.48 mm

Max. thickness = 0.24 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

The majority of publications report *Globotruncana arca* from the Campanian and Maestrichtian, although some record the species from the Santonian (Takayanagi, 1965), and from the Upper Turonian (Bandy, 1967). Berggren (1962) restricted this species to the Maestrichtian and pointed out that a transitional forms may occur in the Upper Campanian. Glaessner (1937a, in Takayanagi, 1965) and Pessagno (1967) gave the range through the Campanian and Maestrichtian. Campanian records were also given by Casati and Tomai (1969) and Sliter (1973). According to the zonation by Postuma (1971), *Globotruncana arca* ranges from the *Globotruncana calcarata* zone to the top of the *Globotruncana gansseri* zone (Upper Campanian to the upper Middle Maestrichtian). (See Range Chart 3).

Globotruncana bulloides Vogler, 1941

Plate 20, fig. 5.

1918 *Rosalina linnei type 3* De Lapparent, p. 4, text-fig. 1h; p. 5, text-figs. 2a, e, g.

1941 *Globotruncana linnei bulloides* Vogler, pl. 23, figs. 32-39. (Lectotype fig. 33 selected by Pessagno, 1967).

1944 *Globotruncana lapparenti bulloides* Vogler; Bolli, p. 231, 232, fig. 1, nos. 17, 18; pl. 9, fig. 12.

1955 *Globotruncana bulloides bulloides* Vogler; Gandolfi, p. 32, pl. 1, figs. 9a-c.

1960 *Globotruncana lapparenti* Brotzen *bulloides* Vogler; Belford, p. 97, pl. 28, figs. 7-13.

1967 *Globotruncana linneiana bulloides* Vogler; Bandy, p. 16, no. 3.

1967 *Globotruncana bulloides* Vogler; Pessagno, p. 324, pl. 67, figs. 1-3; pl. 73, figs. 9, 20; pl. 75, figs. 4-8; pl. 97, figs. 14, 15.

1976 *Globotruncana bulloides* Vogler; Wright and Apthorpe, p. 239, pl. 1, fig. 7.

1979 *Globotruncana bulloides* Vogler; Frerichs, p. 180, pl. 18, figs. 10-12.

Remarks

Globotruncana bulloides Vogler was originally described as *Globotruncana linnei* (d'Orbigny) subspecies *bulloides* by Vogler (1941) as a syntypic series from thin sections from the Upper Cretaceous of Indonesia. Pessagno (1967) designated figs. 33 and 34 of Vogler (1941) as lectotype and paratypes of *Globotruncana bulloides* respectively. The lectotype is similar to the figures illustrated by Pessagno (1967) on plate 97, figs. 14, 15 as indicated by this author.

Globotruncana bulloides from the Nief Beds is identified in thin section only. The section shows two unequal chambers, the larger one with two widely separated keels. Comparison of this specimen with the figure given by Pessagno (1967) on plate 97, figs. 14, 15 shows overall similarity but minor differences in detail. The specimen also shows similarity with the figures published by Bolli (1951, fig. 1C) and Postuma (1971, p. 21). However, it differs in having more inflated and unequal chambers, and the double keels are restricted to one side of the section. It is also closely comparable with the figure given by Lòriga and Mantovani (1965) on plate 112, fig. 17.

Dimensions of the figured specimen

Max. diameter = 0.23 mm

Max. thickness = 0.11 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

In south-central Puerto Rico, Globotruncana bulloides ranges from the Santonian to the Lower Maestrichtian (Pessagno, 1962). A similar range has been reported from the Western Gulf Coastal Plain (Pessagno, 1967), the southern Alps (Casati and Tomai, 1969) and by Postuma (1971). Bolli (1951) recorded the range from Turonian to the Lower Maestrichtian of Trinidad. A similar range has been given by Bandy (1967). Hart and Carter (1975) described this species as dominant or most important in the Upper Coniacian of southeast England. (See Range Chart 3).

Globotruncana calcarata Cushman, 1927

Plate 20, figs. 6a-b

1927b Globotruncana calcarata Cushman, p. 115, pl. 23, figs. 10a, b.

1951 Globotruncana (Globotruncana) calcarata Cushman; Noth, p. 78, pl. 8, figs. 14a-c.

1952 Globotruncana calcarata Cushman; Sigal, p. 39, text-fig. 43.

1955 Rugotruncana calcarata (Cushman); Bronnimann and Brown, p. 548, pl. 23, figs. 1-3; pl. 24, figs. 2, 6, 11.

1963 Rugotruncana calcarata (Cushman); Bronnimann and Rigassi, pl. 17, fig. 1.

1966 Globotruncana calcarata Cushman; Wille-Janoschek, p. 98, pl. 8, fig. 4.

1967 Globotruncana calcarata Cushman; Pessagno, p. 326, pl. 64, figs. 18-20; pl. 72, figs. 5, 6; pl. 93, fig. 14; pl. 94, fig. 8 (cum. syn.).

1970 Globotruncana calcarata Cushman; Papp and Turnovsky, pl. 53, figs. 1, 2.

Remarks

Globotruncana calcarata is a very distinctive and easily identifiable spined species, unlikely to be confused with any other except Globotruncana falsocalcarata Kerdany & Abdelsalam. The latter differs from the former in having peripheral spines in more than one stage of development, and in being restricted to the Upper Maestrichtian (Kassab, 1975).

Globotruncana calcarata was identified in many samples from the Nief Beds. It is readily identifiable in two thin sections; one axial and the other a shallow horizontal cut of the dorsal side which shows all or part of the peripheral spines. Both have been photographed and illustrated. The axial section shows a slight convex dorsal side, a deep umbilicus and a single radial spine. This is in accord with the diagnosis of this species. It agrees closely with the illustrations by Bronnimann and Brown (1955, pl. 24, fig. 11) and Postuma (1971, p. 23). The shallow horizontal cut of the dorsal side shows all the peripheral radial spines which are characteristic of this species. It is closely comparable with the illustration by Pessagno (1967, pl. 94, fig. 8). However, the radial spines in the figured specimen are not perpindicular to the periphery as they are in the figure given by Pessagno (op. cit.).

Dimensions of the figured specimens

Pl. 20, fig. 6a-b.

Max. diameter = 0.47 mm., 0.45.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncana calcarata Cushman is regarded as a reliable index Foraminifera for the Upper Campanian. It was recorded from the Upper Campanian of Tunisia (Dalbiez, 1955); Texas (Bronnimann and Brown, 1955); New Jersy (Olsson, 1964); Algeria, Cuba, Europe, Haiti, Israel, Panama and the Western Gulf Coastal Plain (Pessagno, 1967); and other localities. According to the zonation by Bandy (1967) and

Postuma (1971), it is restricted to the Upper Campanian.

Globotruncana conica White, 1928

Plate 20, fig. 7

1928 Globotruncana conica White, p. 285, pl. 38, figs. 7a-c.

1948 Globotruncana conica White; Cita, pp. 149-150, pl. 3, figs. 5a-c.

1951 Globotruncana conica White; Bolli, p. 196, pl. 34, figs. 13-15.

1955 Globotruncana stuarti conica White; Gandolfi, p. 65, pl. 15, figs. 8a-c.

1966 Globotruncana conica White; El-Naggar, p. 87, pl. 12, figs. 2a-d.

1967 Globotruncana conica White; Pessagno, pl. 65, figs. 8-10; pl. 82, figs. 1-5; pl. 93, figs. 12, 13.

1969 Globotruncana conica White; Dupeuble, p. 157, pl. 2, figs. 6a-d.

1971 Globotruncana conica White; Postuma, p. 28, 29.

1972 Globotruncana conica White; Barr, p. 19, pl. 6, figs. 2a-c.

Remarks

Globotruncana conica White is chiefly characterized by a trochospiral, spiroconvex test with a single keel. Globotruncana stephensoni pessagno is a similar species and differs in having two closely spaced keels which merge into one in the last chamber. These two species can only be separated in thin section (Pessagno, 1967). Globotruncana conica is also similar to Globotruncana stuarti (De Lapparent) from which it is separated by its highly spiroconvex test.

Globotruncana conica was recognised in thin section in many samples from the Nief Beds. It is characterized by a strongly convex spiral side, a single keel and deep umbilicus. It conforms well with the diagnosis and the illustration by Pessagno (1967, pl. 93, figs. 12, 13) and Postuma (1971, p. 28, 29).

Dimensions of the figured specimen

Max. diameter = 0.4 mm

Max. thickness = 0.22 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

The stratigraphical range of Globotruncana conica is variable and depends on the accuracy of the identification. It was reported from the Campanian and Maestrichtian in Tunisia (Dalbiez, 1955), Trinidad (Bolli, 1951) and Europe (Borsetti, 1962). The same range is given by Postuma (1971). In the Western Gulf Coastal Plain it is restricted to the Upper Maestrichtian. Also it was reported from the Maestrichtian of Turkey and Egypt (El-Naggar, 1966), Libya (Barr, 1972), and the northern part of the Mid-Atlantic ridge (Smali, 1973). Rare records extended the range to the Santonian (Bolli, 1957b; Borsetti, 1962). (See Range Chart 3).

Globotruncana contusa (Cushman), 1926

plate 20, figs. 8-9

1926 Pulvinulina arca var. contusa Cushman, p. 23.

1928 *Globotruncana conica* var. *plicata* White, pp. 285-286, pl. 38, figs. 8a-c.

1937a *Globotruncana contusa* (Cushman); Glaessner, p. 37.

1939 *Globotruncana arca* (Cushman) var. *contusa* Cushman; Morozova, p. 80, pl. 1, figs. 1-3 (fide Berggren, 1962).

1946 *Globotruncana arca* (Cushman) Cushman var. *contusa* (Cushman) Cushman, p. 150, pl. 62, fig. 6 (holotype).

1955 *Globotruncana contusa contusa* (Cushman); Gandolfi, p. 53, pl. 4, figs. 3a-c.

1957 *Globotruncana (Globotruncana) contusa* (Cushman); Edgell, pl. 2, figs. 10-12; pl. 3, figs. 7-9; pl. 4, figs. 1-3.

1960b *Globotruncana (Marginotruncana) contusa* (Cushman); Hofker, p. 225, text-figs. 22a-c.

1962 *Globotruncana contusa contusa* (Cushman); Herm, p. 72, pl. 1 figs. 4a-c; pl. 9, figs. 1-5.

1962 *Globotruncana (Globotruncana) contusa* (Cushman); Berggren, p. 51, pl. 9, figs. 3-4.

1964 *Globotruncana contrusa* (Cushman); Bozorgnia, pl. 106, figs. 5, 6.

1967 *Globotruncana contusa* (Cushman); Pessagno, p. 330, pl. 75, figs. 18-20; pl. 77, figs. 4-9; pl. 78, figs. 6-11; pl. 92, figs. 10-12; pl. 96, figs. 15, 16; not pl. 96, figs. 11, 13.

1971 *Globotruncana contusa* (Cushman); Postuma, p. 30, 31.

1973 *Globotruncana contusa* (Cushman); Smith and Pessagno, p. 45, pl. 21, figs. 1-5.

1976 *Globotruncana contusa* (Cushman); Wright and Apthorpe, p. 239, pl. 1, figs. 9-10.

Remarks

This species was first described as *Pulvinulina arca* var. *contusa* by Cushman (1926) from the Mendez shale of Mexico without illustration. Cushman (1927a) established the genus *Globotruncana*, with *Pulvinulina arca* Cushman as the type species. Glaessner (1937a) raised Cushman's variety to specific rank without giving any figures. Morozova (1939, quoted in El-Naggar, 1966) gave the first figure of Globotruncana contusa (Cushman). Cushman illustrated the holotype of this species for the first time in 1946.

Globotruncana contusa (Cushman) exhibits considerable morphologic variation, consequently a number of a subspecies have been proposed by various authors. Troelsen (1955) figured two types of Globotruncana contusa in the White Chalk of Denmark which he called the "typical forms", similar to the holotype illustrated by Cushman (1946) with spiral side plications, and those without plications. Gandolfi (1955) described two subspecies; Globotruncana contusa scutilla and Globotruncana contusa patelliformis. Pessagno (1967), and Smith and Pessagno (1973) gave the name Globotruncana contusa s.s. to the typical plicated forms and Globotruncana contusa s.l. to the non-plicated forms (= Globotruncana patelliformis Gandolfi). According to the above authors the plicated form is characterized by a spiroconvex, umbilicoconcave test; somewhat polygonal and distinctly undulating peripheral outline; and strongly plicated spiral surface. The non-plicated form is smaller, somewhat lower spired and is often spinose spirally. The plicated form of Globotruncana contusa is regarded as the advanced form which gradually evolved from the non-plicated form (Troelsen, 1955 ; Berggren, 1962; Pessagno, 1967; Smith and Pessagno, 1973).

Two main types of Globotruncana contusa were recognized amongst the thin section from the Nief Beds. The first type (pl. 20, fig. 8), is characterized by a high pyramidal trochospire with a sharp apex. The two keels appear only on one side of the section. This may be related to its orientation. Similar forms have been illustrated by Bozorgnia (1964, pl. 106, figs. 5, 6) and Postuma (1971, p. 31). This type probably represents the typical and more advanced forms of Globotruncana contusa. The second (pl. 20, fig. 9) is characterized by a high conical and broadly rounded trochospire. It agrees closely with Globotruncana contusa illustrated by Pessagno (1967, pl. 96, figs. 15, 16), and to the figure illustrated by Papp and Turnovsky (1970, pl. 55, fig. 2).

Dimensions of the figured specimens

Pl. 20, figs. 8, 9.
Max. diameter = 0.35 mm, 0.47
Max. height above the base = 0.22 mm, 0.32

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

All the reliable sources regarded this species as an index for the Maestrichtian in different parts of the world. Most of the records reported the range throughout the Middle and Upper Maestrichtian. It was reported to occur throughout the Maestrichtian of Trinidad (Bolli, 1957b), north Italy, Scaglia Rose Formation (Bolli and Cita, 1960b) and Australia, Miria Marl (Edgell, 1957). In a few papers it is reported from the uppermost Campanian (Noth, 1951; Nakkady & Osman, 1954). It has been reported from the Middle and Upper Maestrichtian of the Western Gulf Coastal Plain (Pessagno, 1967), the Corsicana Formation, Texas (Smith and Pessagno, 1973) and the zonation by Postuma (1971). For detailed accounts of the stratigraphical ranges as well as the geographical distributions of this species, reference is made to the papers by Berggren (1962), Pessagno (1967), and Smith & Pessagno (1973). (See Range Chart 3).

Globotruncana elevata (Brotzen), 1934

Plate 20 fig. 10

1934 Rotalia elevata Brotzen, p. 166, pl. 3, fig. c.

1955 Globotruncana (Globotruncana) elevata elevata (Brotzen); Dalbiez, p. 169, text-fig. 9a-c.

1960 Globotruncana (Globotruncana) stuarti elevata (Brotzen); Pessagno, p. 101, pl. 5, figs. 1-8.

1964 Globotruncana stuarti (De Lapparent) elevata (Brotzen); Bozorgnia, pl. 105, figs. 5, 6.

1967 Globotruncana elevata (Brotzen); Pessagno, p. 336, pl. 78, figs. 12-14; pl. 80, figs. 1, 2; pl. 81, figs. 9-14; pl. 93, figs. 1-5, 8; text-fig. 44.

1970 Globotruncana elevata (Brotzen); Kuhry, p. 293, pl. 1, figs. 1-9 (figs. 1-3 lectotype; figs. 4-9 topotypes).

1971 Globotruncana elevata (Brotzen); Postuma, p. 34, 35.

1972 Globotruncana elevata (Brotzen); Caron, p. 554, pl. 1, fig. 1; text-fig. 3, 9.

1973 Globotruncana elevata (Brotzen); Smith and Pessagno, p. 47, pl. 19, figs. 1-3, 4-6.

1977 Globotruncana elevata (Brotzen); Masters, p. 557, pl. 42, figs. 2-4.

Remarks

Globotruncana elevata (Brotzen) was first described as "Rotalia" elevata from the Santonian - Campanin of Jerusalem by Brotzen (1934) without the formal designation of a holotype. Kuhry (1970) has studied Globotruncana elevata, re-examined the type specimens and selected a lectotype.

In the Nief Beds, Globotruncana elevata (Brotzen) was identified in thin section. It is characterized by a unicarinate periphery and raised central spire. It conforms with the diagnosis and illustration by Postuma (1971, p. 34, 35), and the figures given by Bozorgnia (1964, pl. 105, figs. 5, 6).

Dimensions of the figured specimen

Max. diameter = 0.46 mm

Max. thickness = 0.26 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Most of the reported occurrences of Globotruncana elevata in various parts of the world are from within the range from Lowermost Campanian to the Uppermost Maestrichtian (Dalbiez, 1955; Knipscheer, 1956; Edgell, 1957; Pessagno, 1960, 1962, 1967; Barr, 1972; Olsson, 1964; Douglas, 1969; Kassab, 1979). Records from the Uppermost Coniacian and Santonian, have been made from Papua New Guinea (Owen, 1970), D.S.D.P., Leg. 11, Site 98 (Caron, 1972) and Libya (Barr, 1972). In the Western Gulf Coastal Plain, the species ranges from Upper Campanian to the end of Maestrichtian (Pessagno, 1967). According to Postuma (1971) it ranges throughout the Campanian with questionable occurrence in the uppermost Campanian. (See Range Chart 3).

Globotruncana falsostuarti Sigal, 1952

Plate 20, fig. 11

1952 *Globotruncana falsostuarti* Sigal, p. 43, text-fig. 46.

1963 *Globotruncana (Globotruncana) rosetta falsostuarti* Sigal; Hinte, p. 91, pl. 10, figs. 2a-c.

1966 *Globotruncana falsostuarti* Sigal; Lehman, p. 311, pl. 1, fig. 3.

1969 *Globotruncana falsostuarti* Sigal; Dupeuble, p. 156, pl. 3, figs. 10a-d.

1969 *Globotruncana falsostuarti* Sigal; Funnell, Friend and Ramsay, p. 30, pl. 3, figs. 10-12; text-fig. 14.

1971 *Globotruncana falsostuarti* Sigal; Postuma, p. 36, 37.

1972 *Globotruncana falsostuarti* Sigal; Barr, p. 20, pl. 5, figs. 5a-c.

1979 *Globotruncana falsostuarti* Sigal; Kassab, p. 51, pl. 5, figs. 3-5.

Remarks

Globotruncana falsostuarti Sigal, was first described by Sigal (1952) from the Lower Maestrichtian of Ageria. The unadequate description and the poor illustration of the holotype explain the unclear morphological limits of this species. It has been misidentified with other similar forms such as *Globotruncana arca* (Cushman), *Globotruncana rosetta* (Carsey), *Globotruncana stuarti* (De Lapparent) and *Globotruncana conica* White. *Globotruncana falsostuarti* differs from *Globotruncana arca* mainly in the absence of the second keel in the final chambers of the last whorl. It differs from *Globotruncana stuarti* in having petaloid rather than trapezoid chambers on the spiral side of the last chamber and in the possession of double keels in the initial chambers of the final whorl.

Rare specimens of *Globotruncana falsostuarti* were identified from the Nief Beds. They are in accord with the diagnosis presented by El-Naggar (1966), Dupeuble (1969), Postuma (1971) and Barr (1972). These specimens agree very closely with the figure given by Postuma (1971, p. 37).

Dimensions of the figured specimen

Max. diameter = 0.45 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncana falsostuarti has been described from the Maestrichtian of various parts of the world (cf. Sigal, 1952; Hinte, 1963; Salaj and Samuel, 1966; Barr, 1972; Wright and Apthorpe, 1976; Masters, 1977; Kassab, 1979). This occurrence was extended down to the Upper Campanian in Algeria (Sigal, 1967) and Tunisia (Salaj, 1969). According to the zonation by Postuma (1971), *Globotruncana falsostuarti* ranges through the Maestrichtian. (See Range Chart 3).

Globotruncana fornicata Plummer, 1931

Plate 20, figs. 12, 13

1931 *Globotruncana fornicata* Plummer, pp. 198-199, pl. 13, figs. 4a-c, 5, 6.

1955 *Globotruncana fornicata fornicata* Plummer; Gandolfi, p. 40, pl. 2, figs. 2a-c.

1957 *Globotruncana (Globotruncana) fornicata* Plummer; Edgell, p. 112, pl. 3, figs. 10-12.

1960 Globotruncana (Globotruncana) fornicata Plummer; Pessagno, p. 101, pl. 4, fig. 7.

1962 Globotruncana fornicata Plummer; Herm, p. 78, pl. 7, fig. 2.

1964 Globotruncana fornicata Plummer; Olsson, pp. 164-165, pl. 2, figs. 3, 4; pl. 3, figs. 7a-c, 8a-c.

1966 Globotruncana fornicata fornicata Plummer; El-Naggar, p. 105, pl. 13, figs. 5a-c, 6; pl. 14, figs. 1a-c.

1967 Globotruncana fornicata Plummer; Pessagno, p. 338, pl. 63, figs. 1-9; pl. 80, figs. 7-9; pl. 96, figs. 3, 4.

1969 Globotruncana fornicata Plummer; Douglas, p. 179, pl. 7, fig. 6.

1971 Globotruncana fornicata Plummer; Postuma, p. 38, 39.

1972 Globotruncana fornicata fornicata Plummer; Barr, p. 20, pl. 7, figs. 4-5.

Remarks

Globotruncana fornicata Plummer is regarded as the ancestral form of Globotruncana contusa (Cushman) by many workers (cf. Edgell, 1955; Olsson, 1964; El-Naggar, 1966; Pessagno, 1967; Owen, 1970). The former is separated from the latter basically by the low convexity of the dorsal side.

In the Nief Beds, Globotruncana fornicata was recognized in thin section. These specimens are characterized by the convex and crenulated spiral side, narrow double-keeled peripheral band and wide umbilicus. Some of the specimens have very high trochospire and are probably transitional to Globotruncana contusa. The figured specimens conform well with the diagnosis and the illustration given by Postuma (1971, p. 38, 39). However, the sections from the Nief Beds are less crenulate spirally, have less evidently globigerine initial chambers and a smaller umbilicus. Some of the specimens are similar to the figure illustrated by Pessagno (1967, pl. 96, fig. 3).

Dimensions of the figured specimens

Pl. 20, figs. 12, 13.

Max. diameter = 0.42 mm, 0.52.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncana fornicata is recorded from Coniacian to the Lower Maestrichtian in most of the published literature (Dalbiez, 1955; Edgell, 1957; Klaus, 1959; Barr, 1962; Pessagno, 1962; Olsson, 1964; Douglas, 1969; Hinte, 1969; Postuma, 1971; Thierstein, 1971; Sliter, 1973). Takayanagi (1965) reported this species from the Turonian. According to Douglas (1969a), the reported Turonian occurrence is based on a specific misidentification. Bandy (1967) gave the range from coniacian to the end of Maestrichtian. (See Range Chart 3).

Globotruncana gansseri Bolli, 1951

Plate 20, fig. 14; Plate 21, fig. 1

1950 *Globotruncana gansseri* Bolli, p. 87 (nomen nudum).

1951 *Globotruncana gansseri* Bolli, p. 196, pl. 35, figs. 1-3.

1955 *Globotruncana gansseri* Bolli; Gandolfi, p. 69, pl. 6, figs. 5, 6, 8 a-c.

1956 *Rugotruncana gansseri* (Bolli); Bronnimann and Brown, pp. 549-550, pl. 23, figs. 7-9; text-fig. 23.

1960 *Globotruncana monmouthensis* Olsson, p. 50, pl. 10, figs. 22-24.

1960 Globotruncana (Rugotruncana) gansseri (Bolli); Pessagno, p. 102, pl. 4, fig. 11.

1966 Globotruncana gansseri gansseri Bolli; El-Naggar, p. 117, pl. 5, figs. 1a-d; pl. 11, fig. 3.

1967 Globotruncana gansseri Bolli; Pessagno, pp. 341-343, pl. 75, fig. 1; pl. 92, figs. 13-18; pl. 95, figs. 1-4.

1977 Globotruncana gansseri Bolli; Masters, p. 566, pl. 45, figs. 1-3.

1978 Marginotruncana gansseri (Bolli), forma monmouthensis (Olsson); Hofker, p. 49, pl. 1, fig. 18.

Remarks

Two specimens of Globotruncana gansseri Bolli were recognized amongst the thin section from the Nief Beds. The almost flat to slightly convex dorsal side, the highly umbilically inflated chambers and the peripheral walls slightly inclined toward the umbilicus are the main diagnostic characters of this form from the Nief Beds. The Nief specimens are comparable with the figure given by Bronnimann and Brown (1956, text-fig. 23) and Postuma (1971, p. 43).

Dimensions of the figured specimens

Pl. 20, fig. 14, pl. 21, fig. 1.

Max. diameter = 0.47 mm, 0.35.

Max. thickness = 0.32 mm, 0.20

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

According to Bolli (1966), Globotruncana gansseri ranges from the Lower - Middle Maestrichtian to the Middle - Upper Maestrichtian. In the Western Gulf Coastal Plain, it ranges from uppermost - Lower Maestrichtian to the lower - Upper Maestrichtian (Pessagno, 1967). According to Postuma (1971), it ranges through the Middle Maestrichtian to the middle - Upper Maestrichtian. Globotruncana gansseri was also recorded from the Upper Maestrichtian (Casati and Tomai, 1969; Cita and Gartner, 1971; Barr, 1972), and from the Lower Maestrichtian (Bronnimann and Brown, 1956; Wille-Janoschek, 1966; Sigal, 1967). (See Range Chart 3).

Globotruncana hilli Pessagno, 1967

Plate 21, fig. 2

1967 Globotruncana hilli Pessagno, p. 343, pl. 64, figs. 9-14, 21-23; pl. 94, fig. 1; pl. 97, fig. 7.

1969 Globotruncana hilli Pessagno; Douglas, p. 180, pl. 7, figs. 7-8.

1973 Globotruncana hilli Pessagno; Sliter, p. 174, pl. 3, figs. 4-6.

1979 Globotruncana hilli Pessagno; Kassab, p. 57, pl. 7, figs. 3-6; pl. 12, fig. 8.

Remarks

According to Pessagno (1967), Globotruncana hilli is most likely derived from Globotruncana linneiana (d'Orbigny) from which it is distinguished mainly in having globular chambers, and in lacking double-keeled margins in the early part of the final whorl.

A single specimen of Globotruncana hilli was identified from the Nief Beds. It is comparable with the figure given by Pessagno (1967, pl. 97, fig. 7). However, the Nief's specimen shows a very slightly concave spiral side.

Dimensions of the figured specimen

Max. diameter = 0.21 mm

Max. thickness = 0.1 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Pessagno (1967) gave range of *Globotruncana hilli* as from *Globotruncana calcarata* zonule to the *Globotruncana lapparenti* s.s. zonule (Upper Campanian to the Lower Maestrichtian) in the Western Gulf Coastal Plain. Douglas (1969) recorded the species from the Campanian Marsh Creek, Panoche Formation and Rosaria Formation of California. Sliter (1973) gave the range as from the middle - Lower Campanian to the Lower Maestrichtian in the Vancouvar Island Area - British Columbia, Canada. It was reported from the Upper Maestrichtian and Lower Campanian of the Shiranish Formation, Iraq (Kassab, 1979). (See Range Chart 3).

Globotruncana imbricata Mornod, 1949

Plate 21, figs. 3, 4.

1949 *Globotruncana imbricata* Mornod, p. 589, text-fig. 5, nos. 11a-c, 111a-d; pl. 15, figs. 21-34.

1952 Globotruncana (Globotruncana) imbricata Mornod; Colom, p. 16, pl. 2, figs. 1-11.

1954 Globotruncana imbricata Mornod; Hagn and Zeil, p. 34, pl. 2, fig . 6; pl. 5, figs. 9, 10.

1964 Globotruncana imbricata Mornod; Bozorgnia, pl. 88, fig. 2; pl. 103, fig. 4.

1967 Marginotruncana imbricata (Mornod); Pessagno, p. 306, pl. 57, figs. 3-5.

1969 Globotruncana imbricata Mornod; Douglas, p. 180, pl. 2, figs. 4-7.

1970 Praeglobotruncana (Dicarinella) imbricata (Mornod); porthault, p. 70.

1976 Dicarinella imbricata (Mornod); Caron, p. 332, text-fig. 3a-c (neotype); pl. 3, figs. 1-6 (topotypes); pl. 4, figs. 1-6; pl. 5, figs. 1-6.

Remarks

Originally the species was assigned to the genus Globotruncana Cushman. Later, it was referred to the genera Marginotruncana Hofker, Praeglobotruncana Bermudez and Dicarinella Porthault. The separation of these genera is mainly based on matrix free specimens. Since all the specimens of Globotruncana imbricata were recognized in thin section in the Nief Beds, it is provisionally placed in the genus Globotruncana Cushman.

Caron (1976) in his summary, stated that "the holotype of Globotruncana imbricata was never made publicly available", therefore, he selected a neotype for this species from the same type locality and the type level. Prior to its original description by Mornod (1949), this species was either assigned to Globotruncana linneiana (d'Orbigny) or Globotruncana lapparenti Brotzen.

Rare specimens of Globotruncana imbricata Mornod were identified from the Nief Beds. They are characterised by a low trochospire, and the imbricate, non-keeled final chamber. The section on plate 21, fig. 3 is similar to the Globotruncana imbricata illustrated by Bozorgnia (1964, pl. 103, no. 4) and to a lesser degree to the illustration by Hagn and Zeil (1954, pl. 5, fig. 10). However, it differs from these in having less inflated chambers and a more flattened test. The specimen on plate 21, fig. 4, conforms with the topotypic illustration by Mornod (1949, pl. 15, fig. 23).

Dimensions of the figured specimens

Pl. 21, figs. 3, 4.

Max. diameter = 0.52 mm, 0.2 (holotype = 0.53 mm; cotype = 0.39 mm)

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

The reported range of Globotruncana imbricata Mornod is from the lowermost Turonian to the end of Coniacian (Mornod, 1949; Hagn and Zeil, 1954; Takayangai, 1965; Pessagno, 1967; Douglas, 1969; Postuma, 1971; Caron, 1976). However, Mornod (op. cit., in Takayanagi, 1965) stated that Globotruncana imbricata appears rarely in the Cenomanian with Praeglobotruncana stephani (Gandolfi), and this is the case in the Nief Beds, where Globotruncana imbricata occurs in a foraminiferal assemblage indicative of the Cenomanian. (See Range Chart 3).

Globotruncana lapparenti coronata Bolli, 1944

Plate 21, figs. 5, 6

1918 Rosalina linnei d'Orbigny; De Lapparent, type 4 (not Rosalina linnei d'Orbigny, 1839), p. 7; p. 4, fig. 1g.

1944 Globotruncana lapparenti Brotzen subspecies coronata Bolli, p. 233, text-fig. 1 (figs. 21, 22); pl. 9, fig. 15. Not pl. 9, fig. 14 (= Globotruncana angusticarinata Gandolfi).

1952 Globotruncana coronata Bolli; Sigal, p. 34, fig. 36.

1954 Globotruncana lapparenti Brotzen coronata Bolli; Hagn and Zeil, p. 43, pl. 3, figs. 4a, b; pl. 7, fig. 3 (not figs. 1, 2).

1962 Globotruncana tricarinata coronata (Bolli); Adams and Kirk, pl. 14, fig. 12.

1962 Globotruncana linneiana coronata Bolli; Barr, p. 572, pl. 70, figs. 1a-c; pl. 72, figs. 3, 4.

1967 Marginotruncana coronata (Bolli); Pessagno, pp. 305-306, pl. 65, figs. 11-13; pl. 100, fig. 6.

1969 Globotruncana coronata Bolli; Douglas, p. 177, pl. 3, figs. 5-8.

1972 Globotruncana coronata Bolli; Barr, p. 19, pl. 10, figs. 1a-c.

1979 Marginotruncana coronata (Bolli); Frerichs, p. 172, pl. 7, figs. 4-6.

1979 Marginotruncana coronata (Bolli); Wonders, pl. 8, fig. 8.

Remarks

Globotruncana lapparenti coronata Bolli is a new name given by Bolli (1944) to De Lapparent's (1918) "type 4" of "Rosalina linnei" d'Orbigny. Pessagno (1967) designated the specimen figured by Bolli (1944, pl. 9, fig. 15) as lectotype; the specimens in text - fig. 1, figs. 21, 22 as paralectotypes and referred pl. 9, fig. 14 to Globotruncana angusticarinata Gandolfi.

Globotruncana lapparenti coronata is characterized by a large test, narrow double keels, a large number of chambers and a wide umbilicus (Takayanagi, 1965). According to Barr (1972), the double peripheral keels are more closely spaced on the final chamber. Douglas (1969) pointed out that the two keels tend to merge in a single one on the ultimate or the penultimate chamber. These features distinguish this subspecies from *Globotruncana lapparenti tricarinata* (Quereau) and *Globotruncana linneiana* d'Orbigny.

Globotruncana lapparenti coronata Bolli was recognized in thin section in the Nief Beds. Two specimens have been illustrated. The specimen on plate 21, fig. 5 is characterized by a large size, slightly convex dorsal side, nearly planar ventral side and unequally spaced double keels on the two sides of the section. This form show virtually the same general features as the figure illustrated by Hagn and Zeil (1954, pl. 7, fig. 3). The other specimen, illustrated on plate 21, fig. 6 has a single keel in one side of the test as reported by Douglas (1969). This form shows some similarity with the section illustrated by Bolli (1944) on text-fig. 1, no. 21.

Dimensions of the figured specimens

Pl. 21, figs. 5, 6.

Max. diameter = 0.6 mm, 0.7.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Most of the published occurrences of Globotruncana lapparenti coronata are from within the Turonian to the Santonian (Bolli, 1944; Cita, 1948; Barr, 1962, 1972; Takayanagi, 1965; Owen, 1970; Herb, 1974). Other workers extended the range into the Campanian (Dalbiez, 1955; Wille-Janoschek, 1966; Bandy, 1967; Douglas, 1969). In Austria, the subspecies has been reported from the Maestrichtian (Tollmann, 1960). According to Postuma (1971), it ranges from the coniacian to the Lower Campanian. (See Range Chart 3).

Globotruncana lapparenti tricarinata (Quereau), 1893

Plate 21, figs. 7, 8.

1893 Pulvinulina tricarinata Quereau, pl. 5, fig. 3a.

1918 Rosalina linnei d'Orbigny; De Lapparent, type 2 (not Rosalina linnei d'Orbigny, 1839), p. 4, figs. 1b, d, e, f; p. 5, figs. 2d, n.

1941 Globotruncana linnei tricarinata (Quereau); Vogler, p. 287, pl. 33, figs. 22-31.

1944 Globotruncana lapparenti tricarinata (Quereau); Bolli, p. 232, pl. 9, fig. 13; text-fig. 1, nos. 19-20.

1951 Globotruncana lapparenti tricarinata (Quereau); Bolli, p. 194. text-fig. 1.

1954 Globotruncana lapparenti Brotzen tricarinata (Quereau); Hagn and Zeil, p. 42, pl. 6, figs. 6, 7.

1961 Globotruncana linneiana tricarinata (Quereau); Graham and Clark, p. 112, pl. 5, figs. 8a-c.

1962 Globotruncana tricarinata (Quereau); Adams and Kirk, pl. 14, figs. 10, 11, 13.

1962 Globotruncana (Globotruncana) tricarinata (Quereau); Berggren, p. 64, pl. 10, figs. 3a-c.

1965 Globotruncana lapparenti tricarinata (Quereau); Loriga and Mantovani, p. 171, pl. 5, figs. 2-5.

1972 Globotruncana tricarinata (Quereau); Barr, p. 25, pl. 9, figs. 3a-c.

1976 *Globotruncana tricarinata* (Quereau); Wright and
Apthorpe, p. 230, pl. 2, figs. 6, 7.

Remarks

Globotruncana lapparenti tricarinata (Quereau) was first described as "*pulvinulina*" *tricarinata* by Quereau in 1893, and the type description is based completely on thin sections. Brotzen (1936, quoted in Bolli, 1951 and Berggren, 1962) suggested a new species named *Globotruncana lapparenti* Brotzen for double keeled forms which were misidentified with *Globotruncana linneiana* (d'Orbigny). He regarded De lapparent's (1918) "types 1-6" of "*Rosalina linnei*" d'Orbigny from Henday (Pyrenees) as syntypes. He stated that these forms differ from "*Rosalina*" *linneiana* d'Orbigny in having curved umbilical sutures as against the radial sutures of d'Orbigny's forms. Bolli (1944, quoted in Bolli, 1951) elevated "types 1-4" of De Lapparent (1918) to the following proposed subspecies: *Globotruncana lapparenti lapparenti* Bolli (= type 1); *Globotruncana lapparent* *tricarinata* (Quereau) (= type 2); *Globotruncana lapparenti bulloides* Vogler (= type 3) and *Globotruncana lapparenti coronata* Bolli (= type 4). These subspecies are adopted in this work. For more comments on the *Globotruncana lapparenti* - *linneiana* group, reference should be made to the papers by Bolli (1944, 1951), Gandolfi (1955), Berggren (1962), Pessagno (1967) and Bronnimann and Brown (1955).

In the Nief Beds, *Globotruncana lapparent tricarinata* (Quereau) has been identified in thin sections. Typical specimens are characterized by a nearly flat to slightly convex trochospire; periphery is truncated with two distinctly, broadly spaced keels and a "third keel" formed by the inner portion of the ventral suture; a wide peripheral band which is vertical to the spiral surface and a broad umbilicus.

Two specimens of *Globotruncana lapparenti tricarinata* have been photographed and illustrated. One specimen shows the "third keel" on the two sides of the section (pl. 21, fig. 8). It is comparable with the figures given by Bolli (1951 , p. 190, fig. 1b), Loriga and Mantovani (1965, pl. 113, fig. 2) and Adams and Kirk (1962, pl. 14, fig. 13). The other specimen shows a "third keel" on one side of the section. It conforms with the figure illustrated by Hagn and Zeil (1954, pl. 6, fig. 6).

Dimensions of the figured specimens

Pl. 21, figs. 7, 8.

Max. diameter = 0.45 mm, 0.47

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncana lapparenti tricarinata has been reported from within the "Lower Campanian to the Lower Maestrichtian" of many parts of the world (Quereau, 1893; Dalbiez, 1955; Bolli 1957b; Barr, 1972; Wright and Apthorpe, 1976). This subspecies was also reported from the Santonian and Coniacian (Belford, 1960; Wille-Janoschek, 1966; Takayanagi, 1965). A few papers have reported this subspecies from rocks as old as Turonian (Bolli, 1944; Cita, 1948; Edgell, 1957; Bandy, 1967).

Globotruncana linneiana (d'Orbigny), 1839

Plate 21, figs. 9, 10

1839 Rosalina linneiana d'Orbigny (Rosalina linnei in the plates), pl. 5, figs. 10-12.

1955 Globotruncana linneiana (d'Orbigny); Bronnimann and Brown, p. 540, pl. 20, figs. 13-17; pl. 21, figs. 16-18.

1959 Globotruncana linneiana (d'Orbigny); Naggapa, pl. 6, no. 6.

1962 Globotruncana linneiana linneiana (d'Orbigny); Barr, p. 571, pl. 69, figs. 7a-c; pl. 72, fig. 5.

1962 Globotruncana (Globotruncana) lapparenti linneiana (d'Orbigny); Pessagno, p. 360.

1967 Globotruncana linneiana (d'Orbigny) (part); Pessagno, p. 346, pl. 97, figs. 11-13.

1969 Globotruncana linneiana (d'Orbigny); Douglas, pl. 3, fig. 1.

1970 Globotruncana linneiana (d'Orbigny); Papp and Turnovsky, pl. 51, fig. 1.

1972 Globotruncana linneiana (d'Orbigny); Barr, p. 21, pl. 9, figs. 2a-c.

1976 Globotruncana linneiana (d'Orbigny); Wright and Apthorpe, p. 239, pl. 1, figs. 8, 11.

Remarks

Globotruncana linneiana was originally described by d'Orbigny (1839) as "Rosalina" linneiana in the text and "Rosalina linnei" in the plate explanation. The types were from a Recent beach sands containing reworked Upper Cretaceous Foraminifera from Habana Bay, Cuba. A neotype for d'Orbigny's "Rosalina" linneiana has been chosen by Bronnimann and Brown (1956) from a topotypic sample from approximately the same type locality.

Many workers regard *Globotruncana linneiana* d'Orbigny and *Globotruncana lapparenti lapparenti* Bolli as conspecific (cf. Graham and Clark, 1961; Trujillo, 1960; Barr, 1962, 1972; Papp and Turnovsky, 1970). Others consider both forms as discrete taxa (cf. Bolli, 1951; Bronnimann and Brown, 1956; Klaus, 1959; Naggapa, 1959; Takayanagi, 1965; Douglas, 1969; Cita and Gartner, 1971; Owen, 1970). According to Pessagno (1967), *Globotruncana lapparenti lapparenti* Bolli, 1944 emend. Pessagno, 1967 differs from *Globotruncana linneiana* (d'Orbigny) in having narrower double keels, somewhat spiroconvex test and curved sutures umbilically. In contrast, *Globotruncana linneiana* is characterized by biplanar spiral and umbilical sides, and straight to slightly curved sutures umbilically. On the light of these differences, and personal observations, these two forms are considered to be separate taxa.

The specimens from the Nief Beds are characterized by their parallel biplanar surface, widely spaced peripheral double keels, vertical peripheral bands and wide umbilici. Two specimens were photographed and illustrated. They are similar to the figures given by Naggapa (1959, pl. 6, fig. 6), Barr (1962, pl. 72, fig. 3), Pessagno and Miyano (1968, pl. 4, fig. 2) and Papp and Turnovsky (1970, pl. 51, fig. 1). However, some of the specimens exhibit a slightly convex spiral side.

Dimensions of the figured specimens

Pl. 21, figs. 9, 10.

Max. diameter = 0.42 mm, 0.42.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

The range of Globotruncana linneiana (d'Orbigny) depends on the personal judgement of the specific limit of this species by different authors. It was recorded from rocks as old as Turonian and continues to the Lower Maestrichtian (Subbotina, 1953; Bronnimann and Brown, 1955; Trujillo, 1960; Hinte, 1963). According to Takayanagi (1965), most records from Europe, North America, the Carribean region etc. indicate its range to be from the Coniacian to the Campanian. However, he added that during its appearance in Turonian and its extinction in Maestrichtian, it is rare. In the Western Gulf Coastal Plain, Globotruncana linneiana ranges from within the Lower Campanian to the upper Lower Maestrichtian (Pessagno, 1967). (See Range Chart 3).

Globotruncana loeblichi Pessagno, 1967

Plate 21, fig. 11

1967 Globotruncana loeblichi Pessagno, p. 349, pl. 73, figs. 1-4; pl. 97, fig. 10.

Remarks

According to Pessagno (1967), Globotruncana loeblichi is phylogenetically related to Globotruncana linneiana. This relation is substantiated by the single specimen identified from the Nief Beds, in which the early nepionic stage reveals all the distinguishing features of Globotruncana linneiana.

Globotruncana loeblichi Pessagno differs from Globotruncana linneiana (d'Orbigny) in having more closely spaced double keels, a more compressed test, the dichotomous nature of the keels and the imbricate appearance of the chambers as seen in side view.

A single specimen of Globotruncana loeblichi Pessagno has been recognized in the thin section in the Nief Beds. It has a characteristic axial profile, and can not be misidentified with any other species. It agrees closely with the figure given by Pessagno (1967, pl. 97, fig. 10).

Dimensions of the figured specimen

Max. diameter = 0.6 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

According to Pessagno (1967), Globotruncana loeblichi ranges from the upper Lower Campanian to the end of the Campanian. (See Range Chart 3).

Globotruncana schneegansi Sigal, 1952

Plate 21, fig. 12

1952 Globotruncana schneegansi Sigal, p. 33, fig. 34.

1957b Globotruncana schneegansi Sigal; Bolli, p. 58, pl. 14, figs. 1a-c.

1971 Globotruncana schneegansi Sigal; Postuma, p. 56, 57.

1973 Globotruncana schneegansi Sigal; Premoli Silva and Bolli, p. 526, pl. 5, figs. 4-6.

Remarks

Two sections of Globotruncana schneegansi were identified from the Nief Beds. It is distinguished by its low trochospiral, biconvex test with a single keel. These characteristics are in accord with the diagnosis of this species given by Bolli (1957b) and Takayanagi (1965). The Nief specimens are similar to the thin section figured by Postuma (1971, p. 57). However, the specimens from the Nief have a narrower and shallower umbilicus.

Dimensions of the figured specimen

Max. diameter = 0.37 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncana schneegansi Sigal ranges from Lower Turonian to Lowermost Santonian in various parts of the world. However, most of the published accounts report its occurrence in the Turonian and Coniacian (Bolli, 1957b; Klaus, 1959; Trujillo, 1960; Takayanagi, 1965; Bolli, 1966; Bandy, 1967).

Globotruncana stuarti (De Lapparent), 1918

Plate 21, fig. 13

1918 *Rosalina stuarti* De Lapparent, p. 12, pl. 1, fig. 5; text - figs. 4-5.

1949 *Globotruncana (Globotruncana) Stuarti* (De Lapparent); Reichel, p. 613, text-fig. 7a; pl. 16, fig. 10; pl. 17, fig. 10.

1955 *Globotruncana stuarti* (De Lapparent); Bronnimann and Brown, pl. 24, no. 9.

1955 *Globotruncana (Globotruncana) stuarti* (De Lapparent); Dalbiez, p. 170, text-figs. 4a-c.

1962 *Globotruncana (Globotruncana) stuarti* (De Lapparent); Berggren, pp. 60-64, pl. 10, figs. 2a-c.

1964 *Globotruncana stuarti stuarti* (De Lapparent); Olsson, p. 169, pl. 5, fig. 9.

1966 *Globotruncana stuarti stuarti* (De Lapparent); El-Naggar, p. 133, pl. 8, figs. 4a-d; pl. 9, figs. 1a-d.

1967 *Globotruncana stuarti* (De Lapparent); Pessagno, p. 356, pl. 81, figs. 1-6; pl. 93, figs. 9-11; pl. 94, fig. 7.

1969 *Globotruncana stuarti* (De Lapparent); Dupeuble, p. 155, pl. 1, fig. 1.

1971 *Globotruncana stuarti* (De Lapparent); Postuma, pp. 60-61.

1972 *Globotruncana stuarti* (De Lapparent); Barr, p. 24, pl. 6, figs. 1, 3.

Remarks

Globotruncana stuarti (De Lapparent) was first described as "*Rosalina*" *stuarti* from the Maestrichtian of Hendaye in southwestern France. Arni (1933, quoted by El-Naggar, 1966, without reference) referred this species to the genus *Globotruncana* Cushman.

Globotruncana stuarti (De Lapparent) is similar and related to *Globotruncana stuartiformis* Dalbiez. The former differs from the latter in having trapezoidal chambers in the last two or three chambers of the last volution, a circular periphery and a more convex spiral side.

Globotruncana stuartiformis is characterized by subtriangular chambers and a lobulate periphery.

In the Nief Beds, typical specimens of *Globotruncana stuarti* were identified. They are distinguished by their unicarinate biconvex tests with deep umbilici. It should be mentioned here that the chambers on the two sides of the axial section are almost equal in size. They are unequal and asymmetrical in *Globotruncana stuartiformis*. These specimens are closely comparable with the figure given by Postuma (1971, p. 61).

Dimensions of the figured specimen

Max. diameter = 0.62 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

All reliable sources indicate the restriction of *Globotruncana stuarti* (De Lapparent) to the Maestrichtian. Berggren (1962) stated "valid references to this species indicate its occurrence in the Upper Maestrichtian". According to Postuma (1971), it ranges throughout the Maestrichtian. The occurrence of *Globotruncana stuarti* also was reported from the Campanian (Cita, 1948; Bolli, 1951; Pessagno, 1962; Bandy, 1967). (See Range Chart 3).

Globotruncana stuartiformis Dalbiez, 1955

Plate 21, figs. 14, 15

1955 *Globotruncana (Globotruncana) elevata stuartiformis* Dalbiez, p. 169, text-figs. 10a-c.

1959 *Globotruncana (Globotruncana) elevata stuartiformis* Dalbiez; Banner and Blow, p. 24, pl. 2, figs. 2a-c.

1962 *Globotruncana (Globotruncana) stuarti stuartiformis* Dalbiez; Pessagno, p. 362, pl. 2, figs. 4-6.

1963 *Globotruncana stuartiformis* Dalbiez; Lehman, p. 151, pl. 10, figs. 2a-c.

1966 *Globotruncana stuarti stuartiformis* Dalbiez; El-Naggar, p. 136, pl. 9, figs. 3a-d.

1967 *Globotruncana stuartiformis* Dalbiez; Pessagno, p. 357, pl. 92, figs. 1-3; pl. 93, figs. 6, 7; text-fig. 44, fig. 17 only.

1970 *Globotruncana stuartiformis* Dalbiez; Owen, p. 60, pl. 18, figs. 4-6.

1970 *Globotruncana elevata stuartiformis* Dalbiez; Papp and Turnovsky, pl. 54, fig. 1.

1971 *Globotruncana stuartiformis* Dalbiez; Postuma, pp. 62-63.

1972 *Globotruncana stuartiformis* Dalbiez; Barr, p. 25, pl. 6, figs. 4a-c.

1973 *Globotruncana stuartiformis* Dalbiez; Smith and Pessagno, p. 52, pl. 19, figs. 10-12.

Remarks

Dalbiez (1955) described the holotype of *Globotruncana stuartiformis* as a subspecies of *Globotruncana elevata* (Brotzen) from the Upper Cretaceous of Le Kef-Mellegue in northwestern Tunisia. Since then its affinities, specific limits, taxanomic status and evolution have been the subject of much controversy. *Globotruncana stuartiformis* is regarded here as a separate species but phylogenetically related, and morphologically similar to *Globotruncana elevata*

(Brotzen) and Globotruncana stuarti (De Lapparent). It differs from Globotruncana elevata (Brotzen) in having a biconvex test, a moderately lobulate periphery, a less distinct central cone on the spiral side, and last formed chambers which are almost triangular in shape on the spiral side. Globotruncana elevata is distinguished in having a flat, slightly concave or slightly convex spiral side surrounding a central cone; a lobulate periphery and petaloid chambers on the spiral side (Dalbiez, 1955; Pessagno, 1967; Posturna, 1971; Caron, 1972).

Globotruncana stuartiformis is a common species amongst the thin sections from the Nief Beds. Specimens show some similarity with the figure illustrated by Postuma (1971, p. 63). However, they differ in having more robust tests and less flattened areas around the central elevation of the dorsal side. Similar forms have been illustrated by Papp and Turnovsky (1970, pl. 54, fig. 1). However, these illustrations show a less convex umbilical side than specimens from the Nief Beds.

Dimensions of the figured specimens

Pl. 21, figs. 14, 15.

Max. diameter = 0.58 mm, 0.46.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globotruncana stuartiformis has been reported from various stratigraphical levels within the Cambanian to the Maestrichtian in different parts of the world (Pessagno, 1960; El-Naggar, 1966; Barr, 1968, 1972; Douglas, 1969; Owen, 1970; Cita and Gartner, 1970; Sliter, 1973; Smali, 1973; Kassab, 1979). Only two papers (Pessagno, 1962; Hinte, 1969) report this species from the Upper Santonian. (See Range Chart 3).

Globotruncana sp.1

Plate 22, figs. 1, 2

Remarks

Globotruncana sp.1 is characterized by a large, robust test and double keels which probably merge into one.

Dimensions of the figured specimens

Pl. 22, figs. 1, 2.

Max. diameter = 0.65 mm, 0.77.

Max. thickness = 0.4 mm, 0.4.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globotruncana sp.2

Plate 22, fig. 3

Remarks

Globotruncana sp.2 is similar to Marginotruncana bouldinensis Pessagno, illustrated by Pessagno (1967, pl. 98, fig. 1). However, it differs mainly in having a more convex spiral side. It is distinguished by a convex test with two keels and a large deep umbilicus.

Dimensions of the figured specimen

Max. diameter = 0.4 mm

Max. thickness = 0.2 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globotruncana *sp.3*

Plate 22, fig. 4

Remarks

Globotruncana *sp.3* resembles the *Globotruncana plummerae* Gandolfi illustrated by Pessagno (1967, pl. 96, fig. 9). However, *Globotruncana* *plummerae* has prominent two keels, while only a single keel is present in the specimen from the Nief Beds.

Dimensions of the figured specimen

Max. diameter = 0.62 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globotruncana sp.4

Plate 22, fig. 5

Remarks

Globotruncana sp.4 is characterized by a biconvex test, a single keel on one side and double keels on the other side of the section, and a curved outer wall to the chambers.

Dimensions of the figured specimen

Max. diameter = 0.4 mm.

Max. thickness = 0.25 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globotruncana sp.5

Plate 22, fig. 6

Remarks

Globotruncana sp.5 shows some similarity in general axial profile with Globotruncana gagnebini Tilev, but it differs in having a more convex spiral side, and well developed double keels on one side of the section.

Dimensions of the figured specimen

Max. diameter = 0.37 mm

Max. thickness = 0.22 mm

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globotruncana sp.6

Plate 22, figs. 7, 8

Remarks

Globotruncana sp.6 is characterized by a moderately biconvex test, narrowly spaced double keels which are either directed horizontally or slightly reflected upward, a moderately wide umbilicus, and the slightly curved sides to the chambers of the last whorl. This species differs from Globotruncana ventricosa White in having hemispherical instead of straight sides to the chambers of the last whorl. It is separated from Globotruncana primitiva Dalbiez by its more convex spiral side.

Dimensions of the figured specimens

Pl. 22, figs. 7, 8.

Max. diameter = 0.47 mm, 0.5 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globotruncana sp.7

Plate 22, fig. 9

Remarks

Globotruncana sp.7 shows similarity with Globotruncana primitiva Dalbiez as far as the flattened dorsal side and the compressed chambers are concerned, but it differs in lacking well developed double keels.

Dimensions of the figured specimen

Max. diameter = 0.32 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Genus Archaeoglobigerina Pessagno, 1967

Genotype: Archeoglobigerina blowi Pessagno, 1967

Archaeoglobigerina cretacea (d'Orbigny), 1840

Plate 22 fig. 10

1840 Globigerina cretacea d'Orbigny, p. 34, pl. 3, figs. 12-14

1960 Globotruncana cretacea (d'Orbigny); Banner and Blow, pp. 8-10, pl. 7, figs. 1a-c.

1961 Globigerina (Rugoglobigerina?) cretacea d'Orbigny; Hofker, p. 124, Fig. 1.

1967 Archaeoglobigerina cretacea (d'Orbigny); Pessagno, p. 317, pl. 70, figs. 3-8; pl. 94, figs. 4-5.

1967 Rugoglobigerina cretacea (d'Orbigny); Bandy, p. 21, Text-Fig. 10.

1968 Hedbergella cretacea (d'Orbigny); Neagu, p. 228, text-fig. 2, no. 63.

1969 Globotruncana cretacea (d'Orbigny); Douglas, p. 178, pl. 6, figs. 3-4.

1979 Archaeoglobigerina cretacea (d'Orbigny); Frerichs, p. 178, pl. 8, figs. 4-6.

Remarks

In the Nief Beds, two specimens of Archaeoglobigerina cretacea (d'Orbigny) were identified in thin section. One specimen (pl. 22, fig. 10) shows the slightly truncated peripheral margin on one side. It is comparable with the figure given by Pessagno (1967, pl. 94, fig. 4). The other specimen shows a rounded, peripheral margin on both sides. However, the figured specimen shows a smaller diameter than the lectotype selected by Banner and Blow (1960).

Dimensions of the figured specimen

Max. diameter = 0.28 mm (lectotype = 0.48 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Archaeoglobigerina cretacea (d'Orbigny), 1840 was originally described from the Lower Campanian White Chalk of Saint Germain, near Paris. Because of its misidentification (see Banner and Blow, 1960), later publications have incorrectly recorded the occurrence of this species from the Lower Cretaceous to Recent. Reliable references indicate that Archaeoglobigerina cretaca ranges from the Upper Coniacian to the Lower Maestrichtian (cf. Pessagno, 1967). According to Banner and Blow (1960), it ranges from Coniacian to Campanian. (See Range Chart 3).

Family *Rotaliporidae* Sigal, 1958, emend. Pessagno, 1967

Subfamily *Rotaliporinae* Sigal, 1958

Genus *Rotalipora* Brotzen, 1942

Genotype: *Rotalipora turonica* Brotzen, 1942 (= *Rotalipora Cushmani* (Morrow), 1934)

Remarks

The diagnosis by Loeblich and Tappan (1964) of the genus *Rotalipora* Brotzen is followed here.

Rotalipora appenninica (Renz), 1936

Plate 22, figs. 11-14

1936 *Globotruncana appenninica* Renz, p. 20, 135, text-figs. 2, 7a; pl. 6, figs. 1-11; pl. 7, fig. 1; pl. 8, fig. 4.

1948 *Globotruncana appenninica appenninica* Renz; Cita, p. 1, pl. 3, fig. 1.

1949 *Globotruncana (Rotalipora) apenninica* Renz; Reichel, p. 604, text-fig. 4, pl. 16, fig. 4; pl. 17; fig. 4.

1952 *Rotalipora apenninica* (Renz); Sigal, p. 24, text-fig. 23.

1957 *Globotruncana (Rotalipora) apenninica apenninica* Renz; Gandolfi, p. 60, pl. 9, fig. 1.

1959 *Rotalipora (Thalmanninella) appenninica appenninica* (Renz); Klaus, p. 808, pl. 3, figs. 3a-c.

1967 *Rotalipora appenninica* (Renz); Pessagno, p. 289, pl. 50, figs. 1, 2, 4-6; pl. 51, figs. 10-12; pl. 98, fig. 13; pl. 101, figs. 1, 2.

1971 *Rotalipora appenninica* (Renz); Postuma, pp. 76, 77.

1979 *Rotalipora appenninica* (Renz); Sigal, pl. 4, figs. 29, 30.

1979 *Thalmanninella appenninica* (Renz); Wonders, pl. 2, figs. 3, 5, 7.

Remarks

The published accounts of Rotalipora appenninica (Renz), clearly indicate confusion and misidentification. This results from the original concept of the species, being based on thin section. For more comments on Rotalipora appenninica, reference should be made to the papers by Renz (1936), Gandolifi (1942), Marie (1948), Cita (1948), Reichel (1949), Mornod (1949), Hagn and Zeil (1954), Dalbiez (1955), Klaus (1959), Luterbacher and Premoli silva (1962), Pessagno (1967) and Caron and Luterbacher (1969).

Marie (1948) selected the form figured by Renz (1936) on page 14, fig. 2 (specimen on left side), and the corresponding specimen in Renz's collection in Basel as lectotype. Pessagno (1967) for various reasons, selected another lectotype which is different from that selected by Marie (1948). He designated the form figured by Renz (1936) on pl. 8, fig. 4, and the corresponding specimen in Renz's collection in Basel as a new lectotype.

In Seram, Rotalipora appenninica (Renz) has been identified in thin sections from the Nief Beds. The axial profiles of these specimens show variation similar to that of the original illustrations by Renz (1936). Four sections have been photographed and illustrated. One specimen is similar to the lectotype selected by Marie (1948), two specimens are comparable with the lectotype and paralectotype selected by Pessagno (1967), and the fourth is a fragment of a specimen similar to the figure illustrated by Renz (1936) on plate 6, fig. 11. These specimens are also comparable with the sections given by Hagn and Zeil (1954), Papp and Turnovsky (1970), Postuma (1971) and Wonders (1979).

Dimensions of the figured specimens

Pl. 22, figs. 11-13.

Max. diameter = 0.45 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5, 6 & 7.

Known range

A Cenomanian distribution of Rotalipora appenninica has been recorded in various parts of the world (Dalbiez, 1955; Renz, Luterbacher and Schneider, 1963; Bandy, 1967; Pessagno, 1967; Neagu, 1968; Postuma, 1971; Barr, 1972; Sigal, 1979). According to Wonders (1979), it ranges from Middle Albian to the Lower Cenomanian in the Scaglia Bianca in the Umbrian Sequence, North Italy. Robaszynski and Caron (1979) gave the range from Middle Upper Albian to the Lower Middle Cenomanian. (See Range Chart 3).

Rotalipora cushmani (Morrow), 1934

Plate 22, fig. 15

1934 Globorotalia cushmani Morrow, p. 199, pl. 31, figs. 2, 4.

1942 Rotalipora turonica Brotzen, p. 32, text-fig. 10.

1944 Globotruncana alpina Bolli, pp. 224,-225, pl. 9, figs. 3, 4, text-fig. 1, no. 5.

1948 Globotruncana benacensis Cita, pp. 147-148, pl. 3, figs. 3a-c.

1949 Globotruncana (Rotalipora) montsalvensis Mornod, p. 584, text-fig. 4, no. 1; text-fig. 7, no. 1, 2.

1949 Globotruncana (Rotalipora) turonica Brotzen; Reichel, p. 607, pl. 16, fig. 5; pl. 17, fig. 5.

1952 Globotruncana (Rotalipora) turonica (Brotzen) var. expansa Carbonnier, p. 118, pl. 6, fig. 4.

1954 Rotalipora turonica thomei Hagn & Zeil, p. 28, pl. 1, fig. 6; pl. 4, figs. 5-6.

1954 Rotalipora montsalvensis Mornod; Hagn and Zeil, p. 29, pl. 1, fig . 4; pl. 5, fig. 2.

1954 Rotalipora cushmani (Morrow); Hagn and Zeil, p. 29, pl. 1, fig. 3; pl. 4, figs. 8-10.

1961 Rotalipora cushmani (Morrow); Loeblich and Tappan, p. 297, pl. 8, figs. 1-10.

1966 Rotalipora cushmani cushmani (Morrow); Salaj and Samuel, pp. 184-185, pl. 13, figs. 2a-c; 4a-c.

1967 Rotalipora cushmani (Morrow); Pessagno, p. 292, pl. 51, figs. 6-8; pl. 101, figs. 5-7.

1977 Rotalipora cushmani (Morrow); Carter and Hart, p. 41, pl. 2, fig. 18; pl. 4, figs. 7-9 (Cum. Ref.).

1979 Rotalipora cushmani (Morrow); Sigal, pl. 5, figs. 15-16.

Remarks

For detailed comments on Rotalipora cushmani (Morrow), reference should be made to the papers by Bronnimann and Brown (1955), Loeblich and Tappan (1961), Pessagno (1967) and Carter and Hart (1977).

In Seram, one typical specimen of Rotalipora cushmani was identified in thin section from the Nief Beds. It is distinguished by its inflated but slightly compressed final chambers with a single keel, convex test with a depressed trochospire and wide and deep umbilicus. The high convexity of the test places this species in Rotalipora turonica Brotzen. The specimen agrees well with Rotalipora turonica (= Rotalipora cushmani) illustrated by Hagn and Zeil (1954, pl. 4, fig. 3), and with Globotruncana alpina (= Rotalipora cushmani) illustrated by Bolli (1944, text - fig. 1, no. 5).

Dimensions of the figured specimen

Max. diameter = 0.57 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

In the published accounts of Rotalipora cushmani, the total range was reported to be from within the Middle Cenomanian to the Lower Turonian. However, a Lower to Upper Turonian range was recorded by few workers including Cushman (1946) and Frizzell (1954). Middle Cenomanian occurrence was indicated by Eicher & Worstell (1970a) and Carter and Hart (1977). According to Carter and Hart (op. cit.), it ranges from Upper Middle to the end of the Cenomanian in the southern England and northern France. An Upper Cenomanian to Lower Turonian range was reported from the Aquitaine Basin of France, Germany, Algeria, Morocco and Austria (Pessagno, 1967). (See Range Chart 3).

Rotalipora greenhornensis (Morrow), 1934

Plate 23, fig. 1

1934 Globorotalia greenhornensis Morrow, p. 199, pl. 31, fig. 1.

1940 Planulina greenhornensis (Morrow); Cushman, p. 37, pl. 7, fig. 1.

1948 Rotalipora greenhornensis (Morrow); Sigal, p. 100, pl. 1, fig. 4; pl. 2, figs. 3-5.

1955 Thalmanninella greenhornensis (Morrow); Bronnimann and and Brown, p. 535, pl. 20, figs. 7-9.

1959 Rotalipora (Thalmanninella) greenhornensis (Morrow); Klaus, p. 805, pl. 2, figs. 3a-c.

1963 Rotalipora greenhornensis (Morrow); Renz, Luterbacher and Schneider, p. 1087.

1967 Rotalipora greenhornensis (Morrow); Pessagno, p. 295, pl. 50, fig. 3; pl. 51, figs. 13-21; pl. 101, figs. 3-4.

1971 Rotalipora greenhornensis (Morrow); Postuma, pp. 80-81.

1977 Rotalipora greenhornensis (Morrow, 1934); Carter and Hart, p. 44, pl. 4, figs. 10-12.

1977 Rotalipora greenhornensis (Morrow); Petters, p. 169, pl. 4, figs. 3-5.

Remarks

Pessagno (1967) indicated the possibility that Rotalipora greenhornensis is a junior synonym of Rotalipora deekii (Franke). Carter and Hart (1977) pointed out that many European workers regarded these forms as descrete, and added that one of the latest references to Thalmanninella deekii included Rotalipora greenhornensis in its synonym. The forms described as Globorotalia decorata Cushman & Todd, Rotalipora globotruncanoides Sigal and Thalmanninella brotzeni Sigal were found to show no significant difference from Rotalipora greenhornensis, therefore, the view of Loeblich and Tappan (1961), Bandy (1967), Pessagno (1967) and Carter and Hart (1977) concerning their snyonymity is accepted here. Papers by Bronnimann and Brown (1955), Klaus (1955), Loeblich and Tappan (1961), Pessagno (1967) and Carter and Hart (1977) for more comments on Rotalipora greenhornensis (Morrow) should be referred to.

Rotalipora greenhornensis (Morrow) has been identified in thin section from the Nief Beds. It is distinguished by an almost flat spiral side, gradual increase in the size of the chambers, an umbilical shoulder and an angled periphery with a faint keel. The first character distinguishes this species from *Rotalipora reicheli* which possesses a concave spiral side. The Nief Beds specimens of *Rotalipora greenhornensis* compare closely with the figure given by Postuma (1971, p. 81) except that Postuma's illustration shows more convexity on the spiral side.

Dimensions of the figured specimen

Max. diameter = 0.42 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Rotalipora greenhornensis (Morrow) has a Cenomanian distribution all over the world, although few workers (Bronnimann and Brown, 1955; Bandy, 1967) have indicated its occurrence in Lower Turonian. Most of the reported ranges come from the Middle and Upper Cenomanian in various parts of the world (Neagu, 1968; Pessagno, 1967; Douglas, 1969; Barr, 1972; Carter and Hart, 1977; Robaszynski and Caron, 1979). According to Postuma (1971), the species ranges throughout the *Rotalipora greenhornensis* zone to the middle part of the *Rotalipora cushmani* zone (Upper Cenomanian).

Lower Cenomanian occurrences are reported by many workers including Klaus (1959), McNeely (1973) and Petters (1977). (See Range Chart 3).

Rotalipora reicheli (Mornod), 1949

Plate 23, figs. 2-6.

1949 Globotruncana (Rotalipora) reicheli Mornod, p. 583, fig. 5 (4a-c); fig. 6 (1-6); pl. 15, figs. 2a-p, 3-8.

1954 Rotalipora reicheli Mornod; Hagn and Zeil, p. 25, pl. 1, fig. 2; pl. 4, figs. 1-2; pl. 7, fig. 11.

1959 Rotalipora (Thalmanninella) reicheli (Mornod); Klaus, p. 806, pl. 4, figs. 2a-c; text-fig. 7, 3a-c.

1961 Rotalipora reicheli (Mornod); Loeblich and Tappan, p. 301, pl. 8, fig. 12.

1961 Rotalipora reicheli (Mornod); Borsetti, p. 44, pl. 4, figs. 7-8; text-figs. 94-97.

1969 Rotalipora reicheli (Mornod); Caron and Luterbacher, p. 27, pl. 9, fig. 10.

1971 Rotalipora reicheli (Mornod); Postuma, pp. 82-83.

1972 Rotalipora reicheli (Mornod); Barr, p. 16, pl. 3, figs. 5a-c.

1979 Rotalipora reicheli (Mornod); Sigal, p. 294, pl. 5, figs. 17-18.

Remarks

In Seram, Rotalipora reicheli was recognized in thin section from the Nief Beds. The specimens show considerable variation in the concavity of the spiral side, the degree of the inflation of the final chamber, the rate of the increase in the chambers of the final volution and the size of the umbilicus.

Five specimens have been photographed and illustrated. Those on plate 23, figs. 2 & 4 are similar to the figure given by Postuma (1971). The specimens on plate 23, figs. 5 & 6 compare closely with the figure given by Hagn and Zeil (1954, pl. 4, figs. 1, 2) and Mornod (1949, pl. 15, fig. 6). The specimen on plate 23, fig. 3 shows a peculiar axial profile. It possesses a very large and inflated final chamber compared to the rest of the test. No illustration of this type has been found in the published literature. However, provisonally it is regarded as within the range of variation of Rotalipora reicheli.

Dimensions of the figured specimens

Pl. 23, figs. 2-6.

Max. diameter = 0.42 mm, 0.5, 0.52, 0.57, 0.42.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Rotalipora reicheli (Mornod) is universally known to occur in Upper Cenomanian (Mornod, 1949; Bolli 1966; Caron and Luterbacher, 1969; Postuma, 1971). A Lower Turonian occurrence was reported from Tunisia (Dalbiez, 1955) and in the "Complexe Schisteux Intermediaire", Switzerland (Klaus, 1959). A Middle Cenomanian occurrence was recorded in the Southern Eastern Carpathians, near Brasov (Neagu, 1968). According to Robaszynski and Caron (1979), it ranges throughout their Rotalipora reicheli zone (uppermost Lower Cenomanian to the lowermost Middle Cenomanian). (See Range Chart 3).

Subfamily *Hedbergellinae* Loeblich and Tappan, 1961

Genus *Clavihedbergella* Banner & Blow, 1959?

Genotype *Hastigerinella* *subcretacea* Tappan, 1943

Clavihedbergella *?* *sp*.

Pl. 23, fig. 7

Remarks

Clavihedbergella? *sp* is recognized from the Lower Cretaceous part (Albian?) of the Nief Beds. The species is characterized by a clavate final chamber, elongated in the direction of coiling. The general equitorial profile is in accord with the section of *Clavihedbergella* *subdigitata* given by Bozorgnia (1964) on plate 93, fig. 6. However, the specimens from the Nief Beds are smaller, have a tangentially expanded final chamber and a less lobulate periphery.

Dimensions of the figured specimen

Max. diameter in the direction of the final chamber = 0.17 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 7.

Genus *Hedbergella* Bronnimann & Brown, 1958

Genotype: *Anomalina* *Loreiana* d'Orbigny var. *trochoidea* Gandolfi, 1942

Hedbergella sp. cf. washitensis (Carsey), 1926

Pl. 23, fig. 8

Remarks

The axial section of Hedbergella sp. cf. washitensis is semicircular with the chambers of the final volution occupy most of the test. The surface of the test seems to be either covered by a reticulation or spines. This form is similar to Hedbergella washitensis (Carsey) illustrated by Postuma (1971, p. 67). However, it differs in having a finer reticulation, and the last chambers occupy a larger proportion of the test.

Dimensions of the figured specimen

Max. diameter = 0.4 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Hedbergella sp.1

Plate 23, fig. 9

Remarks

Hedbergella sp.1 is distinguished by an almost splane, or very low spiral side, convex umbilical side and a globular chamber of the last volution with a thin, unornamented wall.

Dimensions of the figured specimen

Diameter = 0.2 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Hedbergella sp.2

Plate 23, fig. 10

Remarks

Hedbergella sp.2 is characterized by a prominent elevation of the dorsal part of the chambers of the final volution, and notably of the last chamber. The wall is thin and covered by costellae which may or may not be arranged in a meridional pattern. The species is referred provisionally to the genus Hedbergella Bronnimann and Brown.

Dimensions of the figured specimen

Diameter = 0.17 mm.

Abundance, distribution faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Hedbergella sp.3

Plate 23, fig. 11

Remarks

The main characteristics of Hedbergella sp.3 are the very low trochospire except for the dorsally convex projection of the last few chambers. The wall is thin and smooth However, this form is kept provisionally in the genus Hedbergella Bronnimann and Brown. If these specimens prove to have sutural apertures, they may be referred to Loeblichell hessi (Pessagno) which is illustrated by Pessagno (1967, pl. 100, fig. 2).

Dimensions of the figured specimen

Diameter = 0.14 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Hedbergella sp.4

Plate 23, fig. 12

Remarks

A few badly preserved sections of *Hedbergella* sp.4 have been identified from the Cenomanian of the Nief Beds. These forms have highly inflated and rapidly increasing chambers. The test is biconvex, notably on the spiral side.

Dimensions of the figured specimen

Diameter of the section = 0.25 mm.

Max. thickness = 0.18 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Hedbergella sp.5

Plate 23, fig. 13

Remarks

One very badly preserved section of *Hedbergella* sp.5 has been identified from the Lower Cretaceous (Albian?) of the Nief Beds. The specimen has highly inflated and rapidly increasing chambers. The test is biconvex with a flattened dorsal side.

Dimensions of the figured specimen

Diameter of the section = 0.24 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 7.

Genus *Praeglobotruncana* Bermudez, 1952

Genotype: *Globorotalia delrioensis* Plummer, 1931,
by original designation.

Remarks

The diagnosis given by Loeblich and Tappan (1964, p. C.659) is followed here.

Praeglobotruncana delrioensis (Plummer), 1931

Plate 23, fig. 14

1931 *Globorotalia delrioensis* Plummer, p. 199, pl. 13, figs. 2a-c.

1946 *Globorotalia marginaculeata* Loeblich & Tappan, p. 257, pl. 37, figs. 19-21, text-fig. 4a.

1952 *Praeglobotruncana delrioensis* (Plummer); Bermudez, p. 52, pl. 7, fig. 1.

1960 *Praeglobotruncana delrioensis* (Plummer); Klaus, p. 300, text-fig. 1a.

1961 *Praeglobotruncana delrioensis* (Plummer); Loeblich and Tappan, p. 280, pl. 6, figs. 9-12.

1967 *Praeglobotruncana delrioensis delrioensis* (Plummer); Bandy, p. 16, text-fig. 8, no. 1.

1967 *Praeglobotruncana delrioensis* (Plummer); Pessagno, p. 286, pl. 52, figs. 3-5; pl. 100, fig. 7.

1977 *Praeglobotruncana delrioensis* (Plummer); Carter and Hart, p. 38, pl. 4, figs. 22-24.

1978 *Praeglobotruncana delrioensis* (Plummer); Pflaumann and Krasheninnikov, p. 548, pl. 4, figs. 1-3.

1980 *Praeglobotruncana delrioensis* (Plummer); Ice and McNulty, p. 407, pl. 4, fig. 3.

Remarks

Praeglobotruncana delrioensis is similar and may be confused with *Praeglobotruncana stephani* (Gandolfi). They have been regarded as synonymous by Bronnimann and Brown (1955), Zeigler (1957) and Banner and Blow (1959). However, most of the published accounts treat them as discrete species although the difficulty of their separation was indicated by Carter and Hart (1977). Bandy (1967) considered *Praeglobotruncana stephani* (Gandolfi) as a subspecies of *Praeglobotruncana delrioensis*. According to Pessagno (1967), *Praeglobotruncana delrioensis* differs from *Praeglobotruncana stephani* in its more biconvex test, in having a coarsely spinose periphery, compressed to subglobular chambers, a smaller size and being stratigraphically older. These two species are retained here as a separate entities.

Praeglobotruncana delrioensis (Plummer) has been recognized in thin section from the Nief Beds. It is characterized by a low trochospiral and biconvex test which is covered by very fine pustules. Initially, the chambers are globular becoming compressed as added which gives a subangular form to the keelless periphery. The specimens compare closely with the axial profile of *Praeglobotruncana delrioensis* given by Pessagno (1967, pl. 100, fig. 7).

Dimensions of the figured specimen

Max. diameter = 0.32 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Most of the published accounts report the occurrence of *Praeglobotruncana delrioensis* from within the Upper Albian to the Lower Cenomanian (Bolli, 1957b; Loeblich and Tappan, 1961; Pessagno, 1967; Barr, 1972; Herb, 1974; Carter and Hart, 1977; Sliter, 1977). Occurrences within the Lower to Middle Albian have been reported by Klaus (1959), Marianos and Zingula (1966), Caron (1978) and Pflaumann and Krasheninnikov (1978). This species has been recorded from within the Middle and Upper Cenomanian by Renz, Luterbacher and Schneider (1963), Eicher (1969) and Carter and Hart (1975). Very rare occurrences were reported from the Lower Turonian (Klaus, 1959). (See Range Chart 3).

Praeglobotruncana? praehelvetica (Trujillo), 1960

Plate 23, fig. 15

1960 *Rugoglobigerina praehelvetica* Trujillo, p. 340, pl. 49, figs. 6a-c.

1966 *Hedbergella praehelvetica* (Trujillo); Douglas and Sliter, p. 104, pl. 4, figs. 3a-c (not pl. 5, figs. 3a-c)

1966 *Praeglobotruncana praehelvetica* (Trujillo); Marianos and Zingula, p. 338, pl. 38, figs. 9a-c.

1969 *Hedbergella praehelvetica* (Trujillo); Douglas, p. 168, pl. 4, fig. 3.

1979 *Whiteinella praehelvetica* (Trujillo); Wonders, pl. 5, fig. 4.

Remarks

Praeglobotruncana? *praehelvetica* Trujillo differs from *Praeglobotruncana* *helvetica* (Bolli) in having a weaker keel, a more convex spiral side, a finely perforated margin, and the upper part of the final volution is rounded in section instead of flattened (Trujillo, 1960; Marianos and Zingula, 1966; Douglas, 1969).

A single specimen of *Praeglobotruncana*? *praehelvetica* was recognized from the Nief Beds. It is characterized by the flattening of the dorsal side and the step-like elevation separating the raised initial volutions and the outer whorl. The specimen from the Nief Beds is comparable with the thin section figure illustrated by Wonders (1979, pl. 5, fig. 4) as far as the general axial profile is concerned. However, the Nief Beds specimen shows a thinner wall, less rugosity and almost half the size. Thus it could be a young specimen.

Dimensions of the figured specimen

Diameter = 0.14 mm (holotype = 0.39 mm).

Thickness = 0.08 mm (holotype = 0.26 mm).

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

According to Robaszynski and Caron (1979), *Praeglobotrunca* *praehelvetica* ranges from Uppermost Cenomanian to the end of Middle Turonian. It has been reported from within this range in California (Douglas, 1969) and the Central Apennines (Wonders, 1979). (See Range Chart 3).

Praeglobotruncana stephani turbinata (Reichel), 1949

Plate 24, figs. 1, 2.

1942 Globotruncana appenninica var. beta Gandolfi, p. 118, fig. 41, no. 2 a, b.

1949 Globotruncana stephani Gandolfi var. turbinata Reichel, p. 609.

1949 Globotruncana stephani turbinata Reichel; Mornod, p. 588, pl. 15, figs. 18a-j, 19, 20; text-fig. 11, no. 1-3.

1955 Praeglobotruncana delrioensis turbinata (Reichel); Bronnimann and Brown, p. 532, text-fig. 17 (i, j, h).

1956 Globotruncana (Praeglobotruncana) stephani turbinata (Reichel); Küpper, p. 43, pl. 8, figs. la-c.

1957 Globotruncana (Globotruncana) stephani turbinata Reichel; Gandolfi, p. 62, pl. 9, figs. 4a-b.

1959 Praeglobotruncana stephani turbinata (Reichel); Klaus, p. 795, pl. 6, figs. 3a-c.

1961 Praeglobotruncana stephani turbinata (Reichel); Borsetti, p. 33, pl. 11, figs. 14-16; text-figs. 102-107.

1971 Praeglobotruncana turbinata (Reichel); Postuma, p. 74, 75.

Remarks

Very few sections of Praeglobotruncana stephani turbinata were recognized from the Nief Beds. It is distinguished by a high spired test, wide umbilicus and inflated but slightly compressed chambers. The peripheral margin is subangular. The specimen on plate 24, fig. 1, exhibits a faint keel on one side of the section. Two specimens were photographed and illustrated. The specimen on plate 24, fig. 1, conforms to the figure given by Borsetti (1961, pl. 2, fig. 16). The specimen on plate 24, fig. 2 is similar to the figure shown by Hagn and Zeil (1954, pl. 5, fig. 3.). However, they differ slightly in the size of the umbilicus and the angularity of the peripheral margin.

Dimensions of the figured specimens

Pl. 23, figs. 1, 2.

Diameter of the section = 0.47 mm, 0.42.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5, 6 & 7.

Known range

Most of the records of *Praeglobotruncana stephani turbinata* are from the Cenomanian and Turonian (Küpper, 1956; Klaus, 1959; Borsett, 1961; Neagu, 1968; Postuma, 1971). According to Robaszynski and Caron (1979), it ranges from Upper Albian to the Middle Turonian. (See Range Chart 3).

Praeglobotruncana? *sp*.

Plate 24, fig. 3

Remarks

Praeglobotruncana? *sp*. is similar to *Loeblichella coarctata* (Bolli) illustrated by Ice and McNulty (1980) on plate 5, fig. 9. However, the specimens from the Nief Beds have much larger diameters.

Dimensions of the figured specimen

Diameter = 0.52 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Family *Schackoinidae* Pokorny, 1958

Genus *Schackoina* Thalmann, 1932

Genotype: "*Siderolina*" *cenomana* Schacko, 1897

Schackoina sp.

Plate 24, fig. 4

Remarks

A very rare section of *Schackoina sp.* was identified from an Upper Cenomanian sample of the Nief Beds. This form seems to be related to *Schackoina cenomana* (Schako) or *Schackoina multispinata* (Cushman & Wickenden).

Dimensions of the figured specimen

Length of the section = 0.37 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Family Planomalinidae Bolli, Loeblich & Tappan, 1957

Genus Globigerinelloides Cushman & Ten Dam, 1948

Genotype: Globigerinelloides algeriana Cushman &
Ten Dam, 1948

Globigerinelloides bentonensis (Morrow), 1934

Plate 24, fig. 5

1934 Anomalina bentonensis Morrow, p. 201, pl. 30, figs. 4-b.

1961 Globigerinelloides bentonensis (Morrow); Loeblich and Tappan, p. 267, pl. 2, figs. 8-10.

1967 Globigerinelloides bentonensis (Morrow); Pessagno, p. 275, pl. 76, figs. 10-11.

1977 Globigerinelloides bentonensis (Morrow); Carter and Hart, p. 27, pl. 1, fig. 11; pl. 2, figs. 19, 20.

1977 Globigerinelloides bentonensis (Morrow); Sliter, p. 541, pl. 5, figs. 4-5.

1978 Globigerinelloides bentonensis (Morrow); Pflaumann and Krasheninnikov, p. 548, pl. 3, figs. 6-7.

Remarks

A single matrix free specimen of Globigerinelloides bentonensis (Morrow) was identified from a Cenomanian sample. It is characterized by a biumbilicate test. The aperture is a low equatorial arch extending around the base of the final chamber on the two sides of the test and covered by a narrow lip. The relict previous apertures and lips are not preserved. This specimen is comparable with the figure given by Carter and Hart (1977, pl. 1, fig. 11). However, the specimen from the Nief Beds shows a narrower and deeper umbilicus and finer pores.

Dimensions of the figured specimen

Max. diameter = 0.4 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Globigerinelloides bentonensis (Morrow) has been reported from the Cenomanian of various parts of the world (Morrow, 1934; Eicher, 1969; Eicher and Wortell, 1970a; Pessagno, 1967; Pflaumann and Krasheninnikov, 1978). In recent accounts the range has been extended down to include the whole Albian (Carter and Hart, 1977; Sliter, 1977; Caron, 1978). (See Range Chart 3).

Globigerinelloides sp.1

Plate 24, fig. 6

Remarks

Globigerinelloides sp.1 shows some similarity with *Globigerinelloides bollii* Pessagno figured by Pessagno (1967) on plate 97, fig. 2.

Dimensions of the figured specimen

Length of the section = 0.2 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globigerinelloides sp.2

Plate 24, fig. 7

Remarks

Globigerinelloides sp.2 shows some similarity with Globigerinelloides prairiehillensis Pessagno figured by Pessagno (1967) on plate 97, fig. 4.

Dimensions of the figured specimen

Length of the section = 0.22 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Globigerinelloides sp.3

Plate 24, fig. 8

Remarks

Many specimens of Globigerinelloides sp.3 were encountered in thin section from two Cenomanian samples.

Dimensions of the figured specimen

Length of the section = 0.22 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Family Heterohelicidae Cushman, 1927

Subfamily Heterohelicinae Cushman, 1927

Genus Racemiguembelina Gallitelli, 1957

Genotype: Guembelina fructicosa Egger, 1899

Racemiguembelina fructicosa (Egger), 1899

Plate 24, figs. 9, 10

1895 Pseudotextularia varians Rzehak, p. 217, pl. 7, figs. 2, 3.

1899 Guembelina fructicosa Egger, p. 35, pl. 14, figs. 8-9, 24.

1929 Pseudotextularia varians Rzehak; White, p. 40, pl. 4, figs. 15a-b.

1957 Racemiguembelina fructicosa (Egger); Gallitelli, p. 142, pl. 32, figs. 14-15.

1962 Pseudotextularia (Racemiguembelina) fructicosa (Egger); Berggren, pp. 22-24, pl. 6, figs. 6a-b.

1965 Pseudotextularia cf. varians Rzehak; Loriga and Mantovani, pl. 114, fig. 6.

1967 Racemiguembelina fructicosa (Egger); Pessagno, p. 270, pl. 90, figs. 14-15.

1970 Pseudotextularia varians Rzehak; Papp and Turnovsky, pl. 56, figs. 1-2.

1973 Racemiguembelina fructicosa (Egger); Smith and Pessagno, p. 33, pl. 12, figs. 1-8.

1976 Racemiguembelina fructicosa (Egger); Wright and Apthorpe, p. 238, pl. 1, fig. 4.

Remarks

The new genus Racemiguembelina suggested by Gallitelli (1957) for specimens of Pseudotextularia varians of Rzehak (1895), showing late chamber proliferation is accepted here as a valid taxon. However, many workers including Brown (1969), Papp and Turnovsky (1970) and Hofker (1978) consider Pseudotextularia varians as a valid species for the proliferated forms described by Rzehak (1895).

Two specimens of *Racemiguembelina fructicosa* were photographed and illustrated. The specimen on plate 24, fig. 9 shows a clear separation between the biserial and the proliferated part. The biserial portion forms the larger part of the test. The separation is less evident in the other specimen. This is probably due to the sub-axial orientation of the section. These specimens conform with the illustration of "*Pseudotextularia* cf. *varians*" (= *R. fructicosa*) given by Loriga and Mantovani (1965, pl. 114, fig. 6), and to the *Pseudotextularia varians* (= *R. fructicosa*) illustrated by Papp and Turnovsky (1970, pl. 56, fig. 2).

Dimensions of the figured specimens

Pl. 24, figs. 9, 10.

Max. length of the section = 0.47 mm, 0.52.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

All the available records of *Racemiguembelina fructicosa* (Egger) indicate its world wide restriction to the Middle and Upper Maestrichtian stage. Neagu (1968)'s is the only publication to have recorded this species from the Lower Maestrichtian. (See Range Chart 3).

Racemiguembelina sp.

Plate 24, fig. 11

Remarks

Racemiguembelina sp. differs from the illustrated specimen of *Racemiguembelina fructicosa* (pl. 24, fig. 9) in having a more robust test and thicker chamber wall. The biserial portion shows similarity to *Pseudotextularia deformis* (Kikoine), particularly with respect to the planar nature of the partitions and the thickened wall. This form seems to be related to *Racemiguembelina powelli* Smith & Pessagno. No thin section illustration of *Racemiguembelina powelli* has been found in the literature for comparison. *Racemiguebelina sp.* occurs together with and is related to *Pseudotextularia elegans* (Rzehak), *Pseudotextularia sp.2* and *Racemiguembelina fructicosa* (Egger).

Dimensions of the figured specimen

Length of the section = 0.50 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Genus *Pseudotextularia* (Rzehak), 1891

Genotype: *Pseudotextularia elegans* (Rzehak)
(= *Cuneolina elegans* Rzehak, 1891 (part)).

Pseudotextularia elegans (Rzehak), 1891

Plate 24, figs. 12, 13

1891 Cuneolina elegans Rzehak, p.2, 4.

1895 Pseudotextularia varians Rzehak (part), p. 217, pl. 7, figs. 1a-b.

1929 Guembelina elegans (Rzehak); White, pp. 34-35, pl. 4, fig. 8.

1937 Guembelina plummerae Loetterle, p. 33, pl. 5, figs. 1-2.

1956 Bronnimannella plummerae (Loetterle); Gallitelli, p. 35, pl. 7, figs. 1, 2.

1957 Pseudotextularia elegans (Rzehak); Gallitelli, p. 138, pl. 33, fig. 6.

1967 Pseudotextularia elegans (Rzehak); Pessagno, p. 268, pl. 75, figs. 12-17; pl. 85, figs. 10-11; pl. 88, figs. 14-16; pl. 89, figs. 10-11; pl. 97, fig. 18; pl. 98, figs. 19-20.

1969 Pseudotextularia cushmani Brown, pp. 55-56, pl. 2, figs. 2a-b, 3a-b; pl. 3, figs. 4a-b.

1973 Pseudotextularia elegans (Rzehak); Smith and Pessagno, p. 30, pl. 9, figs. 5-7, 8-11, 12-15; pl. 10, figs. 2-3, 4-6.

Remarks

The taxanomic history of Pseudotextularia elegans (Rzehak) is confused, and interpreted differently by various workers as indicated by the work of Ellis and Messina (1940, no. 39), Gallitelli (1957), Brown (1969), Smith and Pessagno (1973), Masters (1976) and Smith (1978).

The diagnosis of Pseudotextularia Rzehak presented by Gallitelli (1957) and Loeblich and Tappan (1964) is followed here. They give the basic characteristic features distinguishing this genus as the biserial arrangement of chambers and the greater width compared to the thickness of the chambers. On this basis, many forms described as pseudotextularia elegans, including the illustrations by Naggapa (1959, pl. 7, figs. 7-8), Hiltermann and Koch (1960, text-fig. 4) and Brown (1969, pl. 2, figs. 4a-b; pl. 3, figs. 2-3; text-figs. 13, 14) are excluded from this species.

Pseudotextularia elegans (Rzehak) identified from the Nief Beds is characterized by curves septal partitions, thin walls, a greater width than thickness and the rapid increase in the size of the chambers. The last character places these specimens in Pseudotextularia elegans s.l. of Pessagno (1967). They are comparable with the figure illustrated by Smith and Pessagno (1973, pl. 10, fig. 3).

Dimensions of the figured specimens

Pl. 24, figs. 12, 13.
Max. length of the test = 0.35 mm, 0.57.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Pseudotextularia elegans is widely reported from the Maestrichtian and Campanian in various parts of the world. It has been reported from the Maestrichtian of the Caribbean region (Pessagno, 1960), Egypt (Said and Kerdany, 1961), south eastern Carpathian (Neagu, 1968), Western Aquitain, France (Dupeuble, 1969), Papua New Guinea (Owen, 1970), Texas (Smith and Pessagno, 1973) and Western Australia (Wright et al., 1976). It has been reported throughout the Campanian and Maestrichtian (Pessagno, 1960, 1967). (See Range Chart 3).

Pseudotextularia sp.1

Plate 24, fig. 14

Remarks

Pseudotextularia sp.1 shows some similarity with Pseudotextularia elegans s.s. illustrated by Smith and Pessagno (1973, pl. 10, fig. 2). It differs from the latter in having thicker walls and planar partitions. Pseudotextularia sp.1 may be related to Pseudotextularia deformis (Kikoine).

Dimensions of the figured specimen

Length of the section = 0.27 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Pseudotextularia sp. 2

Plate 24, fig. 15

Remarks

Pseudotextularia sp.2 is probably related to the Pseudotextularia deformis (Kikoine) - Racemiguembelina fructicosa (Egger) bioseries.

Dimensions of the figured specimen

Length of the section = 0.44 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Genus Planoglobulina Cushman, 1927

Genotype: Planoglobulina acervulinoides (Egger)
(= Guembelina acervulinoides Egger, 1899)

Planoglobulina sp.

Plate 25, figs. 1, 2

Remarks

Planoglobulina sp. was identified from a few Campanian and Maestrichtian samples from the Nief Beds. All the specimens are recognized from thin sections. Two of these have been photographed and illustrated. That on plate 25, fig. 1 has an orientation traverse to the chambers proliferation. The other specimen on plate 25, fig. 2 has an orientation parallel to the direction of the chambers proliferation. The specimens are comparable with the figure illustrated by the AGIP Mineraria (1959, pl. 99).

No criteria or illustrations have been found in the literature to separate the various species of the genus Planoglobulina Cushman in thin section.

Dimensions of the figured specimens

Pl. 25, figs. 1, 2.

Max. length of the sections = 0.7 mm, 0.37

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Genus Heterohelix Ehrenberg, 1843

Genotype: Spiroplecta americana Ehrenberg, 1844

Heterohelix globulosa (Ehrenberg), 1840

Plate 25, fig. 3

1840 Textularia globulosa Ehrenberg, p. 135, pl. 4, figs. 2 beta, 4 beta, 5 beta, 7 beta, 8 beta.

1898 Textularia globulosa Ehrenberg; McClung, p. 421, pl. 85, figs. 1-4.

1899 Guembelina globulosa (Ehrenberg); Egger, p. 32, pl. 14, fig. 43.

1955 Guembelina globulosa (Ehrenberg); Weiss, p. 307, pl. 1, fig. 8.

1957 Heterohelix globulosa (Ehrenberg); Gallitelli, p. 137, pl. 31, figs. 12-15.

1964 Guembelina globulosa (Ehrenberg); McGugan, p. 942, pl. 150, fig. 20.

1967 Heterohelix globulosa (Ehrenberg); Pessagno, p. 260, pl. 87, figs. 5-9, 11-13.

1975 Heterohelix globulosa (Ehrenberg); Frerichs, Atherton, and Shive, p. 300, pl. 1, figs. 1-2.

1977 Heterohelix globulosa (Ehrenberg); Sliter, p. 541, pl. 6, figs. 4-6.

Remarks

In the Nief Beds, Heterohelix globulasa (Ehrenberg) was recognized in thin section. The specimens are characterized by a small, triangular, smooth tests with thin walls, biserial and globular chambers, the partitions between which are highly convex, highly arched apertures in the final as well as the preceeding chambers and a weakly lobulate periphery. They compare closely with the sections of Heterohelix globulosa figured by McClung (1898) and re-illustrated by Ellis and Messina et al. (1968, vol. 1, fig. 29).

Dimensions of the figured specimen

Max. length = 0.27 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

The published accounts report the occurrence of Heterohelix globulosa from Upper Cenomanian to the Upper Maestrichtian in various parts of the world (See Range Chart 3).

Heterohelix pulchra (Brotzen), 1936

Plate 25, figs. 4-6

1936 Guembelina pulchra Brotzen, p. 121, pl. 9, figs. 2a-b, 3a-b.

1938 Guembelina pseudotessera Cushman, p. 14, pl. 2, figs. 19-21.

1957 Heterohelix pulchra (Brotzen); Gallitelli, pp. 137-138, pl. 31, fig. 20.

1964 Heterohelix pulchra (Brotzen); Martin, p. 85, pl. 11, figs. 2a-b.

1969 Heterohelix pulchra (Brotzen); Douglas, p. 158, pl. 11, figs. 3, 14.

1969 Heterohelix pulchra (Brotzen); Stenestad, p. 654, pl. 1, figs. 1-3; pl. 3, fig. 3; text-fig. 9a-c.

1970a *Heterohelix pulchra* (Brotzen); Eicher and Worstell, p. 296, pl. 8, figs. 9-10.

1970b *Heterohelix pulchra* (Brotzen); Eicher and Worstell, p. 118, pl. 1, figs. 1-4.

1977 *Heterohelix pulchra* (Brotzen); Petters, p. 169, pl. 1, fig. 8.

1979 *Heterohelix pulchra* (Brotzen); Frerichs, p. 166, pl. 1, figs. 7-8.

Remarks

Heterohelix pulchra was identified in thin section. Two main types have been recognized, depending basically on the convexity and the degree of the interlocking between the biserial chambers. The first type (pl. 25, fig. 4) is characterized by a biserial arrangement of broadened reniform chambers, their breadth increasing as added and becoming slightly curved in the last three. This diagnosis applies to the matrix free specimens illustrated by Kent (1967, pl. 183, fig. 9), Douglas (1969, pl. 11, figs. 3-4), Frerichs et al. (1975, pl. 1, figs. 7-8) and Frerichs (1979, pl. 1, figs. 7-8) as far as the shape and the arrangement of chambers are concerned. No equivalent thin section illustration has been found in the literature.

The other form of *Heterohelix pulchra* (pl. 25, figs. 5, 6) is similar to the first, but differs in having more convex and more interlocked biserial chambers. This may be gradational into *Lunatriella spinifera* Eicher & Worstell as indicated by these authors. It is comparable with the figures illustrated by Stenestad (1969) on plate 3, figure 3.

Dimensions of the figured specimens

Pl. 25, figs. 4-6.

Max. length = 0.2 mm, 0.37, 0.25.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Known range

Heterohelix pulchra (Brotzen) is a long ranging species. Most of the published literature reports this species from within the "Coniacian to the Maestrichtian" in North America and Europe (Martin, 1964; Takayanagi, 1965; Pessagno, 1967; Stenestad, 1969 and Frerichs, 1979). Records from older beds include the Upper Cenomanian to the Late Turonian (Eicher and Worstell, 1970a, b and Frerichs et al., 1975). The species was reported to occur in the Campanian through the Maestrichtian on the northwestern shelf of Western Australia (Wright and Apthorpe, 1976) and in the South Western Atlantic Ocean (Sliter, 1977).

Heterohelix sp.1

Plate 25, fig. 7

Remarks

Heterohelix sp.1 shows similarity to *Heterohelix planata* (Cushman) illustrated by Cushman (1938, pl. 2, fig. 4) and Bandy (1967, text-fig. 12, no. 8) with regard to the arrangement of chambers.

Dimensions of the figured specimen

Max. length = 0.16 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Heterohelix sp.2

Plate 25, fig. 8

Remarks

Heterohelix sp.2 is characterized by a small and long test consisting of seven chambers. It shows similarity with Heterohelix moremani (Cushman).

Dimensions of the figured specimen

Length of the section = 0.32 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Genus Gublerina Kikoine, 1948

Genotype: Gublerina cuvillieri Kikoine, 1948
(= Ventilabrella ornatissima Cushman and Church, 1929

Gublerina sp.

Plate 25, figs. 9, 10?

Remarks

Two specimens of *Gublerina sp.* were chosen for illustration. These may belong to different species. The specimen shown on plate 25, fig. 9 has an orientation parallel to the median line along the non-septate part of the test. A similar form has been reported by Wonders (1979, pl. 12, fig. 7). The specimen on plate 25, fig. 10 has an orientation traverse to the non-septate part of the test. It is questionably included in this genus.

Dimensions of the figured specimens

Pl. 25, figs. 9, 10.

Length = 0.5 mm, 0.25.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 5 & 6.

Upper Triassic Foraminifera of The Asinepe Limestone

Suborder *Textulariina* Delage & Herouard, 1896

Superfamily *Ammodiscacea* Reuss, 1862

Family *Ammodiscidae* Reuss, 1862

Subfamily *Ammodiscinae* Reuss, 1862

Genus *Glomospira* Rzehak, 1885

Genotype: *Glomospira gordialis* (Jones & Parker), 1860

Glomospira sp.

Plate 25, fig. 11

Remarks

The test of *Glomospira sp.* consists of a very dense and packed central ball of many volutions coiled in vertical planes rotating around 360°. This is followed by a looser type of coiling. The wall is very finely agglutinated with a microgranular texture.

Dimensions of the figured specimen

Max. diameter of the test = 0.5 mm.

Max. diameter of the central ball = 0.2 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Genus *Glomospirella* Plummer, 1945

Genotype: "*Glomospira*" *umblicata* Cushman & Water, 1927

Glomospirella friedly Kristan-Tollmann, 1962, emended Bronnimann and Zaninetti (in Bronnimann et al. 1970)

Plate 25, fig. 12

1962 *Glomospirella friedly* Kristan-Tollmann, p. 229, pl. 1, figs. 1-9, 12-17.

Remarks

Glomospirella friedly Kristan-Tollmann may be confused and misidentified with *Involutina gaschei* (Koehn-Zaninetti & Bronnimann). The former is separated from the latter in having a dark imperforate wall compared with the white, thick, calcareous and perforate wall of *Involutina gaschei*. Some of the published reports have considered *Involutina gaschei* as a junior synonym (cf. Hoheneger and Piller, 1975).

Dimensions of the figured specimen

Max. diameter = 0.75 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Superfamily *Lituolacea* de Blainville, 1825

Family *Trochamminidae* Schwager, 1877

Subfamily *Trochammininae* Schwager, 1877

Genus *Trochammina* Parker & Jones, 1859

Genotype: *Trochammina inflata* (Montagu), 1808

Trochammina alpina Kristan-Tollmann, 1964

Plate 25, fig. 13

1964b *Trochammina alpina* Kristan-Tollmann, p. 43, pl. 7, figs. 2, 3.

1969 *Forma indeterminata* Boccaletti Ficcarelli, Manetti and Turi, fig. 43a.

1970 ?*Trochammina alpina* Kristan-Tollman; Tollmann and Kristan-Tollmann, pl. 4, figs. 4-5.

1971 *Trochammina almtalensis* Koehn-Zaninetti; Premoli Silva (not Koehn-Zaninetti, 1969), pl. 26, fig. 4.

1972 *Trochammina alpina* Kristan-Tollmann; Zaninetti, Bronnimann, Bozorgnia and Hubber, p. 232, pl. 2, figs. 1-4, 6, 8-10.

1974 *Trochammina*? *alpina* Kristan-Tollmann; Bronnimann, Zaninetti, Moshtaghian and Huber, p. 27, pl. 6, figs. 1-4, 5? 6-17; pl. 7, figs. 13, 14, 18.

Remarks

Many specimens of *Trochammina alpina* Kristan-Tollmann were recognized in thin section. It is a high spired form with a pointed apex, 5 volutions forming the test which has a microgranular texture. However, the illustrated specimen shows a higher apical angle, smaller test and thinner wall compared with most of the forms illustrated in the literature. It is similar to the figure given by Bronnimann, Zaninetti, Moshtaghian and Huber (1974) on plate 6, fig. 7.

Dimensions of the figured specimen

Max. diameter = 0.23 mm.

Height = 0.17 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

According to the published literature, the total stratigraphical range of *Trochammina alpina* is from Upper Ladinian or Carnian to the Rhaetian. (See Range Chart 4).

Suborder *Miliolina* Delage & Herouad, 1896

Superfamily *Miliolacea* Ehrenberg, 1839

Family *Fischerinidae* Millet, 1898

Subfamily *Calcivertellinae* Loeblich & Tappan, 1964

Genus *Planiinvoluta* Leischner, 1961

Genotype: *Planiinvoluta carinata* Leischner, 1961

Planiinvoluta carinata Leischner, 1961

Plate 25, figs. 14, 15

1961 *Planiinvoluta carinata* Leischner, pl. 10, figs. 1-4; pl. 12, figs. 6, 7a-8a.

1976 *Planiinvoluta carinata* Leichner; Zaninetti, p. 139, pl. 7, figs. 32-33.

Remarks

The specimens of *Planiinvoluta carinata* identified in thin section is similar to specimens illustrated by Zaninetti (1976, pl. 7, figs. 32-33).

Dimensions of the figured specimens

Pl. 25, figs. 14, 15.

Length = 0.5 mm, 0.7.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Family *Nubeculariidae* Jones, 1875

Subfamily *Ophthalmidiinae* Wiesner, 1920

Genus *Ophthalmidium* Kübler & Zwingli, 1870

Genotype: *Ophthalmidium* *liasicum* (Kübler & Zwingli), 1866 (= *Oculina* *liasica* Kübler & Zwingli).

Ophthalmidium *spp*.

Plate 26, figs. 1-5

Remarks

The specimen on plate 26, fig. 4 is from the oolitic-pelletal unit of the Asinepe Limestone.

Dimensions of the figured specimens

Pl. 26, figs. 1-5.

Max. length of the section = 0.37 mm, 0.32, 0.17, 0.17, 0.8.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Family Milioliporidae Bronnimann & Zaninetti, 1971

Genus Galeanella Kristan, 1958

Genotype: Galeanella tollmanni (Kristan), 1957

Remarks

The genera of the family Milioliporidae are crystallized by a perforated or non-perforated porcelaneous wall. Subsequent recrystalization gives the dark brown to almost black microgranular texture as seen in thin section.

Galeanella panticae Zaninetti & Bronnimann, 1973

Plate 26, figs. 6, 7

1967 Foraminifer F-10 Pantic, pl. 4, figs. 1-2.

1973 Galeanella panticae Zaninetti & Bronnimann (in Bronnimann, Cadet, Ricou and Zaninetti, p. 420, pl. 2, figs. 1-21; pl.3, figs. 1-13.

1976 Galeanella panticae Zaninetti & Bronnimann; Zaninetti, p. 149, pl. 6, figs. 12-17; pl. 13, figs. 5-10.

Remarks

Galeanella panticae Zaninetti & Bronnimann is similar to Galeanella tollmanni (Kristan) from which it differs in having partially evolute and less overlapping chambers than the latter. It differs from Galeanella sp. (pl. 26, figs. 8, 9) in having a larger size and a perforated wall.

The record of Galeanella panticae from Seram is the first from the Far East. According to Bronnimann Cadet, Ricou and Zaninetti (1973), Iran is the furthest country from Europe in which this species has so far been identified.

A few specimens of Galeanella panticae were found in the Asinepe Limestone. They are characterized by a thick, microgranular and perforated wall. They conform well with this species illustrated by Bronnimann, Cadet, Ricou and Zaninetti (1973, pl. 2, figs. 11, 15).

Dimensions of the figured specimens

Pl. 26, figs. 6, 7.

Max. diameter = 0.50 mm, 0.45.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

Galeanella panticae Zaninetti & Bronnimann has been recorded from the Norian s.l. of Austria, Yugoslavia, Turkey and Iran (Bronnimann, Cadet, Ricou and Zaninetti, 1973; Zaninetti, 1976). According to Zaninetti (1982, Geneva, personal communication), the species restricted to the Norian s.l. (See Range Chart 4).

Galeanell sp.

Plate 26, figs. 8, 9

Remarks

The main features separating Galeanella sp. from

Galeanella panticae Zaninetti & Bronnimann are the smaller size of the test and the darker, non-perforated wall as seen in thin section.

Galeanella sp. will be described as a new species (Al-Shaibani, Carter and Zaninetti, in preparation).

Dimensions of the figured specimens

Pl. 26, figs. 8, 9.

Max. diameter = 0.3 mm, 0.2.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Genus Miliolipora Bronnimann & Zaninetti, 1971

Genotype: Miliolipora cuvillieri Bronnimann & Zaninetti, 1971

Miliolipora cuvillieri Bronnimann & Zaninetti, 1971

Plate 26, figs. 10, 11

1971 Miliolipora cuvillieri n.gen., n.sp. Bronnimann & Zaninetti; Bronnimann, Zaninetti, Bozorgnia, Dashti and Moshtagian, p.10, pl. 1, figs. 1-12; text - fig. 4.

1976 Miliolipora cuvillieri Bronnimann & Zaninetti; Zaninetti, p. 150, pl. 6, figs. 2-6, 8-11 (Cum. Syn.).

Remarks

Miliolipora cuvillieri was reported in the literature as Guttulina d'Orbigny and "Formes quinqueloculines perforées etc." (Zaninetti, 1976). Later, these forms were described as a new genus, new species from East Central Iran by Bronnimann, Zaninetti et al. (1971).

A few specimens of Miliolipora cuvillieri were identified in thin section. They are characterized by their dark grey, perforated walls with a microgranular texture. The perforations seem to be very badly preserved as a result of the re-crystalization. Individuals are similar to the types illustrated by Bronnimann, Zaninett et al. (1971, pl. 1, figs. 1-12).

Dimensions of the figured specimens

Pl. 26, figs. 10, 11.

Max. diameter = 0.4 mm, 0.3.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

Miliolipora cuvillieri has been reported from the Norian s.l. from Europe and South East Iran (Zaninetti, 1976). According to Zaninetti (1982, Geneva, personal communication), the total range is Norian s.l. (See Range Chart 4).

Suborder Rotaliina Delage & Herouard, 1896
Superfamily Duostaminacea Brotzen, 1963 (nom. transl. herein ex. family)
Family Duostominidae Brotzen, 1963

Genus Duotaxis Kristan, 1957
Genotype: Duotaxis metula Kristan, 1957

Remarks

Kirstan (1957) introduced the genus Duotaxis as member of the subfamily Tetrataxinae placed by this author in the family Trochamminidae. Loeblich and Tappan (1964), regarded Duotaxis as a synonym to the genus Valvulina de' Orbigny (Subfamily Valvulinidae Berthelin). Bronnimann, Whittaker and Zaninetti (1975) stated "As the wall is distinctly microgranular and not agglutinated, it is here suggested that Duotaxis be removed from the genus Valvulina and is considered as an independent genus whose affinities need still be clarified". These authors suggested placing it either in the Superfamily Litulacea or Endothyracea, Family?· Loeblich and Tappan (in Hedley and Adams, 1974) referred it to the Superfamily Duostominacea, family Duostominidae as the wall is hyaline with a microgranular structure, suggestion is provisionally followed here.

Duotaxis birmanica Bronnimann, Whittaker &
Zaninetti, 1975
Plate 26, fig. 12

1975 Duotaxis birmanica Bronnimann, Whittaker & Zaninetti, p. 11, pl. 1, figs. 1-11, 13-15, 17, 18, 20-22.

Remarks

Duotaxis birmanica is distinguished by a rounded trochospire, axially compressed chambers, and a narrow and deep umbilicus with a single-layered, microgranular texture. It conforms with Duotaxis birmanica illustrated by Bronnimann et al. (1975 , pl. 1, figs. 10, 11) from the Norian of the Namyau Group, Burma.

Dimensions of the figured specimen

Max. diameter = 0.37 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Suborder *Involutinina* Hohenegger & Piller, 1977

Family *Involutinidae* Butschli, 1880

Remarks

The family *Involutinidae* was placed in the Superfamily *Cassidulinacea* in the Treatise on Invertebrate Paleontology (C), on the basis of the lamellar microgranular wall described from poorly preserved and recrystalized specimens. Koehn-Zaninetti (1969) has emended the diagnosis of this family and indicated that the wall consists of one layer with a calcareous, perforate, radial and hyaline texture. According to these authors, *Involutinidae* is related to *Spirillinidae* and the microgranular wall of this group was regarded as a result of recrystalization. Loeblich and Tappan (in Hedley and Adams, 1974) referred the Family *Involutinidae* to the Superfamily *Spirillinacea* and regarded this group as having hyaline calcareous test with monocrystaline walls. Loeblich and Tappan (1981) assigned this family to the Suborder *Involutinina* Hohenegger and Piller, and this is followed here. For a detailed historical review of the taxonomic position of the Family *Involutinidae* and the related arguments, reference should be made to the paper by Loeblich and Tappan (1981, p. 160).

Genus Involutina Terquem, 1862, emend. Koehn-Zaninetti, 196

Genotype: Involutina liassica (Jones), 1853

Involutina communis (Kristan), 1957

Plate 26, figs. 13, 14

1957 Angulodiscus communis Kristan, p. 278, pl. 23, figs. 1-7.

1963 Angulodiscus communis Kirstan; Kristan-Tollmann and Tollman, p. 550, pl. 4, figs. 1 & 7.

1964a Angulodiscus communis Kristan; Kristan-Tollmann, p. 139, pl. 4, figs. 3,4.

1969 Involutina communis (Kristan); Koehn-Zaninetti, p. 113, text-figs. 28, 32 and 35 (nos. 1-3).

1970 Involutina communis (Kristan); Bronnimann, Poisson and Zaninetti, pl. 2, figs. 1, 2.

1971 Involutina communis (Kristan); Hohenegger and Lobitzer, pl. 1, fig. 20; pl. 3, fig. 1.

1972 Involutina communis (Kristan); Samuel, Borza and Köhler, pl. 17, fig. 4.

1974 Involutina communis (Kristan); Zaninetti and Bronnimann, pl. 2, nos. 4, 5.

1975 Involutina communis (Kristan); Zaninetti and Bronnimann, p. 264, text-fig. 3 (D, E, H-L), text-fig. 4(E).

Remarks

Involutina communis (Kristan) is characterized by a large (more than 1 mm), lenticular test devoid of umbilical pillars, a periphery which is either rounded or subangular; the test consists of a small proloculus followed by a planispiral, involute, tubular, non-septate second chamber, and occasionally the initial whorls show a slight oscillation axially; in section the lumens of the rolling tube are reniform and increase gradually in size from the inner to the peripheral part of the test; the axial profile is either of diamond or elliptical shape which swells in the median part of the test and tapers at the periphery; the wall is calcareous, finely perforated with a hyaline-radiate texture (Koehn-Zaninetti, 1969).

Involutina communis (Kristan) is separated from the similar *Involutina tumida* (Kristan-Tollmann) by the absence of the evolute peripheral part. According to Koehn-Zaninetti (1969), *Involutina communis* differs from *Involutina sinuosa pragsoides* (Oberhauser) in its lenticular test, and elliptical axial section which swells at the median portion and tapers towards the periphery. Moreover, it has been observed that, the cross-sections of the tubular second chamber in the successive whorls of *Involutina communis* are less flattened than *Involutina sinuosa pragsoides*.

Few specimens of *Involutina communis* (Kristan) have been identified from the Asinepe Limestone. They agree with the original description of the holotype by Kristan (1957), and as given by Koehn-Zaninetti (1969). However, the specimens from the Asinepe Limestone have fewer volutions than the 8-10 indicated by the latter author. It conforms well with *Involutina communis* illustrated by Samuel, Borza and Köehler (1972, pl. 17, fig. 4).

Dimensions of the figured specimens

Pl. 26, figs. 13, 14

Max. length of the section = 0.8 mm, 1.4 mm.

Max. thickness = 0.4 mm, 0.6.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

The total reported range of *Involutina communis* (Kristan) in Turkey, Iran, Austria and Pakistan is from Ladinian to the end of Rhaetian (Bronnimann, Poisson et al. 1970; Bronnimann, Zaninetti et al., 1971; Koehn-Zaninetti, 1969; Kristan, 1957; Kristan-Tollmann, 1964a; Kristan-Tollmann and Tollmann, 1963; Oberhauser, 1964; Zaninetti and Bronnimann, 1974; Zaninetti and Bronnimann 1975). (See Range Chart 4).

Involutina gaschei (Koehn-Zaninetti & Bronnimann), 1968

Plate 26, fig. 15; Plate 27, figs. 1, 2

1968a *Angulodiscus*? *gaschei* Koehn-Zaninetti & Bronnimann, p. 74, pl. 1, 2; text-fig. 3.

1969 *Involutina gaschei* (Koehn-Zaninetti & Bronnimann); Koehn-Zaninetti, p. 127, pl. 11, figs. E, F; text-fig. 38.

1969 *Involutina gaschei praegaschei* Koehn-Zaninetti, p. 130, text-fig. 39.

1970 *Involutina gaschei* (Koehn-Zaninetti & Bronnimann); Bronnimann, Poisson and Zaninetti, p. 26, pl. 2, figs. 3, 4.

1974 *Involutina gaschei gaschei* (Koehn-Zaninetti and Bronnimann); Bronnimann, Zaninetti, Moshtaghian and Huber, pp. 9-10, text-fig. 5, no. 49; text-fig. 6, nos. 26, 32, 45, 46; text-fig. 8, no. 34; pl. 4, figs. 13, 14; pl. 5, figs. 2, 4, 6.

1974 *Involutina gaschei* (Koehn-Zaninetti & Bronnimann); Zaninetti and Bronnimann. p. 409, 411, pl. 1, fig. 26; pl. 2, fig. 25.

1974 *Involutina gaschei praegaschei* Koehn-Zaninetti; Zaninetti and Bronnimann, p. 406, 407, 409-411, pl. 1, figs. 24, 25, 27-33; pl. 2, figs. 24, 26-28, 30-33.

1975 Involutina gaschei praegaschei Koehn-Zaninetti; Bronnimann, Whittaker and Zaninetti, p. 19, text-fig. 5, nos. 7-10, 12.

1976 Involutina gaschei (Koehn-Zaninetti & Bronnimann); Zaninetti, p. 159, pl. 9, figs. 13-15.

1976 Involutina gaschei praegaschei Koehn-Zaninetti; Zaninetti, p. 161, pl. 14, figs. 17, 18, 22; pl. 15, figs. 17-21.

Remarks

Two subspecies were described under Involutina gaschei, vis: Involutina gaschei gaschei (Koehn-Zaninetti & Bronnimann) and Involutina gaschei praegaschei Koehn-Zaninetti. The former differs from the latter in the polarization of the last two or three convolutions. Because of the difficulty of separating these two subspecies in the specimens from the Asinepe Limestone, they are both described here as Involutina gaschei (Koehn-Zaninetti & Bronnimann).

Three specimens from the Asinepe Limestone have been photographed and illustrated. The specimen on plate 26, fig. 15 shows the initially packed and irregularly enrolled whorls followed by a thin planispiral part. It conforms well with the figure given by Bronnimann, Zininetti, Moshtagian and Huber (1974, pl. 4, fig. 13). The other two specimens (pl. 27, figs. 1, 2) show an irregularly enrollment throughout the test. These are comparable with the figures given by Bronnimann, Zaninetti, Moshtagian and Huber (1974, pl. 5, figs. 2, 4, 6).

Dimensions of the figured specimens

Pl. 26, fig. 15; Pl. 27, figs. 1, 2.

Max. diameter = 0.6 mm, 0.8, 0.9.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

The total range of *Involutina gaschei* (Koehn-Zaninetti & Bronnimann) as reported from Austria, Burma, Iran, Pakistan and Turkey is from the Ladinian to the Rhaetian (Bronnimann, Poisson et al., 1970; Bronnimann, Zaninetti et al., 1974; Bronnimann, Whittaker et al., 1975; Hohenegger and Lobitzer, 1971; Koehn-Zaninetti and Bronnimann, 1968b; Koehn-Zaninetti, 1969; Zaninetti and Bronnimann, 1974; Zaninetti and Bronnimann, 1975). (See Range Chart 4).

Involutina impressa (Kristan-Tollmann), 1964

Pl. 27, fig. 3

1962 *Angulodiscus sp.* Kristan-Tollmann, p. 230, pl. 1, fig. 25.

1964a *Angulodiscus impressus* Kristan-Tollmann, p. 140, pl. 2, figs. 11-13.

1976 *Involutina impressa* (Kristan-Tollmann); Zaninetti, p. 161, pl. 9, figs. 11, 12.

Remarks

One specimen of *Involutina impressa* (Kristan-Tollmann) was identified from the Asinepe Limestone. This species differs from *Involutina tenuis* Kristan in having slightly concave sides in contrast to the parallel sides of the latter species. It agrees with the holotype illustrated by Kristan-Tollmann (1964a).

Dimensions of the figured specimen

Max. diameter = 1.5 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 10 & 11.

Known range

The total range of *Involutina impressa* is from the Carnian to the Rhaetian (fide Zaninetti, 1982, Geneva, personal communication). (See Range Chart 4).

Involutina sinuosa sinuosa (Weynschenk), 1956

Plate 27, fig. 4

1950 *Ophthalmididae*, *Genus*? *species*? Weynschenk, p. 15, pl. 1, fig. 5.

1955 *Involutinen* Hagn, pl. 17, fig. 1.

1956 *Aulotortus sinuosus* Weynschenk, p. 26, pl. 6, figs. 1, 3, (not fig. 2).

1964 *Aulotortus sinuosus* Weynschenk; Kristan-Tollmann, p. 143, pl. 4, figs. 11-12.

1965 *Permodiscus pragsoides* var. *oscillens* Oberhauser; Boselini and Loriga, p. 171, pl. 1, fig. 6.

1966 *Permodiscus sinuosus* (Weynschenk); Radoicic, pl. 73, fig. 1.

1967 *Aulotortus bronnimanni* Salaj; Salaj, Biely and Bistricky, p. 127, pl. 4, fig. 3.

1967 *Aulotortus oscillens* (Oberhauser); Salaj, Biely and Bistricky, pl. 1, fig. 16.

1969 *Involutina sinuosus sinuosus* (Weynschenk); Koehn-Zaninetti, p. 121, text-fig. 36, nos. 1-3; text-fig. 37, no. 3.

1971 *Involutina sinuosus sinuosus* (Weynschenk); Cousin and Neumann, pp. 36-39, pl. 1, fig. 1.

1974 Involutina sinuosus sinuosus (Weynschenk); Zaninetti and Bronnimann, p. 406, 407, 410, 411, pl. 1, figs. 15, 16, 19; pl. 2, figs. 1-3, 9, 10; pl. 3, figs. 1-12.

1975 Involutina sinuosa sinuosa (Weynschenk); Bronnimann, Whittaker and Zaninetti, p. 9, 17-19, text-fig. 5, nos. 1-5.

1976 Involutina sinuosa sinuosa (Weynschenk); Zaninetti, p. 167, pl. 9, fig. 18.

Remarks

Involutina sinuosa sinuosa is characterized by a large test (up to 2 mm. or more), elliptical to subcircular in axial section, consisting of a proloculus followed by a spiral non-septate tube; initially the second chamber is winding in a polarized or weakly oscillated pattern, becoming strongly oscillating in the final whorls. The last character separates this subspecies from Involutina sinuosa pragsoides (Oberhauser) which shows almost polarized oscillation throughout the whorls.

A single specimen of Involutina sinuosa sinuosa has been identified from the Asinepe Limestone. Despite the bad preservation of this specimen, it has all the features characteristic of this subspecies. However, it differs from the holotype illustrated by Weynschenk (1956, pl. 6, fig. 1) in having more sinuosity in the initial as well as the final convolutions. It shows similarity with the highly sinuos Involutina sinuosa sinuosa illustrated by Bronnimann, Zaninetti, Bozorgnia, Dashti and Moshtaghian (1971, text-fig. 5, nos. 14, 15), and to the illustration by Zaninetti and Bronnimann (1974, pl. 1, figs. 15, 16, 19) although they differ in the pattern of the enrollment.

Dimensions of the figured specimen

Max. length of the section = 2.2 mm.

Max. width = 1.2 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Nief Beds

See Table 10 & 11.

Known range

The total range of Involutina sinuosa sinuosa as recorded from Turkey (Bronnimann, Poisson et al., 1970), Iran (Bronnimann, Zaninetti et al. 1971; Zaninetti and Bronnimann, 1975), Burma (Bronnimann, Whittaker et al., 1975), Austria (Koehn-Zaninetti, 1969) and Pakistan (Zaninetti and Bronnimann, 1975) is from the Ladinian to the Rhaetian. (See Range Chart 4).

Involutina sinuosa pragsoides (Oberhauser), 1964

Plate 27, figs. 5, 6.

1945 ?? Hydrozoans, Valk, pl. 1, figs. 7-10.

1964 Aulotortus oscillens (Oberhauser); Loeblich and Tappan, p. 741, Fig. 605, nos. 4, 5.

1964 Permodiscus pragsoides Oberhauser, p. 200, pl. 1, figs. 10, 12-14, 17; pl. 2, figs. 3, 16, 23; pl. 4, figs. 8-9.

1967 Arenovidalina pragsoides (Oberhauser); Salaj, Biely and Bistricky, p. 125, pl. 4, fig. 2.

1969 Involutina sinuosa pragsoides (Oberhauser); Koehn-Zaninetti, p. 126, text-fig. 37, nos. 1, 4-6.

1970 Permodiscus pragsoides oscillens Oberhauser; Papp and Turnovsky, pl. 27, figs. 1-3.

1971 Involutina sinuosa pragsoides (Oberhauser); Bronnimann, Zaninetti, Bozorgnia, Dashti and Moshtaghian. p. 12, 14, text-fig. 5, nos. 1-13.

1973 Involutina sinuosa pragsoides (Oberhauser); Bronnimann, Cadet and Zaninetti, p. 315, pl. 19, figs. 1-18; pl. 20, figs. 1-7, 9, 10, 13; text-fig. 1.

1974 Involutina sinuosa pragsoides (Oberhauser); Zaninetti and Bronnimann, pp. 403-417, pl. 1, figs. 9-13; pl. 2, figs. 15-17; pl. 3, figs. 17, 18.

1975 Involutina sinuosa pragsoides (Oberhauser); Bronnimann, Whittaker and Zaninetti, pp. 1-9, 17-21, text-fig. 5, no. 6.

1976 Involutina sinuosa pragsoides (Oberhauser); Zaninetti, p. 165, pl. 12, figs. 1-3.

Remarks

Many specimens of Involutina sinuosa pragsoides were recognized from the Asinepe Limestone. Most of the individuals (pl. 27, fig. 5) are characterized by an elliptical axial profile with a planispiral deuteroloculus that shows a slight oscillation especially in the marginal portion of the test. This type conforms with the figure illustrated by Bronnimann, Cadet and Zaninetti (1973) on plate 19, fig. 19. One specimen (pl. 27, fig. 6) shows a diamond shaped axial profile with a complete polarization of the early volutions, and a slight oscillation in the adult stage. It is comparable with the figure illustrated by Bronnimann, Cadet and Zaninetti (1973a, pl. 19, fig. 1).

Dimensions of the figured specimens

Pl. 27, figs. 5, 6.

Max. diameter = 1.15 mm, 1.7.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

A total range from the Anisian to the Rhaetian of Involutina sinuosa pragsoides was recorded from Austria, Yugoslavia, West Carpathian, Iran and Burma (Bronnimann, Cadet and Zaninetti, 1973; Bronnimann et al., 1974; Bronnimann et al., 1975; Koehn-Zaninetti. 1969; Oberhauser, 1964; Samuel et al., 1972; Zaninetti and Bronnimann, 1974). (See Range Chart 1).

Involutina aff. tenuis Kristan, 1957

Plate 27, fig. 7

1957 Angulodiscus tenuis Kristan, p. 280, pl. 22, fig. 18.

1969 Involutina tenuis (Kristan); Koehn-Zaninetti, p. 116, text-fig. 33 (A-J).

1970 Involutina tenuis (Kristan); Bronnimann, Poisson and Zaninetti, p. 25, text-fig. 7, no. 10.

1972 Involutina tenuis (Kristan); Zaninetti, Bronnimann, Bozorgnia and Hubber, pp. 221, 238-241, pl. 1. fig. 4; text-fig 7, nos. 18-24.

1974 Involutina tenuis (Kristan); Zeninetti and Bronnimann, p. 409, pl. 2, figs. 21-22.

1975 Involutina tenuis (Kristan); Bronnimann, Whittaker and Zaninetti, p. 19, text-fig. 4, nos. 1-5.

Remarks

Involutina tenuis is distinguished from all other Involutines by its flattened and parallel sides.

Very few specimens of Involutina aff. tenuis have been recognized in thin section. The axial profiles of these specimens are elongated with parallel sides. Virtually all the internal features are obscured by the recrystalization. However, the last whorl or two can be seen clearly. They show large and crescentic tubular passages. These specimens resemble the figures given by Koehn-Zaninetti (1969) on text-fig. 33 (I, J), and the figures shown by Bronnimann, Whittaker and Zaninetti (1975) on text-fig. 4, nos. 3-5.

Dimensions of the figured specimen

Max. length of the section = 1.04 mm (holotype = 0.7)

Thickness = 0.32 mm (holotype = 0.11).

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

Koehn-Zaninetti (1969) and Piller (1978) gave the range of *Involutina tenuis* as from the Norian s.s. to the Rhaetian. It has been recorded from within this range in Austria (Kristan, 1957; Kirstan-Tollmann, 1964a), Burma (Bronnimann et al., 1975), Iran (Zaninetti and Bronnimann, 1974) and Turkey (Bronnimann, Poisson et al., 1970). (See Range Chart 4).

Involutina tumida (Kristan-Tollmann), 1964

Plate 27, figs. 8, 9

1962	*Angulodiscus sp.* Kristan-Tollmann, p. 230(5), pl. 1, fig. 24.
1964a	*Angulodiscus tumidus* Kristan-Tollmann, p. 141, pl. 3, figs. 1-6.
1964	*Involutina sp.* Cros & Neumann, pl. 3, fig. 8.
1969	*Involutina tumida* (Kristan-Tollmann); Koehn-Zaninetti, p. 120, text-fig. 35, nos. 5-9.

1970 Involutina tumida (Kristan-Tollmann); Bronnimann, Poisson and Zaninetti, p. 25, text-fig. 7, nos. 7?, 12.

1970 Angulodiscus tumidus Kristan-Tollmann; Tollmann and Kristan-Tollmann, pl. 7, figs. 4-6.

1971 Involutina tumida (Kristan-Tollmann); Hohenegger and Lobitzer, p. 475, pl. 3, fig. 4.

1974 Involutina tumida (Kristan-Tollman); Zaninetti and Bronniman, pp. 409-411, pl. 2, fig. 23; pl. 3, fig. 24.

1976 Involutina tumida (Kristan-Tollmann); Zaninetti, p. 169, pl. 9, figs. 8-10.

Remarks

Involutina tumida is distinguished by its lenticular to discoidal test devoid of an umbilical pillars with a rounded periphery. The central part of the test is involute, slightly to moderate convex and covered by an umbilical mass, followed by a planar, thinner and parallel sided evolute adult stage.

Involutina tumida shows similarity with Involutina Liassica (Jones). The latter differs from the former mainly in the presence of the umbilical pillars, more polarized volutions of the initial stage and in the shape of the cross-section of the second, tubular chamber.

The forms described as Involutina liassica (Jones) by Villa and Pozzi (1962, pl. 34, figs. 1, 2) lack any umbilical pillars, and are referred here to Involutina tumida.

In Seram, both the flattened and the inflated forms (see Kristan-Tollmann. 1964a) of Involutina tumida were recognized in the Asinepe Limestone. The flattened form (pl. 27, 8) conforms well with the holotype given by Kristan-Tollman (1964a) on plate 3, fig. 1, insofar as the general axial profile, as well as the subcircular cross-sections of the later whorls are concerned, otherwise the involute portion of the test is completely recrystalized. The inflated form (pl. 27, fig. 9) is comparable with the *Involutina tumida* illustrated by Zaninetti (1976, pl. 9, fig. 9).

Dimensions of the figured specimens

Pl. 27, figs. 8, 9.

Length of the axial section = 0.66 mm, 0.35.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

A total range from Norian s.l. to the lowermost Jurassic for *Involutina tumida* was recorded from Austria, Burma, Iran and Turkey (Kristan-Tollman, 1964a; Koehn-Zaninetti, 1969; Salaj, 1969; Bronnimann, Poisson et al., 1970; Bronnimann, Zaninetti et al., 1971; Zaninetti and Bronnimann, 1974; Bronnimann et al., 1975; Misik et al., 1977). (See Range Chart 4).

Genus *Triasina* Majson, 1954, emend. Koehn-Zaninetti, 196
Genotype: *Triasina hantkeni* Majzon, 1954

Triasina hantkeni Majzon, 1954
Plate 27, figs. 10-14.

1945 ??*Cymbalopora sp.*, Valk, pl. 1, fig. 3.

1954 Triasina hantkeni Majzon sp. nov., pl. 1, fig. 1; pl. 2, figs. 3-5; pl. 3, fig. 6.

1954 Triasina hantkeni var. elliptica Majzon subsp. nov., pl. 1, fig. 2; pl. 3, fig. 7.

1959 Pseudolacazina(?); AGIP Mineraria, pl. 30, fig. 3; pl. 31, fig. 1; pl. 39, fig. 1.

1964 Triasina hantkeni Majzon; Cros and Neumann, p. 129, pl. 2, figs. 1-5.

1966 Triasina hantkeni Majzon; Salaj, Biely and Bistricky, p. 214, pl. 2, fig. 4b.

1969 Triasina hantkeni Majzon; Koehn-Zaninetti, pp. 104-106, text-fig. 21, no. 12; text-fig. 30 (part).

1970 Triasina hantkeni Majzon; Bassoullet and Guernet, p. 210, pl. 1, fig. 1.

1971 Triasina hantkeni Majzon; Papp and Turnovsky, pl. 28, fig. 1; pl. 29, figs. 1, 2; pl. 30, figs. 1-4; pl. 32, fig. 3.

1971 Triasina hantkeni Majzon; Cousin and Neumann, p. 37, 41, pl. 1, figs. 2, 3.

1977 Triasina hantkeni Majzon; Misik, Rock and Sykora, p. 51, pl. 4, fig. 5.

Remarks

The diagnosis of Triasina hantkeni Majzon has already been given by Majzon (1954), Loeblich and Tappan (1964), Cros and Neumann (1964), Loeblich and Tappan (1964), Cros and Neumann (1964), Oberhauser (1964) and Koehn-Zaninetti (1969). According to the last author, the test is lenticular or subspherical, consisting of a globular proloculus, and a non-segmented, tubular, involute deuteroloculus, planispirally enrolled with occasional initial irregularities. The spaces between the whorls are joined by numerous pillars distributed throughout the test. The wall is calcareous perforate and consists of one layer with a hyaline-radial texture. As seen in thin section, those through the equitor (pl. 27, figs. 10-13), show a circular outline with numerous pseudo-chambers arranged in circular pattern from the center outward. The axial profile which passes through the umbilici (pl. 27, fig. 14), shows a shallow depressions on both sides, with a slightly elongated test.

Koehn-Zaninetti and Bronnimann (1968b) indicated that Triasina oberhauseri Koehn-Zaninetti & Bronnimann gives rise to Triasina hantkeni Majzon. The former species differs from the latter in having a well developed umbilical mass and a smaller number of pillars that are confined to the peripheral part of the test.

Five specimens of Triasina hantkeni from the Asinepe Limestone were photographed and illustrated. The illustrations on plate 27, figs. 10-12 show the circular arrangement of pillars throughout the test. These figures are comparable to the holotype given by Majzon (1954). The specimen on plate 27, fig. 13 shows a complete recrystalization of the test. The section on plate 27, fig. 14, shows an axial profile passing through the umbilici with umbilical depressions on the two sides. It is similar to the form illustrated by Cros and Neumann (1964, pl. 2, fig. 4).

The record of Triasina hantkeni (as ??Cymbalopora sp.) by Valk (1945, pl. 1, fig. 3) from Seram is the first record of this species from the Far East and not that of Fontaine et al. (1979).

Dimensions of the figured specimens

Pl. 27, figs. 10-13.

Diameter = 1.8 mm, 1.08, 1.05, 1.8.

Pl. 27, fig. 14

Length of the section = 1.2 mm.

Abundance, distribution, faunal association and stratigraphical occurrence in the Asinepe Limestone

See Table 10 & 11.

Known range

A total range from the Norian s.s. to the lowermost Jurassic of Triasina hantkeni has been recorded from Italy (AGIP Mineraria, 1959; Cousin and Neumann, 1971), Greece (Bassoullet et al., 1970), Austria (Koehn-Zaninetti, 1969; Oberhauser, 1964; Piller, 1978); Hungary (Majzon, 1954), and the Carpathian (Salaj et al., 1966; Misik et al., 1977). (See Range Chart 4).

Other Triassic Foraminifera of Unknown Affinity

Genus "B" species 1?

Plate 27, fig. 15

Remarks

Genus "B" species 1? is characterized by an early irregular glomospirine coiling followed by a septate? uncoiled part. The test is finely agglutinated.

Dimensions of the figured specimen

Max. diameter of the glomospirine part = 0.15 mm.

Length of the uncoiled part = 0.15 mm.

Abundance, distribution, faunal association and stratigraphical association in the Asinepe Limestone

See Table 10 & 11.

CHAPTER SIX

CONCLUSIONS

1. Re-Evaluation of the Age and the Stratigraphical Breaks of the Nief Beds

On the basis of the distribution of the *Foraminifera* and their stratigraphical ranges, the succession of the Nief Beds extends from the Upper Jurassic to the end of the Miocene.

1:1 The (Upper Jurassic-Lower Cretaceous) portion of the Nief Beds

The benthonic *Foraminifera* and other microfossils recognized from this portion of the Nief Beds are not reliable age indicators (Table 7). According to Audley-Charles et al. (1979), the age ranges from Upper Jurassic to the Lower Cretaceous. The presence of corroded Radiolaria amongst other microfossils indicate deposition close to the compensation depth for silica at about 4,000 metres.

1:2 Re-Evaulation of the Age and the Stratigraphical Breaks Within the Upper Cretaceous to the Upper Miocene portion of the Nief Beds

From the distribution of the planktonic *Foraminifera* (Table 1, 3, 5) and their stratigraphic ranges (Range Chart 1-3), the ages and the stratigraphical breaks within the Nief Beds (Table 2, 4, 6, 8) are established using the "P/N" zonation by Blow (1969, 1979). The planktonic *Foraminifera* and lithology of this part of the section indicate deposition in a deep bathyal (Slope and Rise) environment.

1:2:1 Table 6 and 8 indicate the presence of Upper Cenomanian, Campanian and Lower Maestrichtian. Sample (17-2) and CER 21(i) are doubtfully assigned to the Lower Cenomanian. The Turonian to the Santonian, and the Middle & Upper Maestrichtian are missing from the Nief Beds.

1:2:2 Table 4 & 8 indicate that the Lower Paleocene (zone P.α , subzone P.1a and subzone P.1b?), Upper Paleocene (zone P.6 - P.7) and Upper Late Eocene (zone P.15) are missing from the Nief Beds.

1:2:3 The recognition of *Globigerina officinalis* Subbotina and *Globorotalia (T) opima nana* Bolli indicate the presence of zone N.3. Otherwise all the Oligocene is missing from the Nief Beds.

1:2:4 Table 2 & 8 reveal the presence of Aquitanian to the Lower Langhian (zone N.4 - N.9) and Tortonian/Messinian (zone N.15 - N.17). The Middle and Upper Langhian (zone N.10 - N.14) are missing. Also there is some indication that the Upper Aquitanian and Lower Burdigalian (zone N.5 - N.6) are missing (see Table 2).

1:3 A comparison of the age and the stratigraphical breaks of the Nief Beds based on Audley-Charles et al. (1979) and their re-evaluation in the present work is given in Table 8.

2. The benthonic Foraminifera identified from the Wakuku Beds are not reliable age indicators (Table 9). According to the palynological analysis given in the A.A.R. Limited Lab. Report N.200/1 (Price, 1976), and Audley-Charles et al. (1979), the age of the Wakuku Beds ranges from Early Triassic to Early Jurassic. The benthonic Foraminifera and lithology of the Wakuku Beds indicate deposition in low energy, moderately deep marine water.

3. The benthonic Foraminifera identified from the Saman Saman Limestone are not reliable age indicators. According to Audley-Charles et al. (1979), the age of this Formation is Triassic. The planktonic microfossils of the Saman Saman Formation and its fine grain-size sediments indicate deposition in very deep marine water beyond the shelf.

4. On the basis of the distribution of the benthonic Foraminifera (Table 10) and their stratigraphical ranges (Range Chart 4), the age of the Asinepe Limestone is inferred to be Norian s.l. (Table 11). The calcareous bioclastic nature of the Formation, its benthonic Foraminifera and other microfossils indicate deposition in a warm, reefal to sublagoonal environment.

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PLATE 1

The Miocene Part of The Nief Beds

Fig. 1 *Sphaeroidinellopsis seminulina seminulina* (Schwager). Ventral view (X 79). Sample (70-1). This form is similar to the neotype selected by Banner and Blow (1960 , pl. 7, figs. 2a-b).

Fig. 2 *Sphaeroidinellopsis seminulina seminulina* (Schwager). Ventral view (X 74). Sample (70-1). This form is similar to the Schwager's (1866) original illustration.

Fig. 3 *Sphaeroidinellopsis seminulina seminulina* (Schwager). X 68. Sample CER. 50(B).

Fig. 4 *Sphaeroidinellopsis subdehiscens subdehiscens* (Blow). Ventral view (X 76). Sample C.C. 79.

Fig. 5 *Sphaeroidinellopsis subdehiscens subdehiscens* (Blow). Ventral view (X 106). Sample C.C. 79.

Fig. 6 *Globigerinatella insueta* Cushman & Stainforth. X 139. Sample CER. 50B.

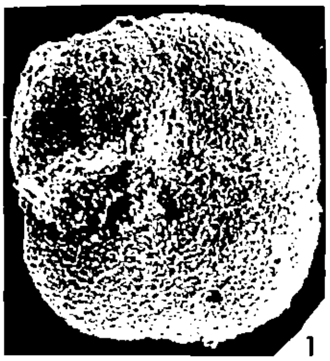
Fig. 7 *Globigerina angustiumblicata* Bolli. (7a) Dorsal view (X123); (7b) Side view (X 119); (7c) Ventral view (X 117). Sample C.C. 69.

Fig. 8 *Globigerina binaensis* Koch. (8a) Umbilical view (X 84); (8b) Side view (X 92). Sample C.C. 69

Fig. 9 *Globigerina binaensis* Koch. X 78. Sample C.C. 57.

Fig. 10 *Globigerina gortanii gortanii* (Borsetti). (10a) Dorsal view (X 88); (10b) Side view (X 73); (10C) Ventral view (X 93).

PLATE 1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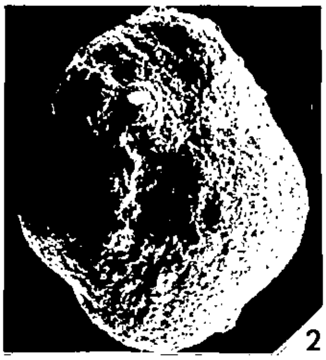
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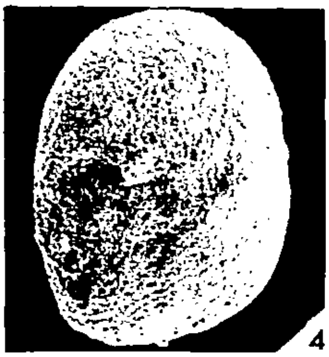
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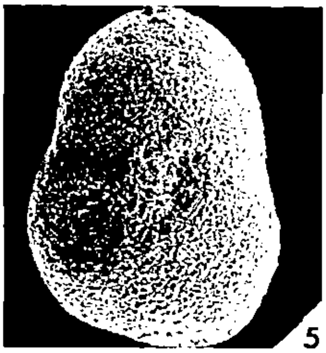
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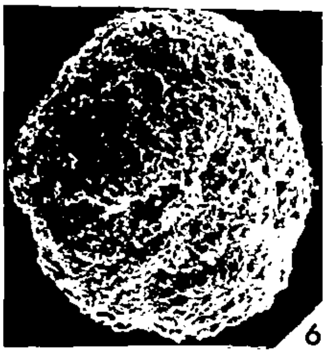
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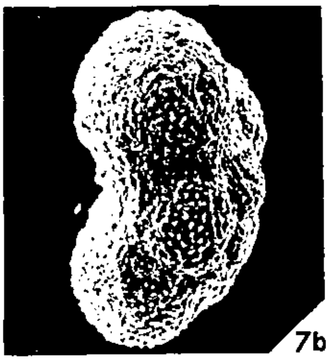
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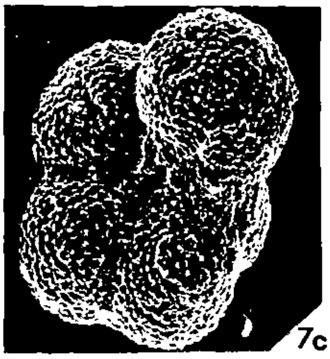
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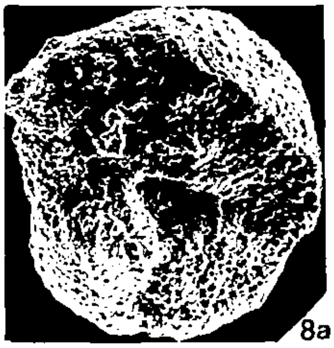
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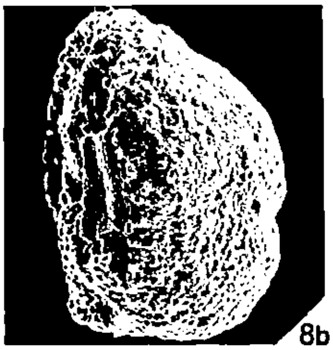
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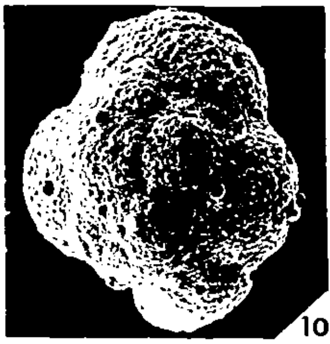
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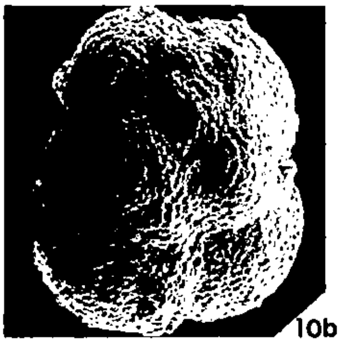
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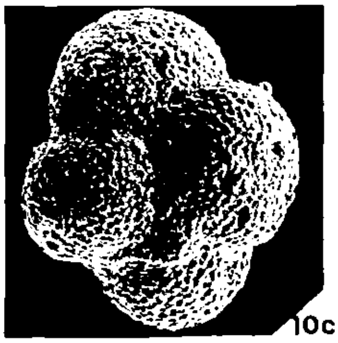
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PLATE 2

The Miocene Part of the Nief Beds

Fig. 1 *Globigerina sp.* cf. *euapertura* Jenkins. Apertural view (X 83). Sample CER. 63B.

Fig. 2 *Globigerina officinalis* Subbotina. (2a) Dorsal view (X 131); (2b) Side view (X 136); (2c) Ventral view (X 100). Sample C.C. 65.

Fig. 3 *Globigerina ouachitaensis ciperoensis* Bolli. (3a) Dorsal view (X 95); (3b) Side view (X 105); (3c) Ventral view (X 92). Sample C.C.72.

Fig. 4 *Globigerina praebulloides leroyi* Blow and Banner. (4a) Dorsal view (X 127); (4b) Side view (X 143); (4c) Ventral view (X 127). Sample C.C. 64.

Fig. 5 *Globigerina praebulloides occlusa* Blow and Banner. (5a) Dorsal view (X 94); (5b). Side view (X 113); (5c) Ventral view (X 99). Sample C.C. 66.

PLATE 2


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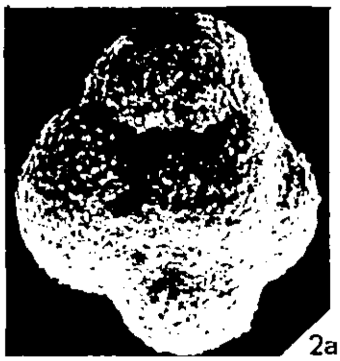
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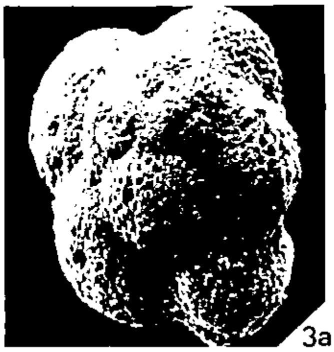
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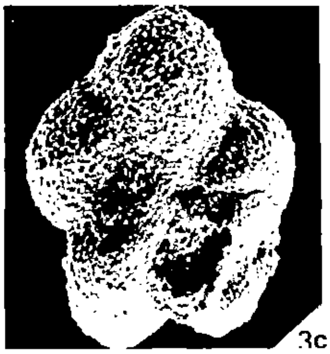
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4a


4b


4c

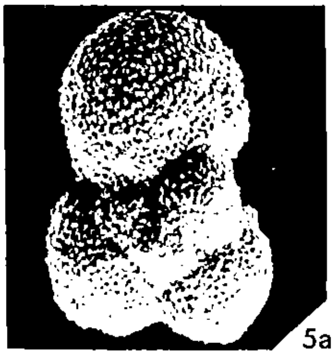
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PLATE 3

The Miocene Part of the Nief Beds

Fig. 1 *Globigerina praebulloides praebullodies* Blow (1a). Dorsal view (X 74), (1b) Side view (X 67), (1c) Ventral view (X 82). Sample C.C. 68.

Fig. 2 *Globigerina praebulloides praebulloides* Blow?. X162. Sample CER. 14B.

Fig. 3 *Globigerina sellii* (Borsetti). Apertural View (X 74). Sample C.C. 46.

Fig. 4 *Globigerina sellii* (Borsetti). X 145. Sample C.C. 30.

Fig. 5 *Globigerinoides obliquus obliquus* Bolli (5a) Dorsal view (X 129); (5b) Ventral view (X 90). Sample (70-1).

Fig. 6 *Globigerinoides quadrilobatus altiaperturus* Bolli. Side view (X 138). Sample CER. 50B.

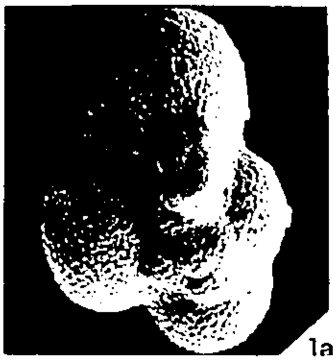
Fig. 7 *Globigerinoides quadrilobatus immaturus* Le Roy. (7a) Dorsal view (X 119); (7b) Ventral view (X 113). Sample (70-1).

Fig. 8 *Globigerinoides quadrilobatus irregularis* Le Roy. (8a) Dorsal view (X 65); (8b) Ventral view (X 84). Sample (70-1).

Fig. 9 *Globigerinoides quadrilobatus primordius* Blow & Banner. Dorsal view (X 80). Sample C.C. 46.

Fig. 10 *Globigerinoides quadrilobatus primordius* Blow & Banner. Dorsal sutural aperture (X 288). Sample C.C. 46.

PLATE 3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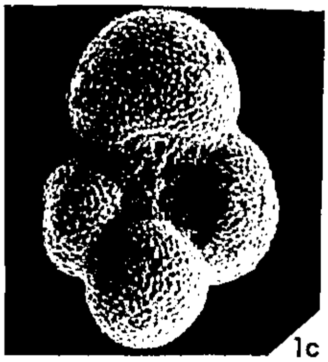
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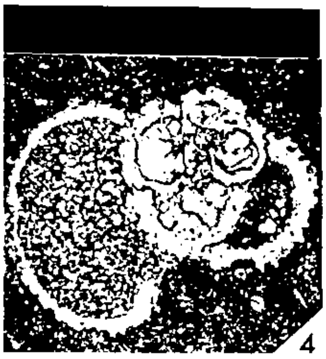
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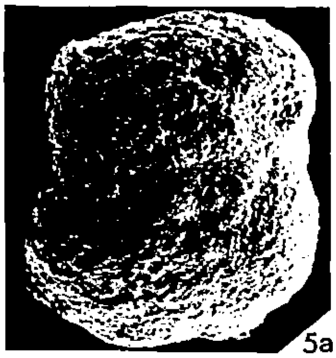
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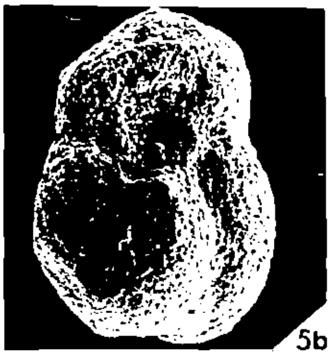
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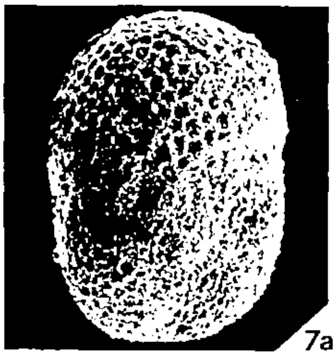
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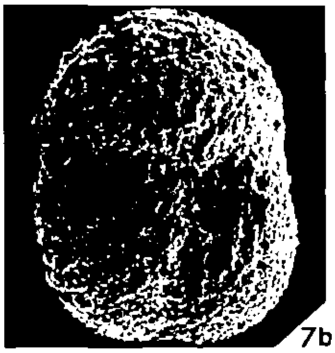
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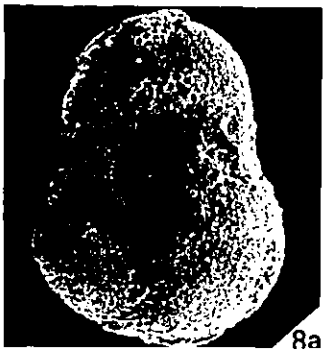
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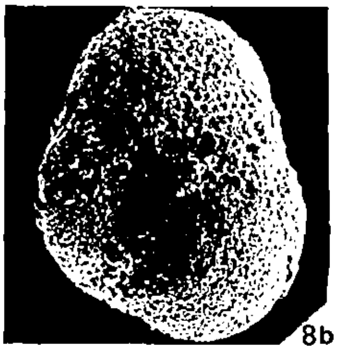
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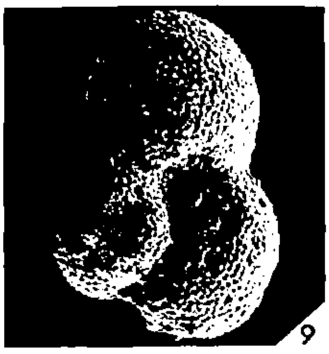
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10

PLATE 4

The Miocene Part of the Nief Beds

Fig. 1 *Globigerinoides quadrilobatus primordius* Blow and Banner. X 111. Sample C.C. 48.

Fig. 2 *Globigerinoides quadrilobatus quadrilobatus* (d Orbigny). (2a) Dorsal view (X 76); (2b) Ventral view (X 77). Sample C.C. 79.

Fig. 3 *Globigerinoides quadrilobatus sacculifer* (Brady). Dorsal view (X 47). Sample (70-1).

Fig. 4 *Globigerinoides quadrilobatus sacculifer* (Brady). Side view (X 54). Sample (70-1).

Fig. 5 *Globigerinoides quadrilobatus trilobus* (Reuss). (5a) Dorsal view (X 86); (5b) Side view (X 86); (5c) Side view (X 99). Sample (71-1).

Fig. 6 *Globigerinoides ruber cyclostomus* (Galloway & Wissler). (6a) Dorsal view (X 102); (6b) Side view (X 94); (6c) Ventral view (X 92). Sample (71-1).

Fig. 7 *Globigerinoides sicanus* de Stefani, sensu Blow, 1956. Ventral view (X 86). Sample CER. 50B.

Fig. 8 *Globigerinoides sicanus* de Stefani, sensu Blow, 1956. Ventral view (X 69). Sample CER. 50 (B).

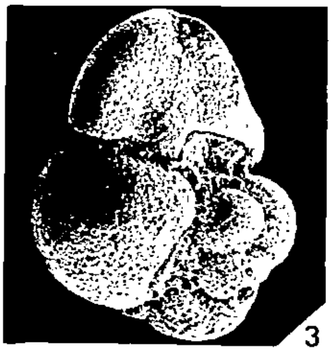
Fig. 9 *Biorbulina bilobata* (d'Orbigny). X 64. Sample (70-1).

Fig. 10 *Biorbulina bilobata* (d'Orbigny). X 108. Sample CER. 50B.


1


2a


2b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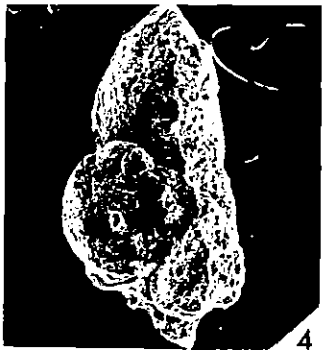
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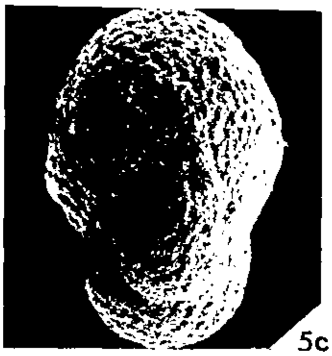
5b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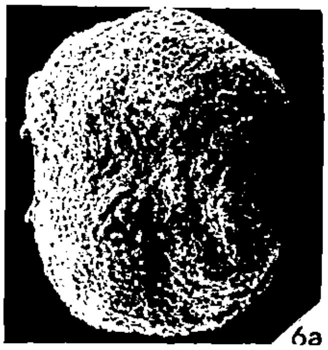
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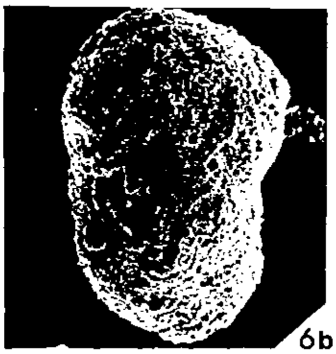
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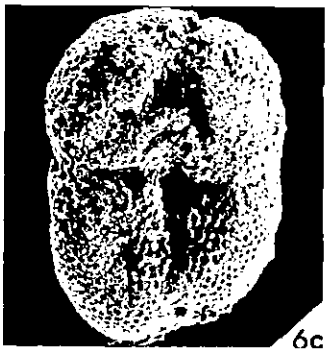
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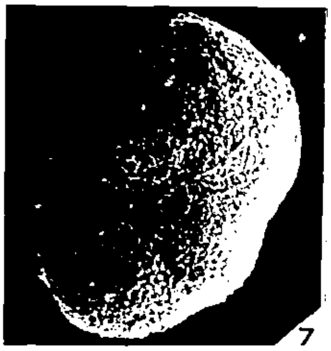
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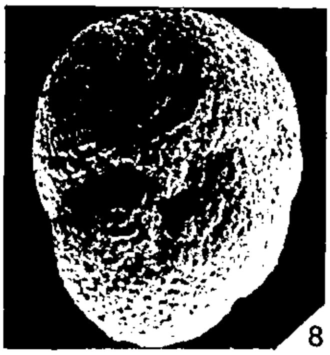
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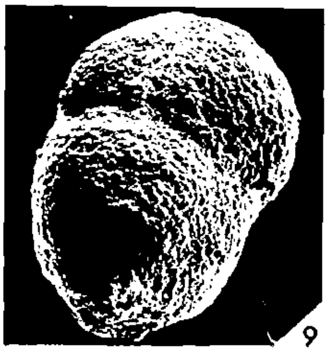
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10

PLATE 5

The Miocene Part of the Nief Beds

Fig. 1 *Orbulina suturalis* Bronnimann, sensu Blow, 1956. Sutural apertures view (X 69). Sample C.C. 79.

Fig. 2 *Orbulina suturalis* Bronnimann, sensu Blow, 1956. X 83. Sample CER. 50B.

Fig. 3 *Orbulina universa* d'Orbigny. The globular form (X 91). Sample C.C. 79.

Fig. 4 *Orbulina universa* d'Orbigny. The compressed form (X 86). Sample C.C. 79.

Fig. 5 *Orbulina universa* d'Orbigny. The compressed form (X 77). Sample C.C. 79.

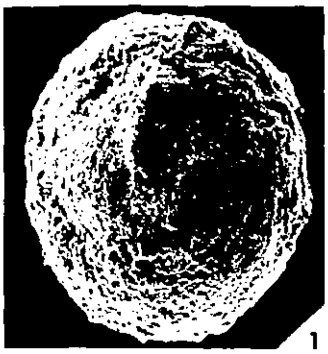
Fig. 6 *Orbulina universa* d'Orbigny. X 79. Sample CER. 50 B.

Fig. 7 *Globorotalia (Globorotalia) merotumida* Blow and Banner. (7a) Dorsal view (X 80); (7b) Side view (X 89); (7c) Ventral view (X 73). Sample C.C. 79.

Fig. 8 *Globorotalia (Globorotalia) tumida plesiotumida* Blow and Banner. (8a) Dorsal view (X 58); 8b Side view (X 67); (8c) Ventral view (X 55). Sample C.C. 79.

Fig. 9 *Globorotalia (Turborotalia) acostaensis acostaensis* Blow. (9a) Dorsal view (X 123); (9b) Side view (X 115); (9c) Ventral view (X 120). Sample C.C. 79.

PLATE 5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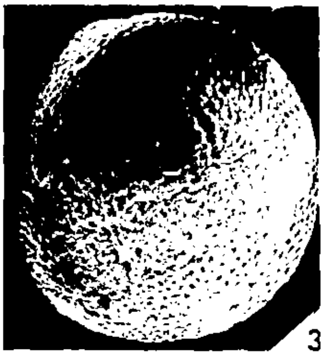
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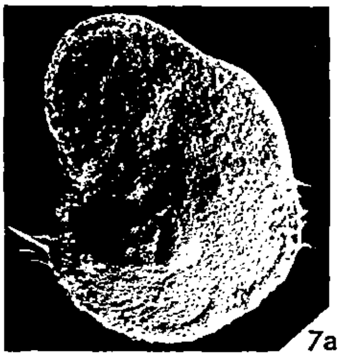
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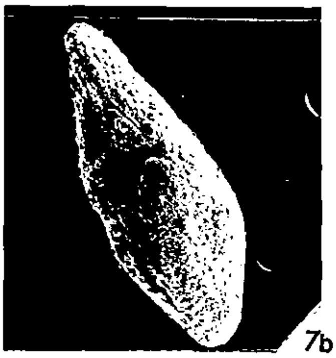
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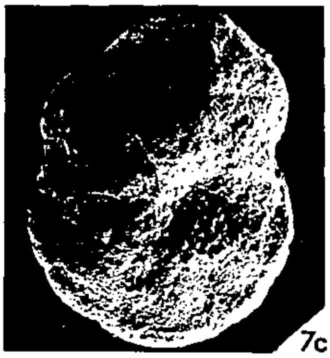
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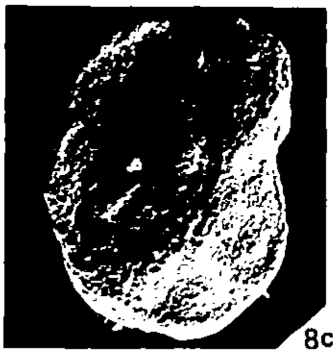
8a


8b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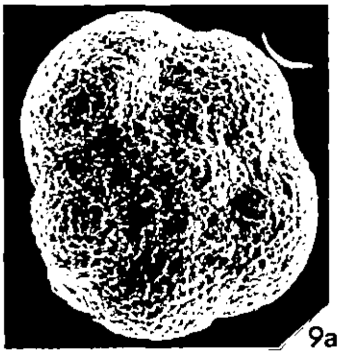
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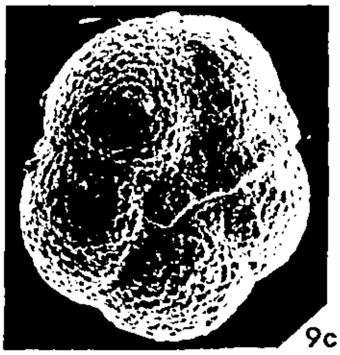
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PLATE 6

The Miocene Part of the Nief Beds

Fig. 1 *Globorotalia* (*Turborotalia*) *kugleri* Bolli. (1a) Dorsal view (X 158); (1b) Side view (X 167); (1c) Ventral view (X 154). Sample C.C. 59.

Fig. 2 *Globorotalia* (*Turborotalia*) *obesa* Bolli. (2a) Dorsal view (X 103); (2b) Side view (X 90); (2c) Ventral view (X 118). Sample C.C. 72.

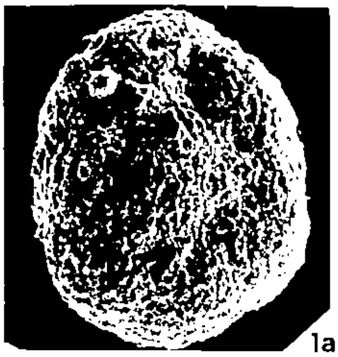
Fig. 3 *Globorotalia* (*Turborotalia*) *opima nana* Bolli. (3a) Dorsal view (X 161); (3b) Ventral view (X 140). Sample C.C. 72.

Fig. 4 *Globorotalia* (*Turborotalia*) *pseudokugleri* Blow. (4a) Dorsal view (X 116); (4b) Side view (X 120); (4c) Ventral view (X 124). Sample C.C. 72.

Fig. 5 *Globorotalia* (*Turborotalia*) *siakensis* (Le Roy). (5a) Dorsal view (X 108); (5b) Side view (X 108); (5c) Ventral view (X 118). Sample C.C. 59.

Fig. 6 *Globorotalia* (*Turborotalia*) *siakensis* (Le Roy). X 154. Sample C.C. 48.

PLATE 6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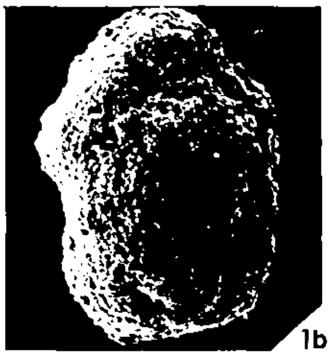
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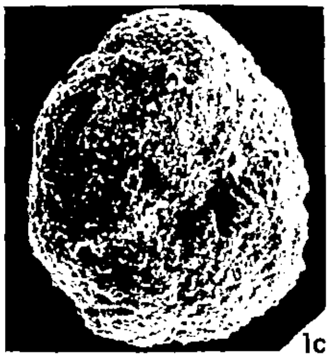
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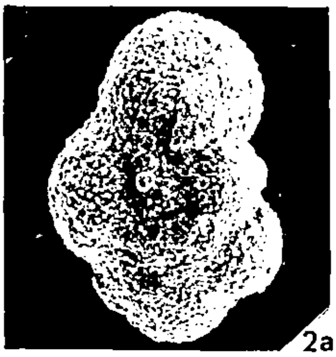
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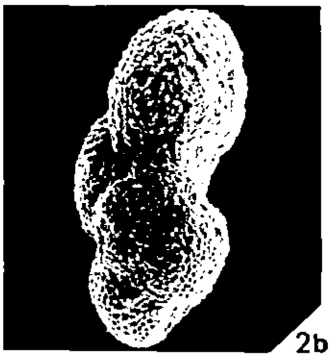
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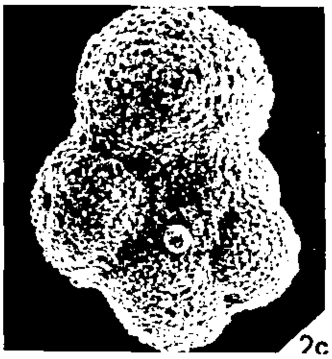
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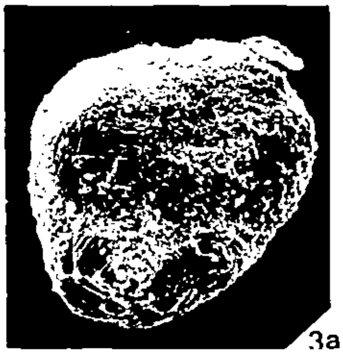
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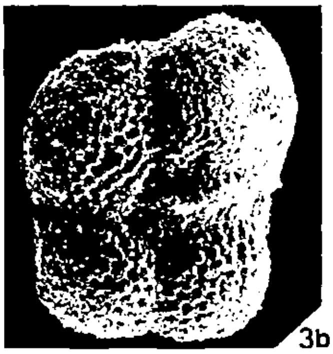
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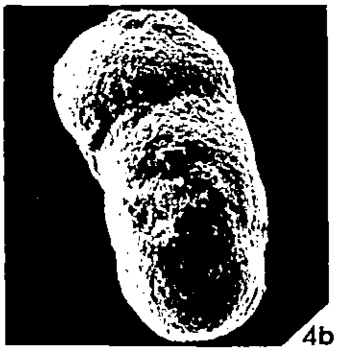
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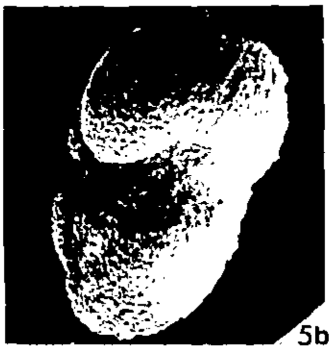
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6

PLATE 7

The Miocene Part of the Nief Beds

Fig. 1 *Hastigerina siphonifera involuta* (Cushman). (1a) Side view (X 123); (1b) Peripheral view (X 98). Sample C.C. 79.

Fig. 2 *Dentoglobigerina altispira altispira* (Cushman & Jarvis). (2a) Spiral view (X 62); (2b) Side view (X 68); (2c) Ventral view (X 72). Sample C.C. 56.

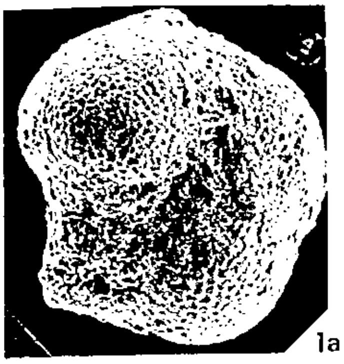
Fig. 3 *Dentoglobigerina altispira altispira* (Cushman & Jarvis)?· X 114. Sample C.C. 57.

Fig. 4 *Dentoglobigerina altispira globosa* (Bolli). (4a) Dorsal view (X 62); (4b) Side view (X 65); (4c) Ventral view (X 80). Sample C.C. 79.

Fig. 5 *Dentoglobigerina baroemoensis* (Le Roy). (5a) Dorsal view (X 62); (5b) Side view (X 59); (5c) Ventral view (X 70). Sample C.C. 56.

Fig. 6 *Dentoglobigerina baroemoensis* (Le Roy)?· X 90. Sample C.C. 48.

PLATE 7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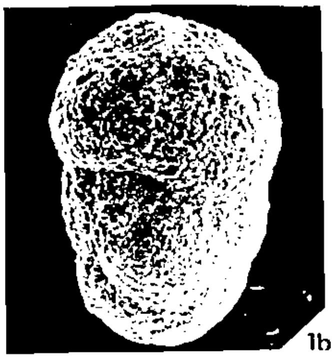
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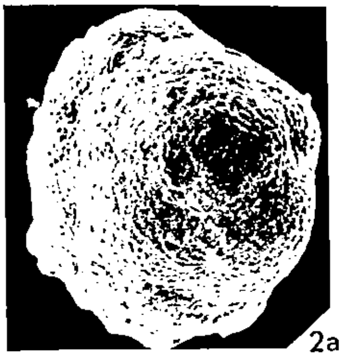
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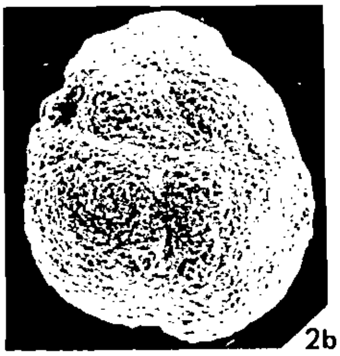
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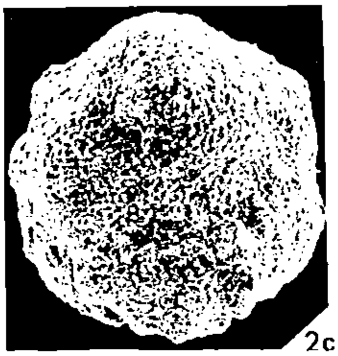
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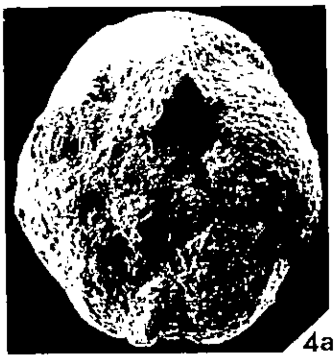
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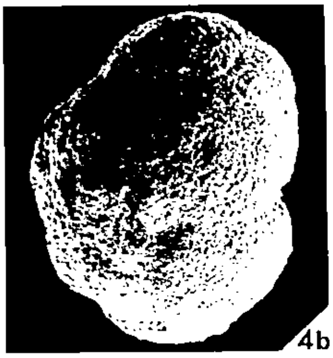
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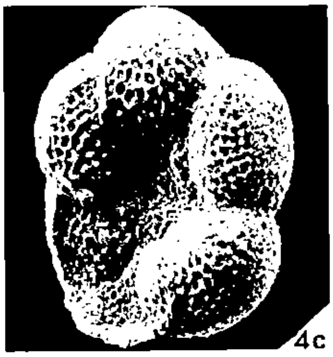
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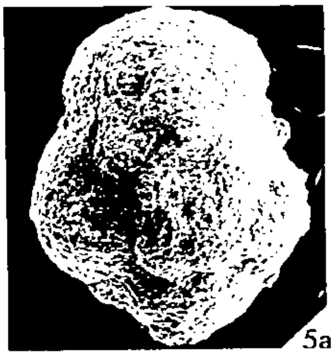
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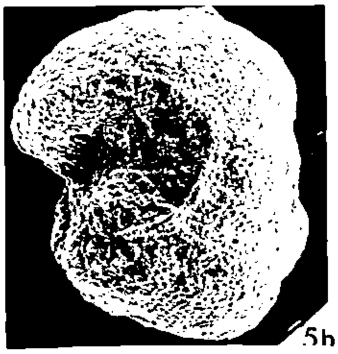
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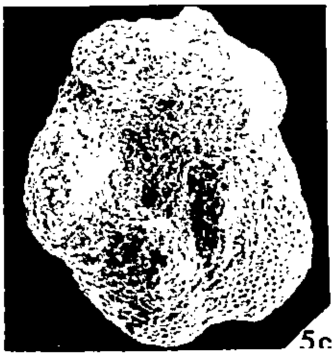
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6

PLATE 8

The Miocene Part of The Nief Beds

Fig. 1 *Dentoglobigerina larmeui larmeui* (Akers). (1a) Dorsal view (X 95); (1b) Side view (X 101); (1c) Ventral view (X 87). Sample CER. 50B.

Fig. 2 *Dentoglobigerina praedehiscens* (Blow and Banner). (2a) Dorsal view (X 75); (2b) Side view (X 74); (2c) Ventral view (X 74). Sample C.C. 70.

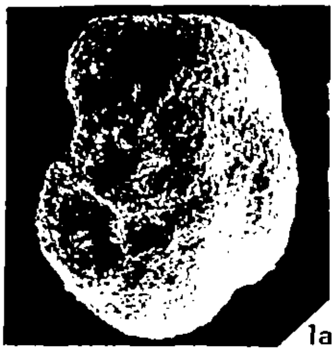
Fig. 3 *Dentoglobigerina? sastrii* Raju. (3a) Dorsal view (X 48); (3b) Side view (X 48). Sample C.C. 72.

Fig. 4 *Dentoglobigerina tripartita* (Koch). (4a) Dorsal view (X 49); (4b) Ventral view: three chambered forms (X 44), (4c) Ventral view: four chambered forms (X 48). Sample C.C. 72.

Fig. 5 *Dentoglobigerina tripartita* (Koch). X 76. Sample C.C. 45.

Fig. 6 *Dentoglobigerina tripartita* (Koch). X 118. Sample C.C. 48.

PLATE 8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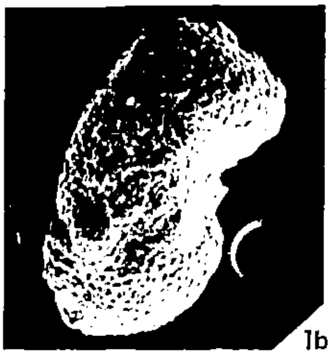
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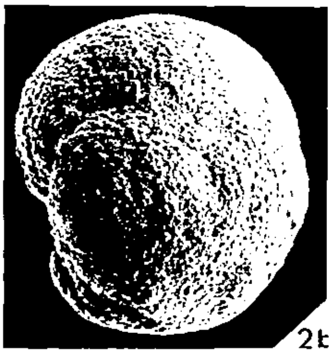
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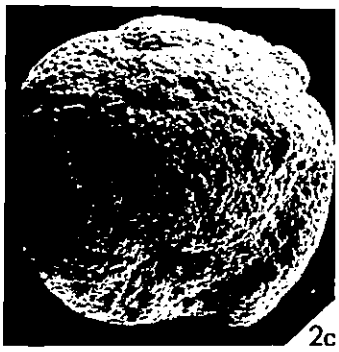
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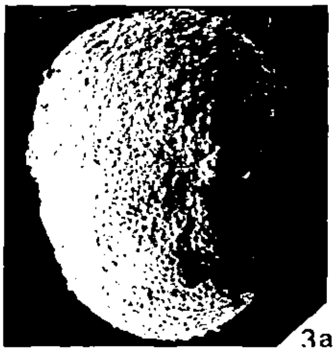
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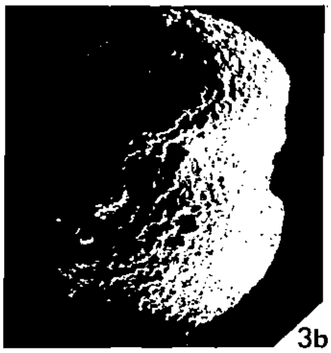
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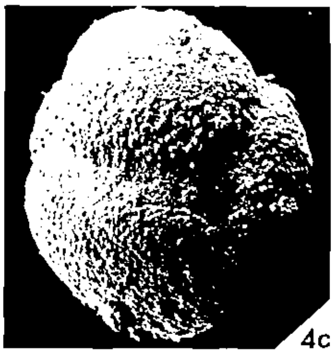
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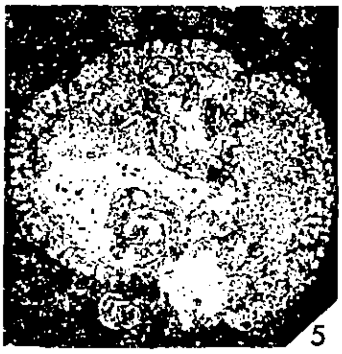
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6

PLATE 9

The Miocene Part of the Nief Beds

Fig. 1 *Dentoglobigerina venezuelana* (Hedberg). (1a) Dorsal view (X 66); (1b) Side view (X 62); (1c) Ventral view (X 64). Sample C.C. 72.

Fig. 2 *Dentoglobigerina venezuelana* (Hedberg)?. X 121. Sample C.C. 50 (B).

Fig. 3 *Globigerinita dissimilis ciperoensis* Blow and Banner. (3a) Dorsal view (X 97); (3b) Ventral view (X 96). Sample C.C. 46.

Fig. 4 *Globigerinita dissimilis dissimilis* (Cushman & Bermudez). (4a) Dorsal view (X 88); (4b) Ventral view (X 89). Sample C.C. 69.

Fig. 5 *Globigerinita sp.* cf. *dissimilis* s.l.?. X 163. Sample C.C. 44.

Fig. 6 *Globigerinta uvula* (Ehrenberg), 1861?. X 79. Sample C.C. 72.

Fig. 7 *Globigerinita uvula* (Ehrenberg), 1861?. X 72. Sample C.C. 72.

Fig. 8 *Globigerinita sp.* cf. *unicava unicava* (Bolli, Loeblich and Tappan). (8a) Dorsal view (X 66); (8b) Ventral view (X 62). Sample C.C. 66.

Fig. 9 *Globoquadrina dehiscens dehiscens* (Chapman, Parr and Collins) (9a) Dorsal view (X 75); (9b) Ventral view (X 70). Sample C.C. 66.

PLATE 9

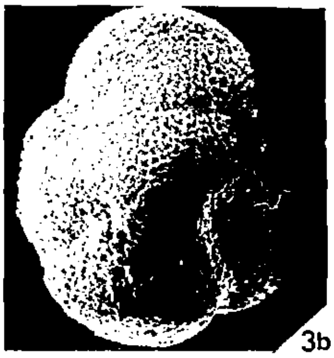

1a


1b


1c


2


3a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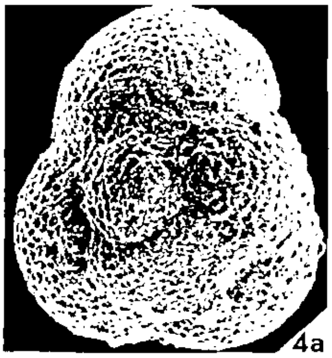
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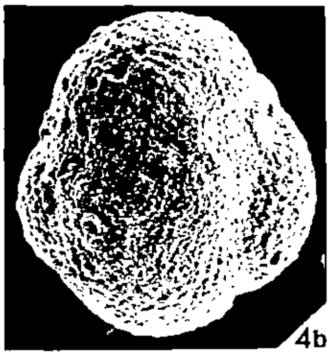
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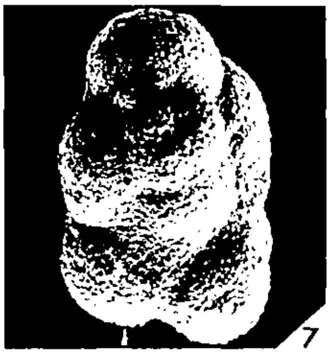
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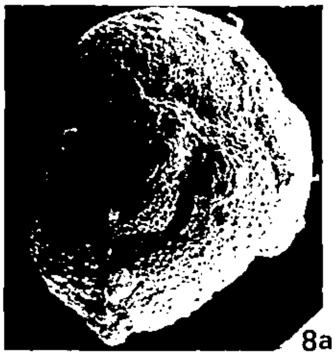
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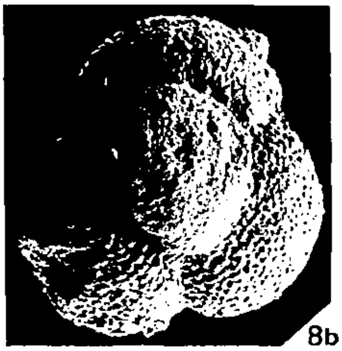
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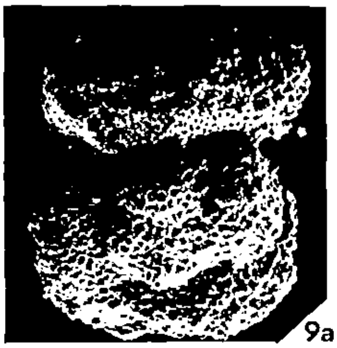

9a


9b

PLATE 10

The Miocene And Eocene Part of the Nief Beds

Fig. 1 *Globoquadrina dehiscens dehiscens* (Chapman, Parr Collins). X 104. Sample CER. 50 B.

Fig. 2 *Globorotaloides hexagona variabilis* Bolli. (2a) Dorsal view (X 111); (2b) Side view (X 129); (2c) Ventral view (X 111). Sample (71-1).

Fig. 3 *Globorotaloides suteri* Bolli. (3a) Dorsal view (X 106); (3b) Side view (X 101); (3c) Ventral view (X 90). Sample (81-1).

Fig. 4 *Genus "A" species 1?* (4a) The spherical side (X 125); (4b) The opposite side (X 132). Sample C.C. 68.

Fig. 5 *Genus "A" species 1?* X 52. Sample C.C. 68.

Fig. 6 *Globigerina lozanoi prolata* Bolli. (6a) Dorsal view (X 111); (6b) Side view (X 101); (6c) Ventral view (X 107). Sample C.C. 76.

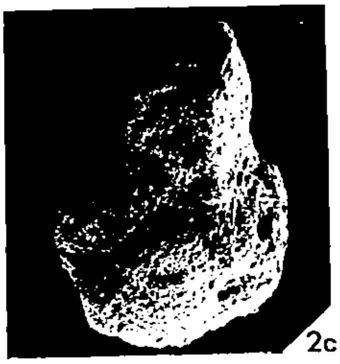
Fig. 7 *"Globigerinoides"* (?) *higginsi* Bolli. X 90, Sample C.C. 76.

PLATE 10


1


2a


2b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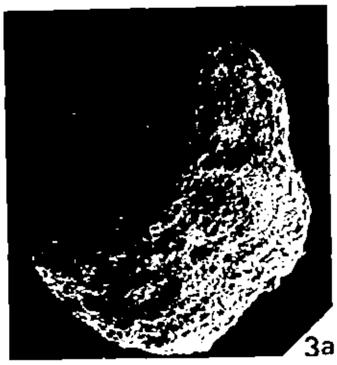
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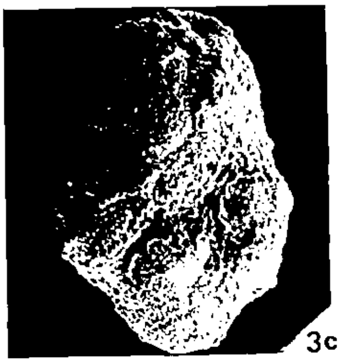
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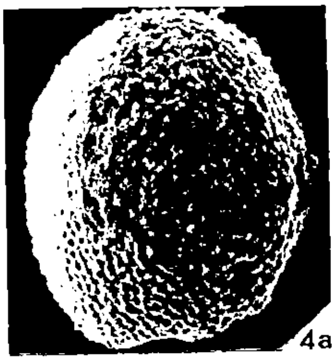
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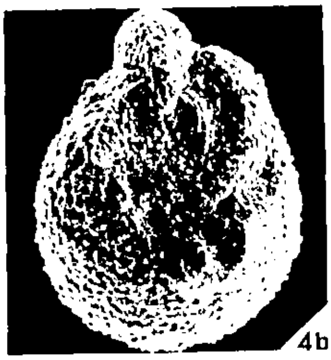
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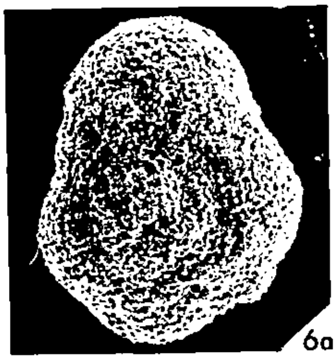
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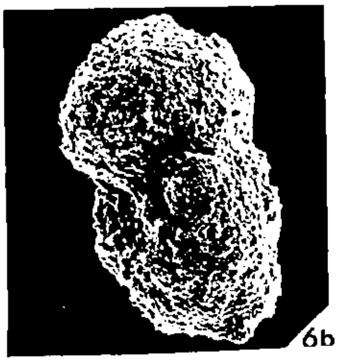
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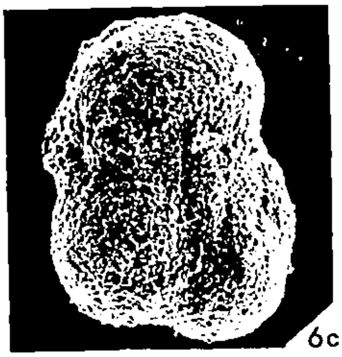
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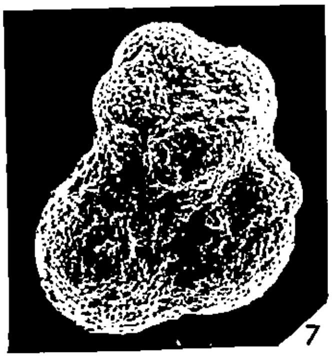
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PLATE 11

The Eocene Part of The Nief Beds

Fig. 1 Globorotalia (Acarinina) aspensis (Colom). (1a) Dorsal view (X 87); (1b) Side view (X 107); (1c) Ventral view (X 95). Sample CER. 14A.

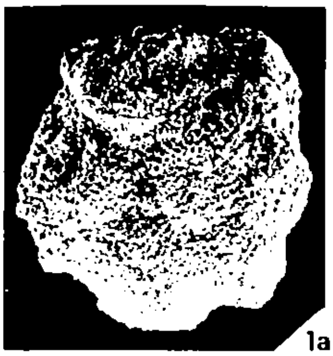
Fig. 2 Globorotalia (Acarinina) broedermanni Cushman and Bermudez. (2a) Dorsal view (X 149); (2b) Side view (X 141); (2c) Ventral view (X 149). Sample C.C. 76.

Fig. 3 Globorotalia (Acarinina) collactea Finlay. (3a) Dorsal view (X 123); (3b) Side view (X 152); (3c) Ventral view (X 148). Sample C.C. 76.

Fig. 4 Globorotalia (Acarinina) primitiva (Finlay). The walls in these specimens are covered by coarse pustules. (4a) Dorsal view (X 132); (4b) Side view (X 107); (4c) Ventral view (X 111). Sample (60-1).

Fig. 5 Globorotalia (Acarinina) primitiva (Finlay). The walls in these specimens are covered by fine pustules. (5a) Dorsal view (X 123); (5b) Side view (X 117); (5c) Ventral view (X 110). Sample C.C. 76.

PLATE 11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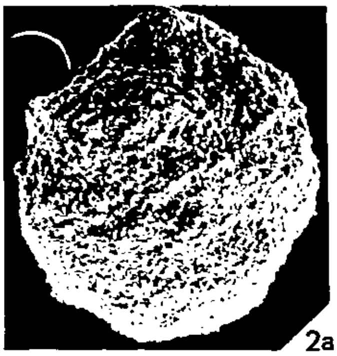
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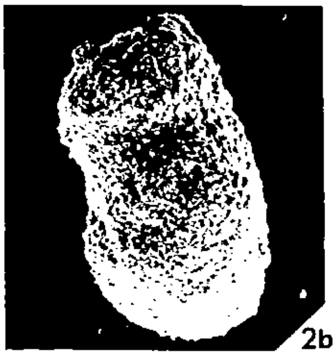
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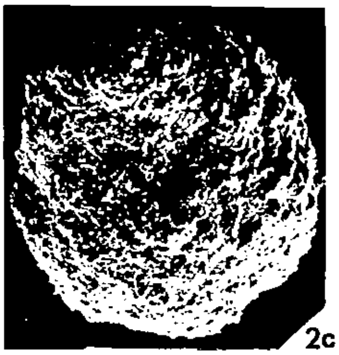
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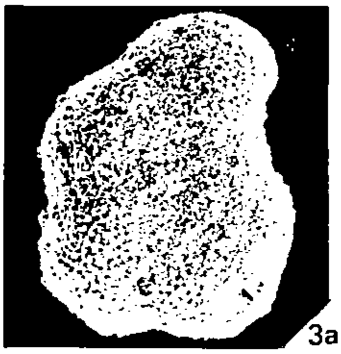
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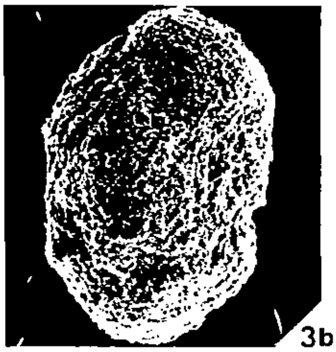
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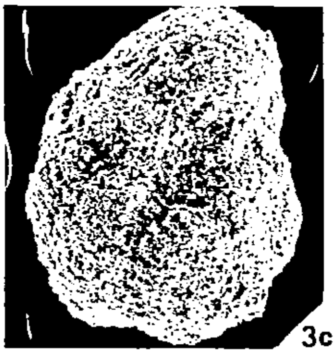
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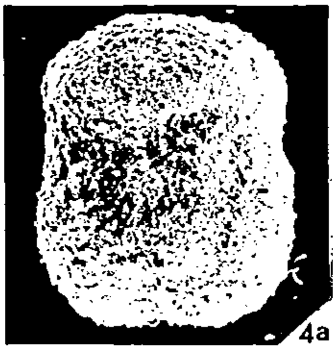
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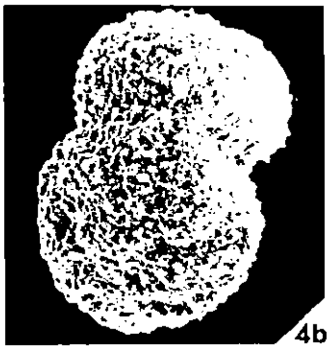
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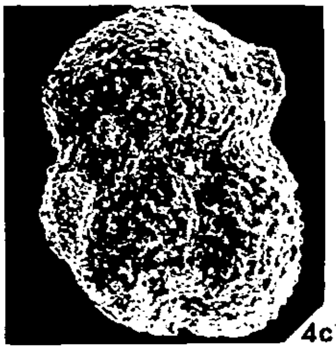
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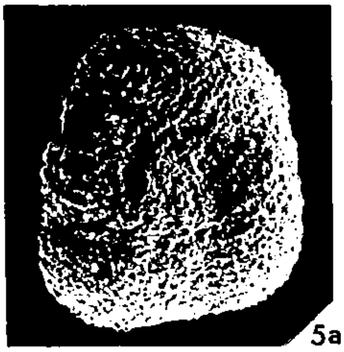
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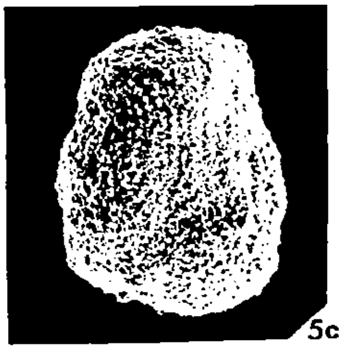
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PLATE 12

The Eocene and Paleocene Part of The Nief Beds

Fig. 1 *Globorotalia (Morozovella) aequa* Cushman & Renz. (1a) Dorsal view (X 88); (1b) Side view (X 104); (1c) Ventral view (X 95). Sample (60-1).

Fig. 2 *Globorotalia (Morozovella) aequa* Cushman & Renz. X 129. Sample CER. 66.

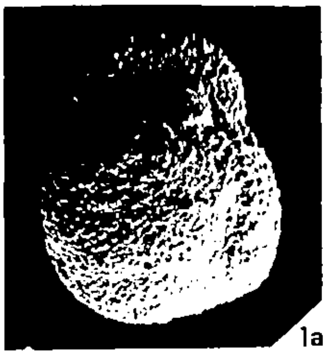
Fig. 3 *Globorotalia (Morozovella) aragonensis* Nuttall. (3a) Dorsal view (X 75); (3b) Side view (X 69); (3c) Ventral view (X 88). Sample CER. 14A.

Fig. 4 *Globorotalia (Morozovella) formosa formosa* Bolli. (4a) Dorsal view (X 49); (4b) Side view (X 59); (4c) Ventral view (X 62). Sample CER. 14A.

Fig. 5 *Globorotalia (Morozovella) formosa formosa* Bolli. X 80. Sample C.C. 34(2)

Fig. 6 *Globorotalia (Morozovella) formosa gracilis* Bolli. (6a) Dorsal view (X 82); (6b) Side view (X 95); (6C) Ventral view (X 89). Sample (60-1).

PLATE 12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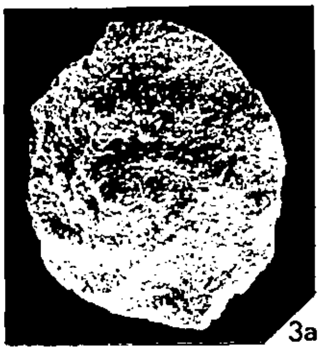
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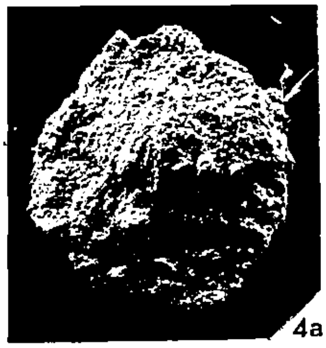
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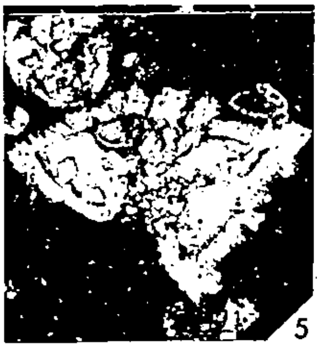
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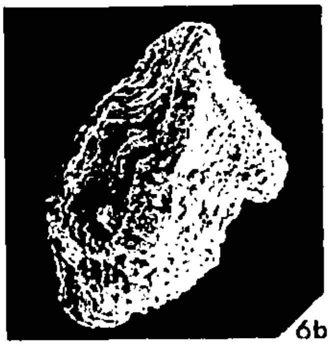
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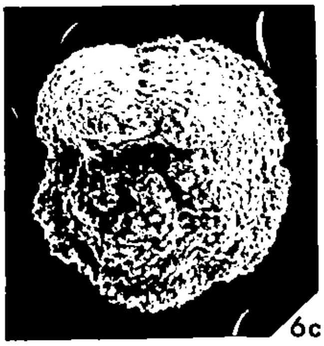
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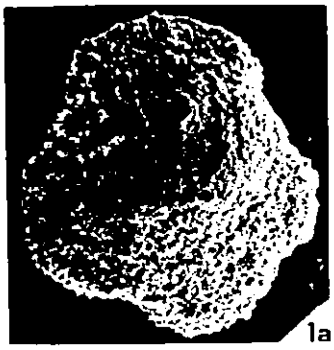
PLATE 13

The Eocene Part of The Nief Beds

Fig. 1	*Globorotalia* *(Morozovella)* *lehneri* Cushman and Jarvis. (1a) Dorsal view (X 120); (1b) Side view (X 126); (1c) Ventral view (X 120). Sample (73-2).
Fig. 2	*Globorotalia* *(Morozovella)* *sp.* cf. *lehneri* Cushman and Jarvis. X 137. Sample (63-3).
Fig. 3	*Globorotalia* *(Morozovella)* *spinulosa* Cushman. (3a) Dorsal view (X 80); (3b) Side view (X 89); (3c) Ventral view (X 75). Sample (73-2).
Fig. 4	*Globorotalia* *(Morozovella)* *spinulosa* Cushman. X 51. Sample (63-3).
Fig. 5	*Globorotalia* *(Morozovella)* *subbotinae* Morozova. (5a) Dorsal view (X 76); (5b) Side view (X 76); (5c) Ventral view (X 75). Sample CER. 14A.
Fig. 6	*Globorotalia* *(Truncorotaloides)* *rohri* Bronnimann & Bermudez. (6a) Dorsal view (X 107); (6b) Side view (X 120); (6c) Ventral view (X 104). Sample (73-2).

PLATE 13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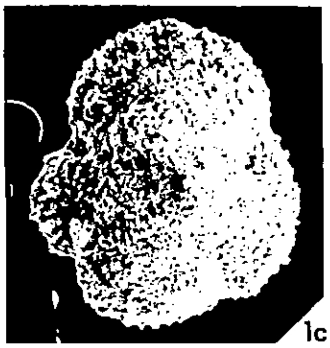
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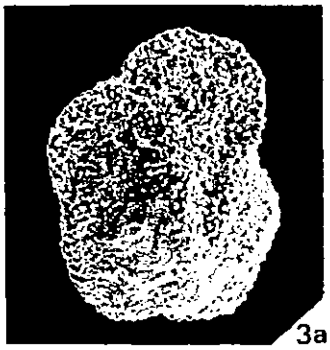
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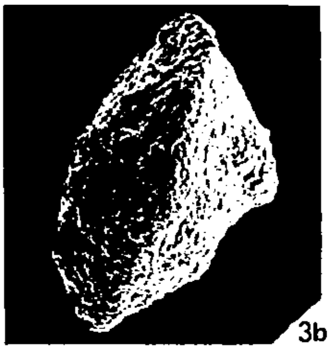
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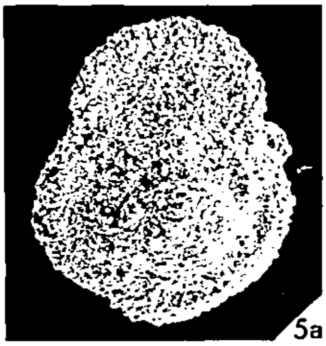
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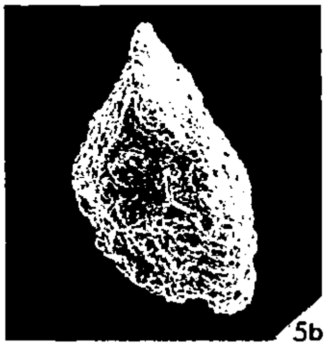
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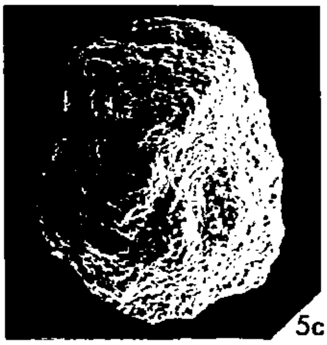
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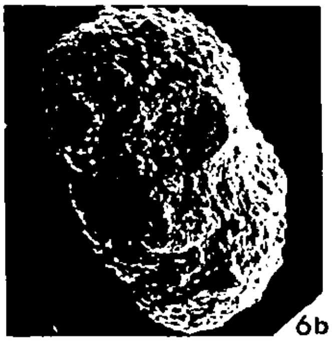
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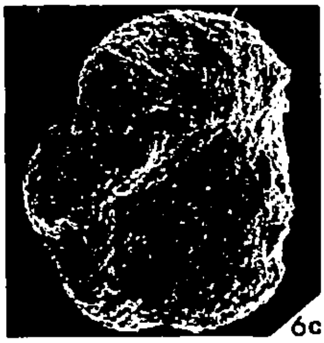
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PLATE 14

The Eocene Part of The Nief Beds

Fig. 1 *Globorotalia* *(Truncorotaloides)* *topilensis* (Cushman)?· (1a) Dorsal view (X 108); (1b) Side view (X 113). Sample (73-2).

Fig. 2 *Globorotalia* *(Turborotalia)* *centralis* Cushman & Bermudez. (2a) Dorsal view (X 93); (2b) Side view (X 116); (2c) Ventral view (X 118). Sample (79-1).

Fig. 3 *Globorotalia* *(Turborotalia)* *centralis* Cushman & Bermudez. X 59. Sample (63-3).

Fig. 4 *Globorotalia* *(Turborotalia)* *cerroazulensis* (Cole). X 101. Sample C.C. 32.

Fig. 5 *Muricoglobigerina* *gravelli* (Bronnimann). (5a) Dorsal view (X 73); (5b) side view (X 118), (5c) Ventral view (X 88). Sample CER. 14A. (See pl. 16, fig. 6 for thin section illustration).

Fig. 6 *Muricoglobigerina* *soldadoensis* *soldadoensis* (Bronnimann). (6a) Dorsal view (X 101); (6b) Side view (X III); (6c) Ventral view (X 98). Sample CER. 14A.

PLATE 14


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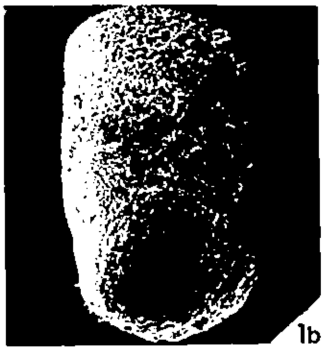
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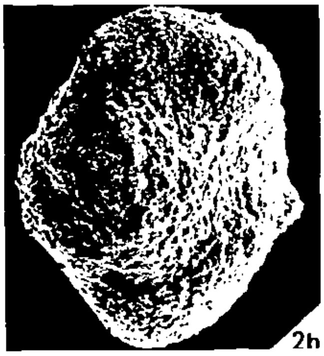
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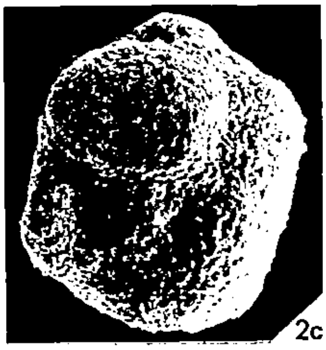
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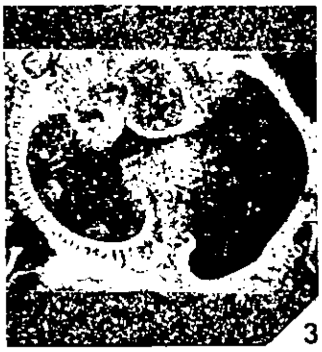
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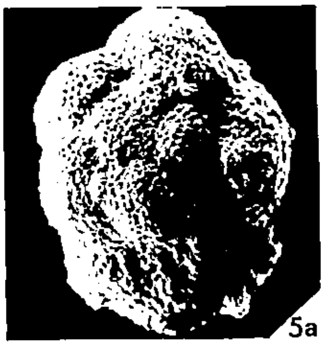
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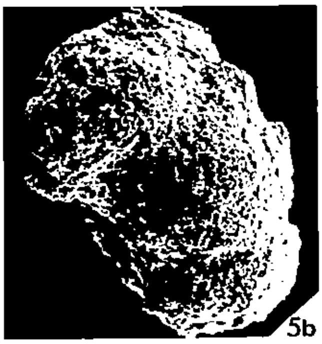
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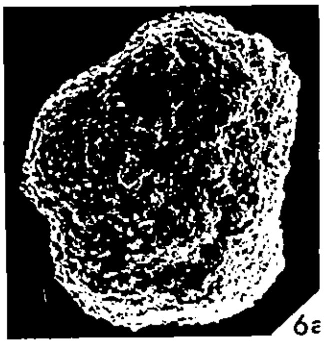
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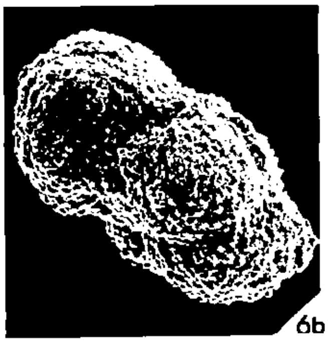
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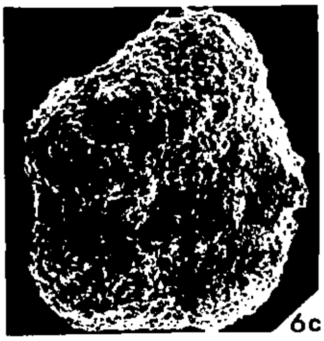
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PLATE 15

The Eocene and Paleocene Part of The Nief Beds

Fig. 1 Ex interc *Muricoglobigerina gravelli* (Bronnimann) and *Muricoglobigerina soldadoensis soldadoensis* (Bronnimann). (1a) Dorsal view (X 121); (1b) Side view (X 140); (1c) Ventral view (X 138). Sample (60-1).

Fig. 2 *Muricoglobigerina soldadoensis angulosa* (Bolli). (2a) Dorsal view (X 82); (2b) Side view (X 103); (2c) Ventral view (X 105). Sample (60-1).

Fig. 3 *Hantkenina sp.* cf. *mexicana* Cushman. X 118. Sample C.C. 32.

Fig. 4 *Pseudohastigerina micra* (Cole). X 170. Sample C.C. 32.

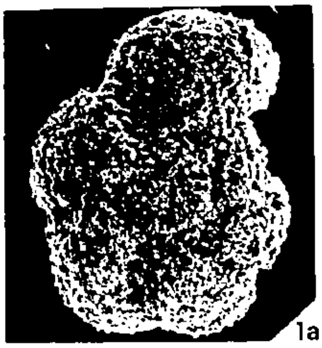
Fig. 5 *Subbotina sp.* cf. *eocaenica* (Terquem). Ventral view (X 146). Sample (73-2).

Fig. 6 *Subbotina sp.* cf. *frontosa boweri* Bolli. (6a) Dorsal view (X 120); (6b) Ventral view (X 162). Sample (73-2).

Fig. 7 *Subbotina linaperta* (Finlay). (7a). Dorsal view (X 140); (7b) Side/Ventral view (X 105); (7C) Ventral view (X 141). Sample (79-1).

Fig. 8 *Subbotina sp.* aff. *S. linaperta* (Finlay). X 186. Sample C.C. 33.

PLATE 15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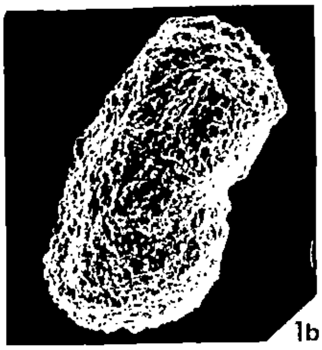
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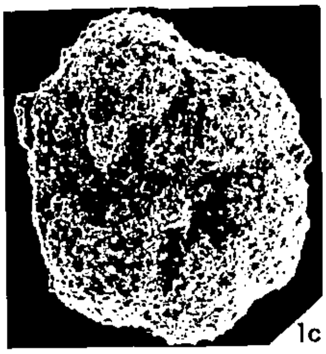
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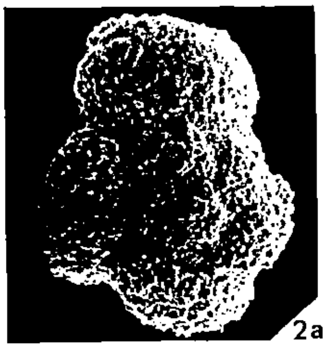
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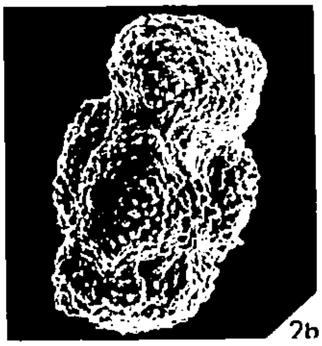
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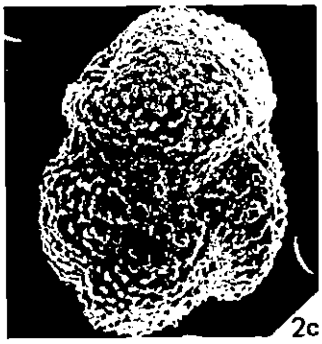
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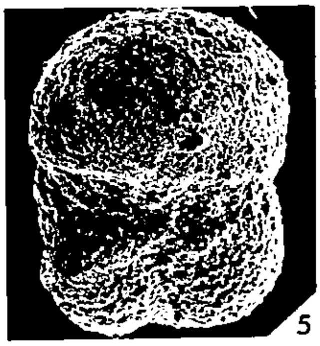
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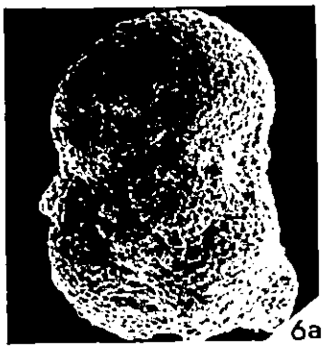
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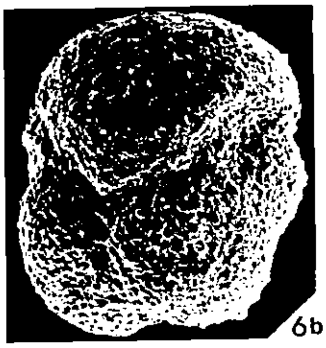
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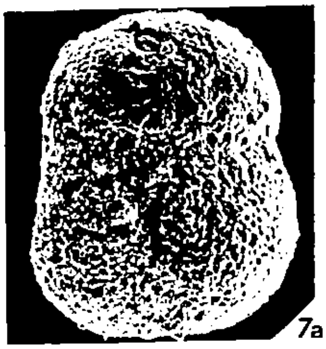
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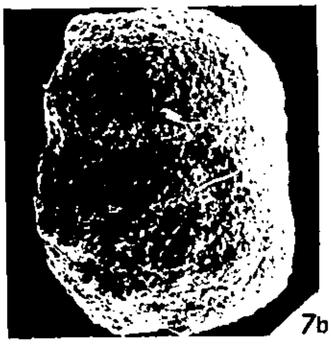
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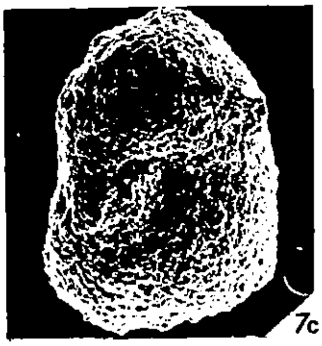
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PLATE 16

The Eocene And Paleocene Part Of The Nief Beds

Fig. 1 *Subbotina triangularis triangularis* (White). (1a) Dorsal view (X 111); (1b) Side view (X 121); (1c) Ventral view (X 105). Sample C.C. 37.

Fig. 2 *Dentoglobigerina pseudovenezuelana* (Blow and Banner). (2a) Dorsal view (X 118); (2b) Side view (X 130); (2c) Ventral view (X 105). Sample (79-1).

Fig. 3 *Dentoglobigerina yeguaensis* (Weinzierl and Applin). (3a) Dorsal view (X 125); (3b) Side view (X 137); (3c) Ventral view (X 128). Sample (73-2).

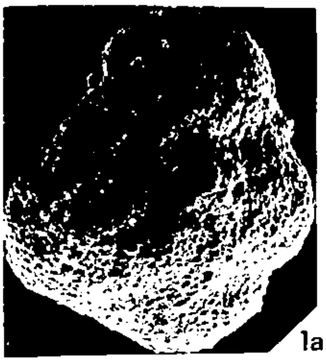
Fig. 4 *Dentoglobigerina sp.* cf. *yeguaensis* (Wienzierl and Applin). X 105. Sample C.C. 32.

Fig. 5 *Globigerinita turgida* (Finlay). (5a) Dorsal view (X 98); (5b) Side view (X 111); (5c) Ventral view (X 92). Sample C.C. 76.

Fig. 6 *Muricoglobigerina gravelli* (Bronnimann). X 122. Sample C.C. 34 (2).

Fig. 7 *Globorotalia (Acarinina) uncinata* Bolli?· Dorsal view (X 211). Sample (74-2).

PLATE 16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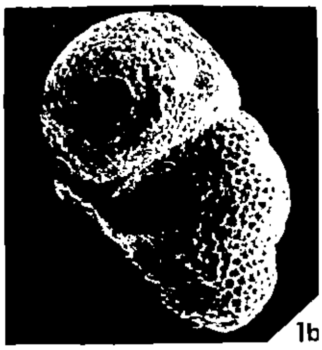
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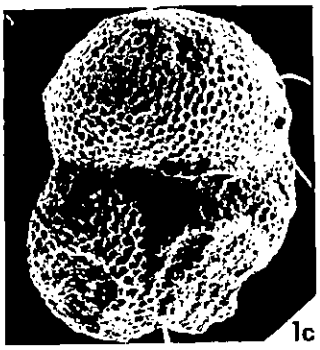
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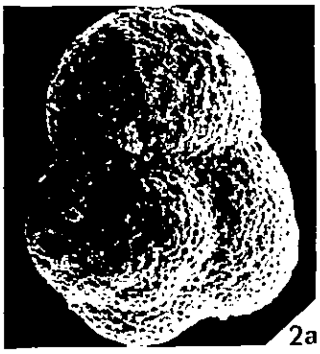
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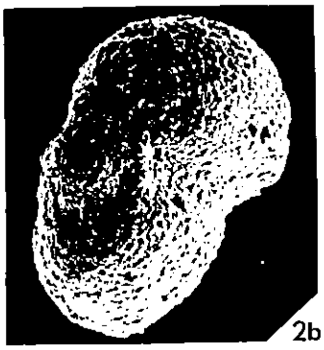
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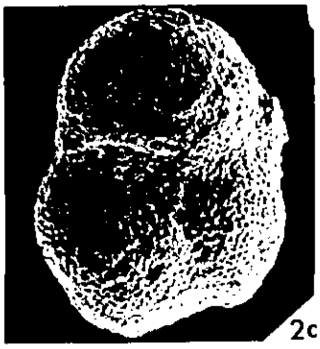
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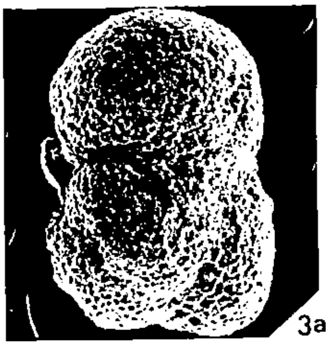
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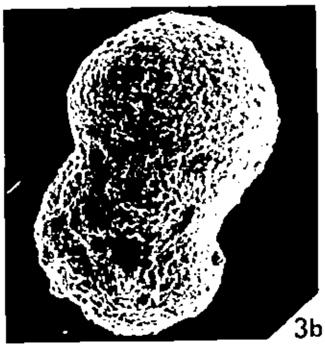
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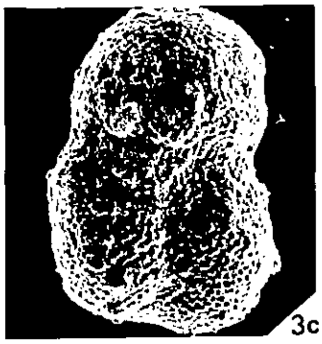
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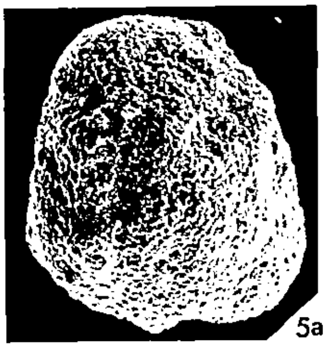
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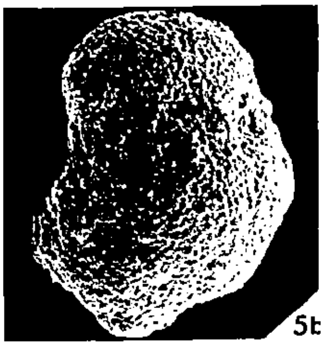
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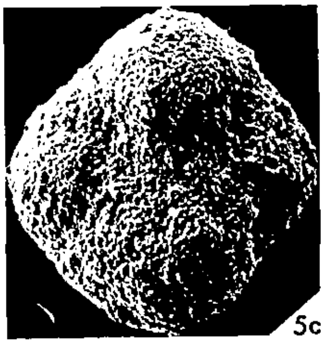
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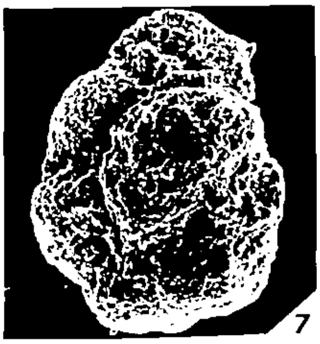
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PLATE 17

The Paleocene Part of The Nief Beds

Fig. 1 *Globorotalia* *(Acarinina)* *uncinata* Bolli? X 137. Sample C.C. 39.

Fig. 2 *Globorotalia* *(Globorotalia)* *ehrenbergi* Bolli. X 90). Sample C.C. 39.

Fig. 3 *Globorotalia* *(Globorotalia)* *ehrenbergi* Bolli. X 142. Sample CER. 18.

Fig. 4 *Globorotalia* *(Globorotalia)* *ehrenbergi* Bolli. X 161. Sample CER. 18.

Fig. 5 *Globorotalia* *(Globorotalia)* *pseudomenardii* Bolli. X 166. Sample C.C. 33.

Fig. 6 *Globorotalia* *(Globorotalia)* *pseudomenardii* Bolli. X 121. Sample C.C. 34(2).

Fig. 7 *Globorotalia* *(Globorotalia)* *pusilla* *laevigata* Bolli. X 205. Sample CER. 66.

Fig. 8 *Globorotalia* *(Morozovella)* *angulata* *angulata* (White). (8a) Dorsal view (X 122); (8b) Side view (X 93); (8c) Ventral view (X 118). Sample C.C. 37.

Fig. 9 *Globorotalia* *(Morozovella)* *angulata* *angulata* (White). X 169. Sample C.C. 39.

Fig. 10 *Globorotalia* *(Morozovella)* *angulata* *conicotruncana* Subbotina. (10a) Dorsal view (X 75); (10 b) Side view (X 82); (10c) Ventral view (X 91). Sample C.C. 37.

Fig. 11 *Globorotalia* *(Morozovella)* *velascoensis* (Cushman). X 72. Sample C.C. 33.

PLATE 17


1


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6


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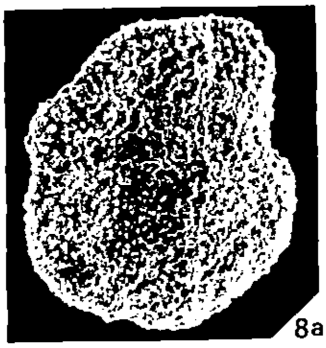
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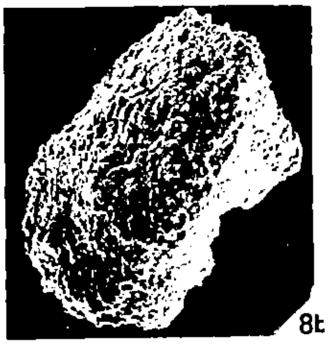
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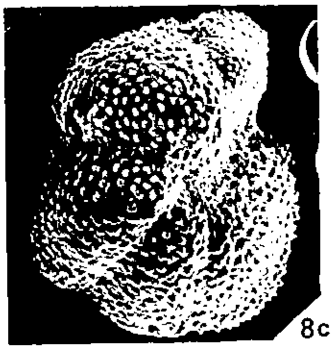
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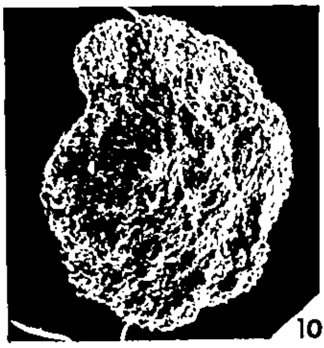
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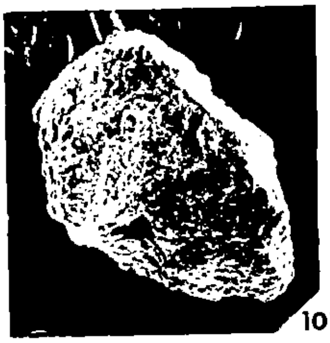
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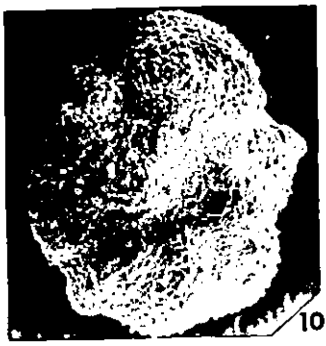
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PLATE 18

The Paleocene Part of The Nief Beds

Fig. 1 *Globorotalia* (*Morozovella*) *velascoensis* (Cushman). (1a) Dorsal view (X 74); (1b) Ventral view (X 98). Sample C.C. 34(1).

Fig. 2 *Globorotalia* (*Morozovella*) *chapmani* Parr. X 120. Sample C.C. 39.

Fig. 3 *Globorotalia* (*Turborotalia*) *compressa* (Plummer). (3a) Dorsal view (X 117); (3b) Side view (X 128). Sample C.C. 38.

Fig. 4 *Globorotalia* (*Turborotalia*) *compressa* (Plummer). X 179. Sample C.C. 39.

Fig. 5 *Globorotalia* (*Turborotalia*) *compressa* (Plummer). X 143. Sample C.C. 39.

Fig. 6 *Globorotalia* (*Turborotalia*) *sp*. cf. *inconstans* (Subbotina). X 128. Sample C.C. 33.

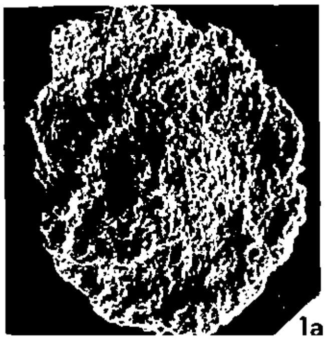
Fig. 7 *Globorotalia* (*Turborotalia*) *pseudobulloides* (Plummer). (7a) Dorsal view (X 93); (7b) Side view (X 109); (7c) Ventral view (X 115). Sample C.C. 38.

Fig. 8 *Globorotalia* (*Turborotalia*) *pseudobulloides* (Plummer). X 83. Sample CER. 18.

Fig. 9 *Globorotalia* (*Turborotalia*) *trinidadensis* Bolli. (9a). Dorsal view (X 107); (9b) Side view (X 131). Sample C.C. 38.

Fig. 10 *Globorotalia* (*Turborotalia*) *trinidadensis* Bolli?. X 222. Sample C.C. 39..

PLATE 18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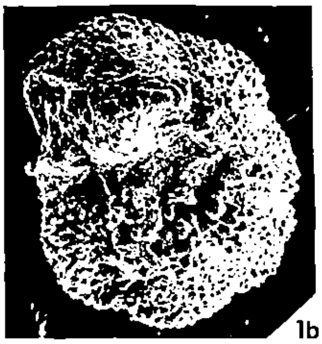
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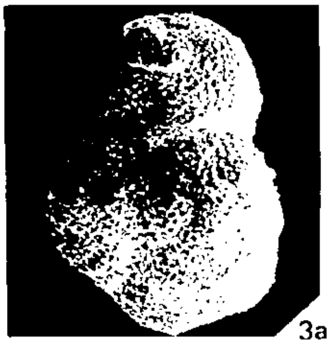
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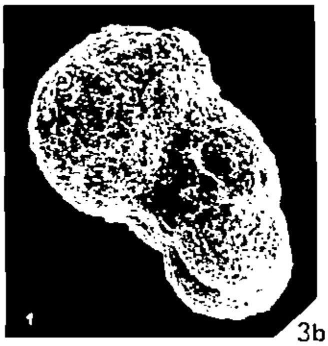
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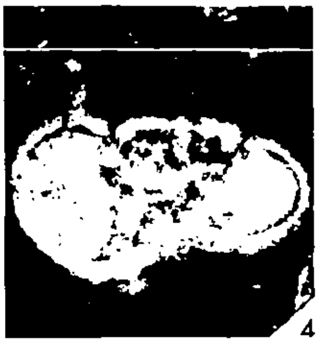
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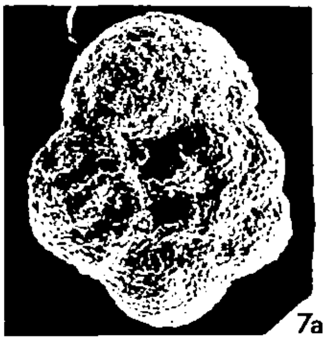
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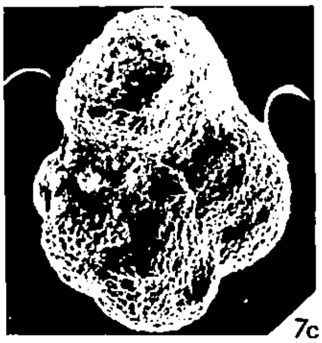
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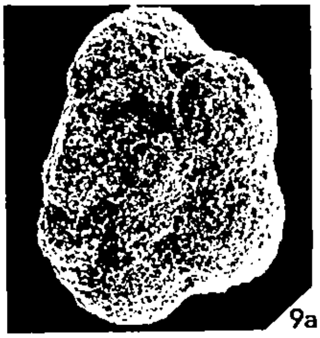
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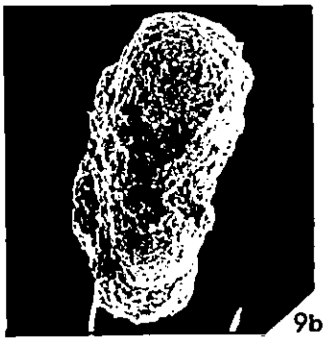
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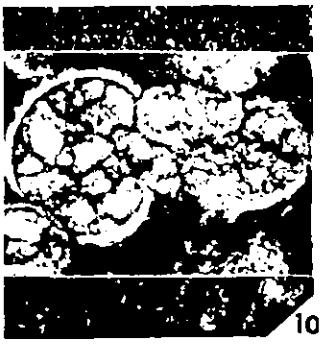
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PLATE 19

Paleocene And Cretaceous Part of The Nief Beds

Fig. 1 Ex interc *Globorotalia (Turborotalia) trinidadensis/ inconstans*, and *Globorotalia (Acarinina) uncinata* Bolli. (1a) Dorsal view (X 234); (1b) Side view (X 318); (1c) Ventral view (X 240). Sample (74-1).

Fig. 2 *Muricoglobigerina mckannai* (White)?·X 64. Sample C.C. 32.

Fig. 3 *Eoglobigerina* aff. *spiralis* (Bolli). X 133. Sample C.C. 39.

Fig. 4 *Subbotina triloculinoides* (Plummer). (4a) Dorsal view (X 107); (4b) Side view (X 115); (4c) Ventral view (X 116). Sample C.C. 37.

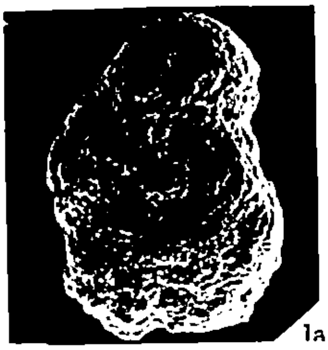
Fig. 5 *Subbotina triloculinoides* (Plummer). X 137. Sample CER. 39.

Fig. 6 *Subbotina velascoensis* Cushman. (6a) Dorsal view (X 134); (6b) Side view (X 137); (6c) Ventral view (X 110). Sample C.C. 37.

Fig. 7 *Globotruncanella havanensis* (Voorwijk). X 202. Sample CER. 3.

Fig. 8 *Globotruncanella havanensis* (Voorwijk). X 237. Sample C.C. 43.

Fig. 9 *Globotruncanella havanensis* (Voorwijk). X 111. Sample C.C. 41.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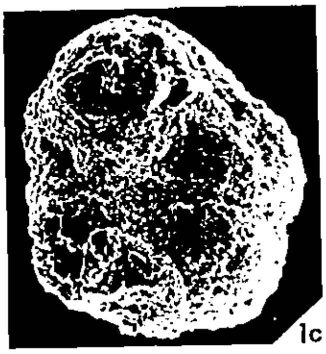
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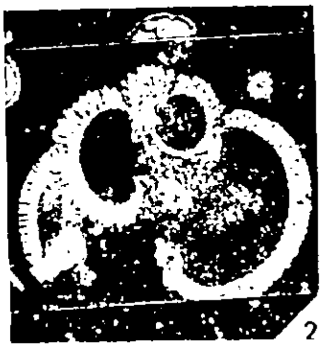
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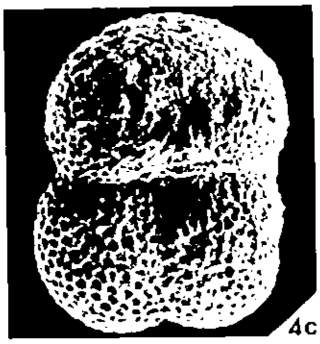
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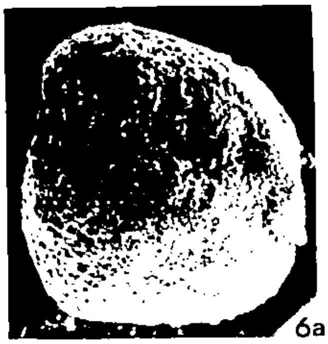
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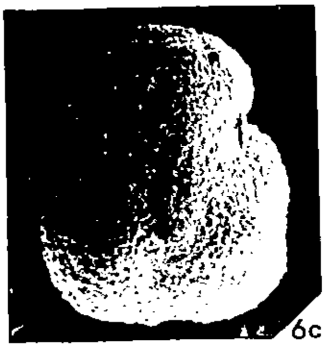
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PLATE 20

The Cretaceous Part of The Nief Beds

Fig. 1 *Rugoglobigerina rotundata* Bronnimann? X 235. Sample (12-1).

Fig. 2 *Rugoglobigerina rugosa* (Plummer). X 103. Sample (61-4).

Fig. 3 *Rugoglboigerina sp.* cf. *scotti* (Bronnimann). X 350. Sample CER. 10.

Fig. 4 *Globotruncana arca* (Cushman). X 93. Sample C.C. 43.

Fig. 5 *Globotruncana bulloides* Vogler. X 174. Sample (56-2).

Fig. 6 *Globotruncana calcarata* Cushman. (6a) Axial section (X 88), Sample CER. 7A; (6b) Equitorial section (X 78), Sample CER. 3.

Fig. 7 *Globotruncana conica* White. X 110. Sample CER. 3.

Fig. 8 *Globotruncana contusa* (Cushman). X 120. Sample (17-1a).

Fig. 9 *Globotruncana contusa* (Cushman). X 90. Sample C.C. 42.

Fig. 10 *Globotruncana elevata* (Brotzen). X 91. Sample C.C. 43.

Fig. 11 *Globotruncana falsostuarti* Sigal. X 96. Sample C.C. 35.

Fig. 12 *Globotruncana fornicata* Plummer. X 96. Sample (56-2).

Fig. 13 *Globotruncana fornicata* Plummer. X 82. Sample (75-3).

Fig. 14 *Globotruncana gansseri* Bolli. X 84. Sample (12-8).

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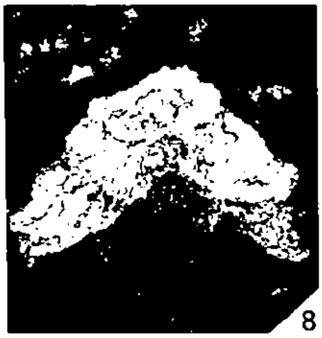
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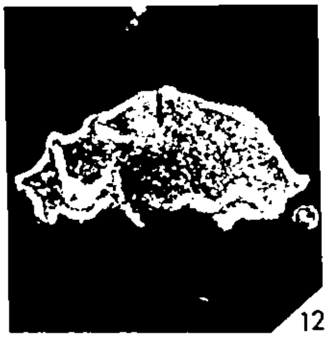
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PLATE 21

The Cretaceous Part of The Nief Beds

Fig. 1 *Globotruncana gansseri* Bolli. X 114. Sample (17-1a).

Fig. 2 *Globotruncana hilli* Pessagno. X 195. Sample CER. 10.

Fig. 3 *Globotruncana imbricata* Mornod. X 78. Sample (13-2).

Fig. 4 *Globotruncana imbricata* Mornod. X 200. Sample CER. 27.

Fig. 5 *Globotruncana lapparenti coronata* Bolli. X 68. Sample C.C. 36.

Fig. 6 *Globotruncana lapparenti coronata* Bolli. X 61. Sample (12-1).

Fig. 7 *Globotruncana lapparenti tricarinata* (Quereau). X 91. Sample C.C. 35.

Fig. 8 *Globotruncana lapparenti tricarinata* (Quereau). X 88. Sample (12-1).

Fig. 9 *Globotruncana linneiana* (d'Orbigny). X 89. Sample C.C. 35.

Fig. 10 *Globotruncana linneiana* (d'Orbigny). X 92. Sample C.C. 35.

Fig. 11 *Globotruncana loeblichi* Pessagno. X 68. Sample (75-3).

Fig. 12 *Globotruncana schneegansi* Sigal. X 114. Sample CER. 27.

Fig. 13 *Globotruncana stuarti* (De Lapparent). X 72. Sample C.C. 42.

Fig. 14 *Globotruncana stuartiformis* Dalbiez. X 74. Sample C.C. 43.

Fig. 15 *Globotruncana stuartiformis* Dalbiez. X 95. Sample C.C. 43.

PLATE 21


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PLATE 22

The Cretaceous Part of The Nief Beds

Fig. 1 *Globotruncana sp.1*. X 66. Sample C.C. 42.

Fig. 2 *Globotruncana sp.1*. X 53. Sample C.C. 42.

Fig. 3 *Globotruncana sp.2*. X 108. Sample C.C. 43.

Fig. 4 *Globotruncana sp.3..* X 66. Sample (17-1a).

Fig. 5 *Globotruncana sp.4.* X 83. Sample (17-1a).

Fig. 6 *Globotruncana sp.5*. X 109. Sample (61-4).

Fig. 7 *Globotruncana sp.6.* X 89. Sample (20-1).

Fig. 8 *Globotruncana sp.6*. X 84. Sample (20-1).

Fig. 9 *Globotruncana sp.7*. X 129. Sample (17-1a).

Fig. 10 *Archaeoglobigerina cretacea* (d'Orbigny). X 154. Sample (12-1).

Fig. 11 *Rotalipora appenninica* (Renz). X 92. Sample CER. 27.

Fig. 12 *Rotalipora appenninica* (Renz). X 111. Sample CER. 27.

Fig. 13 *Rotalipora appenninica* (Renz). X 88. Sample CER. 27.

Fig. 14 *Rotalipora appenninica* (Renz). X 88. Sample CER. 27.

Fig. 15 *Rotalipora cushmani* (Morrow). X 70. Sample CER. 27.


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PLATE 23

The Cretaceous Part of The Nief Beds

Fig. 1 *Rotalipora greenhornensis* (Morrow). X 94. Sample (13-5).

Fig. 2 *Rotalipora reicheli* (Mornod). X 96. Sample (13-2).

Fig. 3 *Rotalipora reicheli* (Mornod). X 86. Sample (13-5).

Fig. 4 *Rotalipora reicheli* (Mornod). X 78. Sample (13-5).

Fig. 5 *Rotalipora reicheli* (Mornod). X 73. Sample CER 27.

Fig. 6 *Rotalipora reicheli* (Mornod). X 96. Sample CER 27.

Fig. 7 *Clavihedbergella*? *sp*. X 274. Sample (82-4).

Fig. 8 *Hedbergella sp*. cf. *washitensis* (Carsey). X 100. Sample (13-5).

Fig. 9 *Hedbergella sp.1*. X 221. Sample (17-1b).

Fig. 10 *Hedbergella sp.2*. X 244. Sample CER. 10.

Fig. 11 *Hedbergella sp.3*. X 315. Sample (17-1b).

Fig. 12 *Hedbergella sp.4.* X 160. Sample (61-5).

Fig. 13 *Hedbergella sp.5*. X 171. Sample (82-4).

Fig. 14 *Praeglobotruncana delrioensis* (Plummer). X 141. Sample (13-5).

Fig. 15 *Praeglobotruncana*? *praehelvetica* (Trujillo). X 272. Sample CER. 27.


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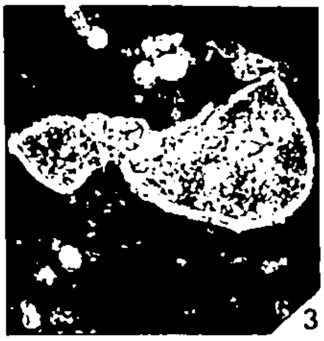
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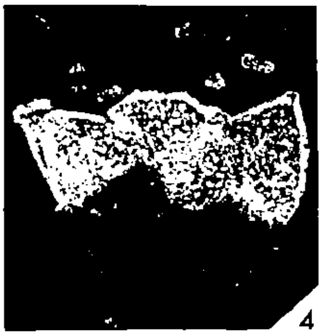
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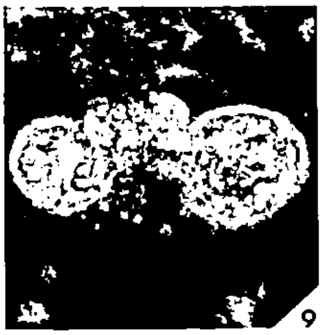
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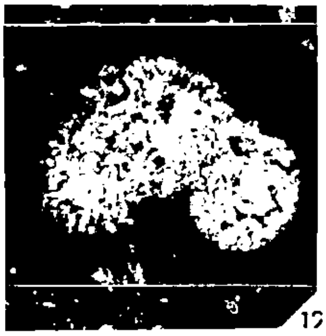
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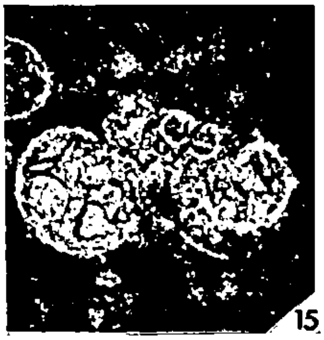
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PLATE 24

The Cretaceous Part of The Nief Beds

Fig. 1 *Praeglobotruncana stephani turbinata* (Reichel). X 88. Sample CER. 27.

Fig. 2 *Praeglobotrucnana stephani turbinata* (Reichel). X 96. Sample CER. 27.

Fig. 3 *Praeglobotruncana? sp.* X 78. Sample (13-2).

Fig. 4 *Schackoina sp.* X 128. Sample CER. 27.

Fig. 5 *Globigerinelloides bentonensis* (Morrow). X 184. Sample CER. 21(i).

Fig. 6 *Globigerinelloides sp.1.* X 205. Sample CER. 10.

Fig. 7 *Globigerinelloides sp.2.*. X 207. Sample CER. 61.

Fig. 8 *Globigerinelloides sp.3.* X 189. Sample CER. 27.

Fig. 9 *Racemigüembelina fructicosa* (Egger). X 94. Sample C.C. 40.

Fig. 10 *Racemigüembelina fructicosa* (Egger). X 85. Sample C.C. 40.

Fig. 11 *Racemigüembelina sp.* X 88. Sample C.C. 43.

Fig. 12 *Pseudotextularia elegans* (Rzehak). X 127. Sample C.C. 41.

Fig. 13 *Pseudotextularia elegans* (Rzehak). X 89. Sample C.C. 42.

Fig. 14 *Pseudotextularia sp.1.* X 169. Sample C.C. 43.

Fig. 15 *Pseudotextularia sp.2.* X 95. Sample C.C. 43.

PLATE 24


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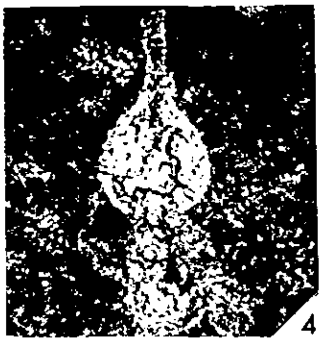
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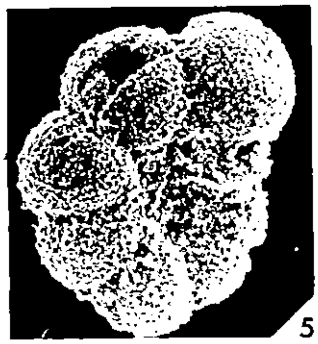
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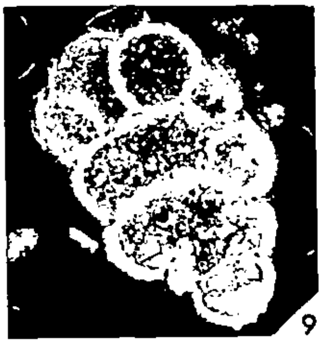
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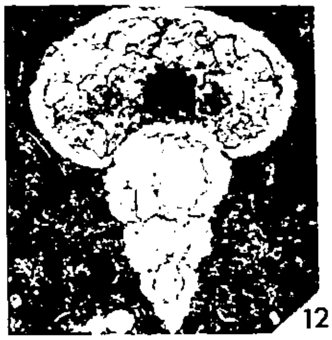
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PLATE 25

The Cretaceous Part of The Nief Beds, And The Upper Triassic of the Asinepe Limestone

Fig. 1 *Planoglobulina sp*. X 69. Sample C.C. 42.

Fig. 2 *Planoglobulina sp*. X 129. Sample (72-2).

Fig. 3 *Heterohelix globulosa* (Ehrenberg). X 168. Sample C.C. 35.

Fig. 4 *Heteroehlix pulchra* (Brotzen). X 233. Sample (12-1).

Fig. 5 *Heterohelix pulchra* (Brotzen). X 120. Sample (20-1).

Fig. 6 *Heterohelix pulchra* (Brotzen). X 180. Sample (72-4).

Fig. 7 *Heterohelix sp.1*. X 257. Sample C.C. 43.

Fig. 8 *Heterohelix sp.2*. X 153. Sample C.C. 43.

Fig. 9 *Gublerina sp.* X 100. Sample C.C. 43.

Fig. 10 *Gublerina sp*. X 184. Sample C.C. 35.

Fig. 11 *Glomospira sp.1*. X 80. Sample (12-9).

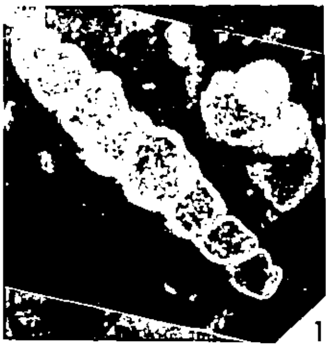
Fig. 12 *Glomospirella friedly* Kristan-Tollmann. X 52. Sample (12-9).

Fig. 13 *Trochammina alpina* Kristan-Tollmann. X 191. Sample (12-1).

Fig. 14 *Planiinvolutina carinata* Leischner. X 82. Sample (13-1)

Fig. 15 *Planiinvolutina carinata* Leischner. X 60. Sample CER. 20.

PLATE 25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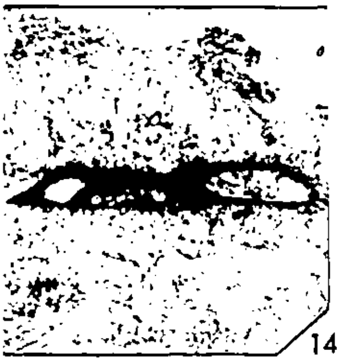
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PLATE 26

The Upper Triassic of The Asinepe Limestone

Fig. 1 *Ophthalmidium sp.* X 129. Sample C.C. 13D.

Fig. 2 *Ophthalmidium sp.* X 129. Sample C.C. 13D.

Fig. 3 *Ophthalmidium sp.* X 259. Sample C.C. 85.

Fig. 4 *Ophthalmidium sp.* X 254. Sample C.C. 28.

Fig. 5 *Ophthalmidium sp.* X 59. Sample C.C. 10.

Fig. 6 *Galeanella panticae* Zaninetti & Bronnimann. X 88. Sample C.C. 10.

Fig. 7 *Galeanella panticae* Zaninetti & Bronnimann. X 91. Sample C.C. 10.

Fig. 8 *Galeanella sp.* X 133. Sample C.C. 10.

Fig. 9 *Galeanella sp.* X 187. Sample C.C. 10.

Fig. 10 *Miliolipora cuvillieri* Bronnimann & Zaninetti. X 108. Sample C.C. 13D.

Fig. 11 *Miliolipora cuvillieri* Bronnimann & Zaninetti. X 98. Sample C.C. 13D.

Fig. 12 *Duotaxis birmanica* Bronnimann, Whittaker & Zaninetti X 103. Sample CER. 55.

Fig. 13 *Involutina communis* (Kristan). X 63. Sample C.C. 85.

Fig. 14 *Involutina communis* (Kristan). X 45. Sample C.C. 85.

Fig. 15 *Involutina gaschei* (Koehn-Zaninetti & Bronnimann) X 77. Sample C.C. 85.

PLATE 26


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PLATE 27

The Upper Triassic of The Asinepe Limestone

Fig. 1 *Involutina gaschei* (Koehn-Zaninetti & Bronnimann). X 55. Sample C.C. 85.

Fig. 2 *Involutina gaschei* (Koehn-Zaninetti & Bronnimann). X 49. Sample (12-4).

Fig. 3 *Involutina impressa* (Kristan-Tollmann). X 29. Sample CER. 55.

Fig. 4 *Involutina sinuosa sinuosa* (Weynschenik). X 32. Sample CER. 1A.

Fig. 5 *Involutina sinuosa pragsoides* (Oberhauser). X 41. Sample (12-9).

Fig. 6 *Involutina sinuosa pragsoides* (Oberhauser). X 29. Sample CER. 20c.

Fig. 7 *Involutina* aff. *tenuis* Kristan X 41. Sample (12-9).

Fig. 8 *Involutina tumida* (Kristan-Tollmann). X 90. Sample (12-9).

Fig. 9 *Involutina tumida* (Kristan-Tollman). X 116. Sample (12-6).

Fig. 10 *Triasina hantkeni* Majzon. X 22. Sample CER. 20 B.

Fig. 11 *Triasina hantkeni* Majzon. X 37. Sample CER. 19.

Fig. 12 *Triasina hantkeni* Majzon. X 42. Sample (12-9).

Fig. 13 *Triasina hantkeni* Majzon. X 43. Sample CER. 20 B.

Fig. 14 *Triasina hantkeni* Majzon. X 41. (Axial Section). Sample (12-9).

Fig. 15 *Genus "B" species 1*. X 145. Sample CER. 44.

PLATE 27


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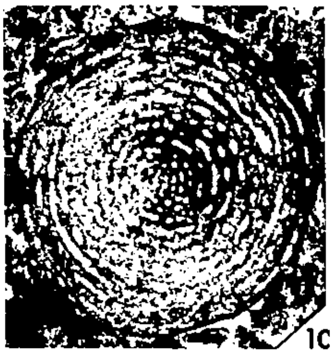
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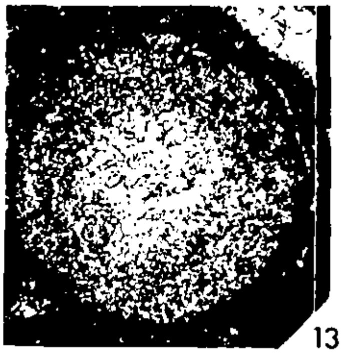
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Geological and micropaleontological investigations in the Upper Triassic (Asinepe Limestone) of Seram, Outer Banda Arc, Indonesia

by

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Résumé

Le Trias supérieur en facies carbonaté récifal de Seram présente deux associations distinctes de Foraminifères, l'une essentiellement faite d'Involutinidae, avec pour espèce dominante *Triasina hantkeni* MAJZON, l'autre de Foraminifères porcelanés dont les principaux représentants sont *Planiinvoluta*, *Ophthalmidium* et les Milioliporidae *Miliolipora* et *Galeanella*. Une nouvelle espèce, *Galeanella* ? *laticarinata*, n.sp., est attribuée avec doute à ce dernier genre.
La microfaune d'accompagnement des Involutinidae et des Foraminifères porcelanés comprend des Ammodiscidae, des Lituolidae (ou Endothyridae), des Trochamminidae (?), des Duostominidae, des Nodosariidae, etc., qui seront décrits dans une note ultérieure (AL-SHAIBANI, CARTER et ZANINETTI, en préparation).

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Introduction

The materials described here were collected from the Asinepe Limestone (the "massive Triassic limestone" of Valk, 1945) in 1975 by members of the London University and B.P. Expedition to Seram, Eastern Indonesia. This rock unit, named informally after Mt. Asinepe in the Lamoemoete Mountain range of N. central Seram, outcrops in the main central ranges of the island, extending from the Manusela mountains of S. Seram to the Lamoemoete mountains in the N. and N.W. It also occurs in parts of eastern and western Seram as much smaller outcrops. It is present also as large exotic blocks and boulder and pebble sized clasts in the Salas Block Clay olistostrome of N. Seram.

The Asinipe Limestone forms a thrust sheet and, with the Salas Block Clay olistostrome and other thrust sheets (Kaibobo Complex, Tehoru Formation, etc.) constitutes an allochthonous stratigraphical-structural element overthrust on to the entirely marine, Triassic to Miocene, imbricated para-autochthon in the earliest Pliocene (N.18). In the N.W. of the island outcrops of Asinepe Limestone have been strongly affected by steep, post-thrusting faults and appear as small klippen. Autochthonous Plio-Pleistocene sediments were deposited in basins produced by the post-thrusting faults. A detailed discussion of the various stratigraphic-structural units making up the island of Seram is given by Audley-Charles et al. (1979).

The para-autochthon forming the basal exposed portion of the island, was deposited on the Australian shelf, slope and rise and includes both Triassic siliciclastics (lower part of the Wakuku beds) containing palynomorphs (Price, 1976) and Triassic marls and calcilutites containing chert, radiolaria and Halobia. These deposits differ markedly both in lithology and biofacies from the tropical or subtropical, reefal-subreefal Asinepe Limestone, which is usually a grey, sometimes crystalline, oolitic & bioclastic grainstone containing calcareous algae, Foraminiferida, sponges, corals, crinoid ossicles, echinoids and brachiopods. The age of this limestone is shown here to be Norian, substantiating the views of Valk (1945) and of Audley-Charles et el. (1979) who considered it to be late Triassic by analogy with the Triassic part of the Maubisse Limestone of Timor (Carter et al. 1976), dated by Yamagawa (1963) on corals and the associated fauna, and contradicting those of Van der Sluis (1950) who supposed it to be Jurassic because the deposit contains _Lovcenipora_. Like the Maubisse Limestone, the Asinepe Limestone is considered to have been deposited on the margin of Sundaland (see also Kanmera and Nakazawa, 1973) and to have been thrust on to the margin of the Australian plate in the earliest Pliocene.

II. MICROPALEONTOLOGY

The Upper Triassic of Seram contains a rich foraminiferal fauna. It will be described in 2 papers. The present first paper contains the description of the Involutinidae and the Miliolina /̄Fischerinidae, Nubeculariidae (Nubeculariinae and Ophthalmidiinae), Miliolidae (?) and Milioliporidae̲7.

Involutinids and porcelaneous foraminifera represent two facies controlled associations which we did not find intermixed. However ther are a number of forms common to both associations, such as Duotaxis birmanica ZANINETTI and BRÖNNIMANN in BRÖNNIMANN, WHITTAKER and ZANINETTI, 1975, Ammodiscidae, Trochamminidae (?), Nodosariidae, etc. which will be described in the second paper (AL-SHAIBANI, CARTER an ZANINETTI, in preparation).

The foraminiferal fauna of the Upper Triassic of Seram shows a distinct relationship with that from the Upper Triassic of the Shan Plateau, Burma (BRÖNNIMANN, WHITTAKER and ZANINETTI, 1975), however the dominant species of Seram, Triasina hantkeni MAJZON, 1954, is absent in the Burmese material (AL-SHAIBANI, ALTINER, BRÖNNIMANN, CARTER and ZANINETTI, 1982), as well as the representatives of the Milioliporidae.

In the following we are listing all the species which have been used for paleoecological interpretation of the Upper Triassic sediments of Seram.

1. Association of involutinids

This group, which is mostly found in samples 12-9 and CER 20, is characterized by the abundantly occurring Triasina hantkeni MAJZON. Other involutinids /̄Aulotortus spp., pl. 1, fig. 1-8, 12, 15 ; Auloconus permodiscoides (OBERHAUSER), not illustrated)7 are rare.

The involutinids and associated forms are listed below :

Triasina hantkeni MAJZON, 1954 (pl. 1, fig. 1-3, 5, 6)
Aulotortus sinuosus sinuosus WEYNSCHENK, 1956 (pl. 1, fig. 1)
Aulotortus ex gr. *sinuosus* WEYNSCHENK, 1956 (pl. 1, fig. 23)
Aulotortus sinuosus pragsoides (OBERHAUSER, 1964) (pl. 1, fig. 4, 7?, 8?, 13?)
Aulotortus communis (KRISTAN, 1957) (pl. 1, fig. 9, 10, 14)
Aulotortus tumidus (KRISTAN-TOLLMANN, 1964) (pl. 1, fig. 11, 1
Aulotortus ex gr. *impressus* (KRISTAN-TOLLMANN, 1964) or *tenuis* (KRISTAN, 1957) (pl. 1, fig. 15, 16)
Aulotortus gaschei (KOEHN-ZANINETTI and BRÖNNIMANN, 1968) (or *Glomospirella friedli* KRISTAN-TOLLMANN, 1964) (pl. 1,fig. 17-22)
Auloconus permodiscoides (OBERHAUSER, 1964) (not illustrated)
Agathammina austroalpina KRISTAN-TOLLMANN and TOLLMANN, 1964 (pl. 3, fig. 9, 10, 11?, 14, 15?, 16?)
Duotaxis birmanica ZANINETTI and BRÖNNIMANN *in* BRÖNNIMANN, WHITTAKER and ZANINETTI, 1975

In addition species of the families Ammodiscidae, Trochamminidae (?), Lituolidae (or Endothyridae), Nodosariidae, etc., are also present.

The microfacies of the sediments with involutinids and other small foraminifera is a biosparite (grainstone). The involutinids are always strongly recrystallized.

2. Porcelaneous foraminifera

They occur mostly in samples CC 10, CC 13 and 13-1 (pl. 2, fig. 1-25 ; pl. 3, fig. 1-3, 5, 7-13, 15, 17-26, 28-31). The porcelaneo foraminifera and associated forms are listed below :

Agathammina austroalpina KRISTAN-TOLLMANN and TOLLMANN, 1964 (pl. 3, fig. 9, 10, 11?, 15?)

Planiinvoluta carinata LEISCHNER, 1961 (pl. 2, fig. 15-19, 21-24; pl. 3, fig. 31)

Nubecularia sp. (AL-SHAIBANI, CARTER and ZANINETTI, in preparation, pl. 1, fig. 14, 15)

Ophthalmidium spp. (pl. 2, fig. 25; pl. 3, fig. 3, 5, 7, 28-30)

Spiriamphorella ? sp. (pl. 3, fig. 1, 2)

Galeanella ? *laticarinata* n. sp. (pl. 3, fig. 17-20, 21?)

Galeanella panticae ZANINETTI and BRÖNNIMANN *in* BRÖNNIMANN, CADET, RICOU and ZANINETTI, 1973 (pl. 3, fig. 22-24, 25?)

Galeanella sp. 1 or overgrown *Galeanella panticae* ZANINETTI and BRÖNNIMANN, 1973 (pl. 2, fig. 5, 6, 9, 10)

Galeanella ? sp. (pl. 2, fig. 11)

Miliolipora cuvillieri BRÖNNIMANN and ZANINETTI *in* BRÖNNIMANN, ZANINETTI, BOZORGNIA, DASHTI and MOSHTAGHIAN, 1971 (pl. 2, fig. 1-4, 7, 8, 14; pl. 3, fig. 8?, 12?, 13?)

"*Sigmoilina*" *schaeferae* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982 (pl. 2, fig. 12, 13, 20; pl. 3, fig. 26?)

Duotaxis birmanica ZANINETTI and BRÖNNIMANN *in* BRÖNNIMANN, WHITTAKER and ZANINETTI, 1975

In addition species of the families Duostominidae, Trochamminidae (?), Lituolidae (or Endothyridae), "Textulariidae", Nodosariidae, etc., are also present.

Associated with these foraminifers we also find the incertae sedis Muranella sphaerica BORZA, 1975, and Globochaete gregaria SCHÄFER and SENOWBARI-DARYAN, 1980.

The microfacies of the sediments in which the above listed species have been found is a biosparite (grainstone).

Paleoecological interpretation

With reference to SADATI's (1981, fig. 8) interpretation of the distribution of the foraminifera in the reefal environment of the Upper Triassic, the following conclusions can be made :

1. Association of involutinids

This association is dominated by Triasina hantkeni. The involutine Aulotortus is less common and the trocholine Auloconus very rare. The facies of the involutinid association does not correspond with any of the 3 facies types (biolithite-grapestone-mud facies) recognized by SADATI (1981) in the reefal developmen of the Upper Triassic of the Hohe Wand, Eastern Austria.

The abundant occurrence of Triasina hantkeni is quite similar to that observed by one of us (L.Z.) in the Upper Triassic of the southern Appennine mountains. It is here interpreted to suggest a shallow water, low energy lagoonal environment, protected from the open sea by a reefal barrier . In fact, the accumulation of the subglobular tests of the triasines without involutines and trocholines has to be envisaged to occur in an environment away from immediate reefal influences. In this case the "mud facies" of SADATI (1981, fig. 8) would best represent this type of environment and sedimentation.

2. Association of porcelaneous foraminifera

The dominant genera of this association are Agathammina, Planiinvoluta, Nubecularia, Ophthalmidium, "Sigmoilina", Galeanella and Miliolipora. Duostominidae, Trochamminidae (?), Lituolidae (or Endothyridae), Nodosariidae, etc., may also be present. This associatio characterizes quite well the limit of the reefal facies "biolithite and "grapestone" which occurs precisely in the subdivision I D of SADATI, 1981, fig. 8.

Occasionally, there occurs in this association of porcelaneous foraminifera also Globochaete gregaria SCHÄFER and SENOWBARI-DARYAN, 1980, which might place the sediments with this species in a quiet back reef environment corresponding to the "mud facies" (= Schlamm-Fazies of SCHÄFER and SENOWBARI-DARYAN, 1980, p. 101).

In conclusion, the samples from the beds 12-9, CER 20, CC 10, CC 13 and 13-1 can be interpreted paleoecologically as follows :

- the samples 12-9 and CER 20, with Triasina hantkeni, Aulotortus spp., Glomospira, Glomospirella, Duotaxis (= Tetrataxis in SADATI 1980 ?), trochamminids (?) and nodosariids are considered to represent the "mud facies", subdivision III B of SADATI,1981,fig.8
- the samples CC 10, CC 13 and 13-1 with Agathammina, Planiinvoluta Nubecularia, Ophthalmidium, "Sigmoilina", Spiriamphorella ?, Galeanella, Miliolipora, Duotaxis, ammodiscids, trochamminids (?), lituolids (or endothyrids), attached agglutinated forms, etc., are believed to represent the "biolithite" and "grapestone" facies, subdivisions I B to I D of SADATI, 1981, fig. 8.

Systematic description of the more important species

Miliolina DELAGE and HEROUARD, 1896, emend. BRONNIMANN and ZANINETTI *in* BRONNIMANN, ZANINETTI, BOZORGNIA, DASHTI and MOSHTAGHIAN, 1971

Miliolacea EHRENBERG, 1839, emend. BRONNIMANN and ZANINETTI, 1971

Fischerinidae MILLETT, 1838

This family is represented in the Upper Triassic of Seram by the genera *Agathammina* NEUMAYR, 1887, and *Planiinvoluta* LEISCHNER, 1961. We have identified *Agathammina austroalpina* KRISTAN-TOLLMANN and TOLLMANN, 1964 (pl. 3, fig. 9, 10, 11?, 14, 15?, 16?), *Agathammina* sp. (pl. 3, fig. 27) and *Planiinvoluta carinata* LEISCHNER, 1961 (pl. 2, fig. 15-19, 21-24; pl. 3, fig. 31). The last cited species shows occasionaly in axial section irregularities in the enrollment (pl. 2, fig. 16, 21) and agglutination of the walls (pl. 2, fig. 17). Further we have observed in some forms that the proloculus is not attached to the substratum (pl. 2, fig. 17, 21, 24).

Nubeculariidae JONES, 1875
Ophthalmidiinae WIESNER, 1920

The Ophthalmidiinae are not well represented in the Upper Triassic of Seram and taxonomically it seems best to list them under the name of *Ophthalmidium* spp. (pl. 2, fig. 25; pl. 3, fig. 3-7, 28-30).

Nubeculariidae (Ophthalmidiinae)
or Milioliporidae BRONNIMANN and ZANINETTI, 1971
Spiriamphorella BORZA and SAMUEL, 1977

Two specimens have been placed with reservation into the genus Spiriamphorella BORZA and SAMUEL, 1977 (Spiriamphorella ? sp., pl. 3, fig. 1, 2).

Miliolidae EHRENBERG, 1839 ?
Quinqueloculininae CUSHMAN, 1917 ?
Sigmoilina SCHLUMBERGER, 1887 ?
"Sigmoilina" schaeferae ZANINETTI, ALTINER, DAĞER and DUCRET, 1982
Pl. 2, fig. 12, 13, 20; pl. 3, fig. 26?

1978? "Sigmoilina" sp.
SCHAFER and SENOWBARI-DARYAN, pl. 1, fig. 4.
1979? "Sigmoilina" sp.
SCHAFER, pl. 19, fig. 9.
1980. "Sigmoilina" sp.
SENOWBARI-DARYAN, pl. 19, fig. 10
1980. Sigmoilina sp.
DULLO, pl. 12, fig. 7.
1981. "Sigmoilina" sp.
FLUGEL, fig. 14 B.
1982. "Sigmoilina" sp.
1982. "Sigmoilina" schaeferae
ZANINETTI, ALTINER, DAĞER and DUCRET, pl. 8, fig. 3, 6, 9, 12, 13.

This species is characteristic of the late Triassic reefal facies of the Alps and the Taurus. Three specimens are illustrated (pl. 2, fig. 12, 13, 20).

Milioliporidae BRONNIMANN and ZANINETTI in BRONNIMANN, ZANINETTI, BOZORGNIA, DASHTI and MOSHTAGHIAN, 1971

Galeanellinae ZANINETTI, ALTINER, DAĞER and DUCRET, 1982

Galeanella KRISTAN, 1958, emend. ZANINETTI and BRONNIMANN in BRONNIMANN, CADET, RICOU and ZANINETTI, 1973

Galeanella ? laticarinata, n. sp.
Pl. 3, fig. 17-20, 21?;
holotype, pl. 3, fig. 18

1978. Galeanella sp. 1
SCHAFER and SENOWBARI-DARYAN, pl. 1, fig. 5; pl. 2, fig. 4.

1979. Galeanella sp. 1
SCHAFER, pl. 19, fig. 19.

1980. Galeanella sp. 1
SENOWBARI-DARYAN, pl. 17, fig. 2.

This new foraminifer, which seems to be the same form as that illustrated by SCHAFER and SENOWBARI-DARYAN (1978, pl. 1, fig. 5; pl. 2, fig. 4), by SCHAFER (1979, pl. 19, fig. 19) and by SENOWBARI-DARYAN (1980, pl. 17, fig. 2) is here only with doubt placed into Galeanella KRISTAN, 1958, because the reticulate perforation characteristic of the genus could not be clearly recognized. The new species is named for the well developed keels.

Material: Five individuals in thin sections from the samples CC 10 (type level), CC 13 and 13-1. The material will be deposited in the Imperial College, micropaleontological research collection.

Holotype: The specimen illustrated by pl. 3, fig. 18, from sample CC 10.

Paratypes: Two paratypes are illustrated by pl. 3, fig. 20, 21?

Type-locality: Lola Kechil River, 1.3 km from its mouth, in float.

Type-level

Upper Triassic, Norian/Rhetian.

Morphological description:

The strongly keeled test of Galeanella ? laticarinata, n. sp., with 350 µ maximum diameter, falls in the medium range of dimensions of the genus. The total number of chambers cannot be determined. Their basal parts are thickened and their apertural parts thinned out. The early enrollment is irregular, in the adult it seems to be rather regular with 2 chambers per whorl. The chambers carry an elongate and sharp keel which is apparently the continuation of the "foot". This keel differs from that of Galeanella tollmanni (KRISTAN, 1957) which is proximal in respect to the "foot" and characterized by a less sharp border.

The calcareous wall is opaque in transmitted light, probably originally of porcelaneous microstructure. The perforations, typical for the family Milioliporidae and the genus Galeanella are not well recognizable in our material.

The aperture was not seen. It is probably a simple terminal opening.

Stratigraphic range and environment

Norian/Rhetian, reefal facies.

Remarks:

Galeanella ? laticarinata, n. sp., differs from all other species of the genus /Galeanella expansa ZANINETTI, ALTINER, DAGER and DUCRET, 1982; Galeanella irregularis (BORZA and SAMUEL, 1977) (synonyme: *Urnulinella andrusovi* BORZA and SAMUEL, 1977); *Galeanella ? minuta* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982; *Galeanella ovata* (SAMUEL, SALAJ and BORZA, 1981) (synonyme: *Galeanella bronnimanni* ALTINER and ZANINETTI, 1981); *Galeanella panticae* ZANINETTI and BRONNIMANN *in* BRONNIMANN, CADET, RICOU and ZANINETTI, 1973); *Galeanella ? salaji* (SAMUEL and BORZA, 1981); *Galeanella tollmanni* (KRISTAN, 1957); *Galeanella variabilis* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982] by its strongly keeled periphery which seems to be the result of a differenciation of the "foot".

Association:

In the type-sample CC 10, *Galeanella ? laticarinata*, n. sp., is associated with *Galeanella panticae*, *Ophthalmidium* spp., *Nubecularia* sp., *Duotaxis birmanica* ZANINETTI and BRONNIMANN *in* BRONNIMANN, WHITTAKER and ZANINETTI, 1975, the families Ammodiscidae, Lituolidae (or othyridae), "Textulariidae", Trochamminidae (?), etc. In the other samples (CC 13 and 13-1), *Galeanella ? laticarinata*, n. sp. is accompanied by *Agathammina austroalpina*, *Planiinvoluta carinata*, *Spiriamphorella ?* sp., *Galeanella panticae*, *Milioli~~s~~pora cuvillieri*, *Ophthalmidium* spp., *Nubecularia* sp., "*Sigmoilina*" *schaeferae*, *Duotaxis birmanica*, *Aulotortus* ex gr. *impressus* or *tenuis*, the families Ammodiscidae, Lituolidae ndothyridae), Trochamminidae (?), Duostominidae, etc., and the *Incertae sedis* *Muranella sphaerica* BORZA, 1975, and *Globochaete gregaria* SCHAFER and SENOWBARI-DARYAN, 1980.

Galeanella panticae ZANINETTI and BRONNIMANN *in*
BRONNIMANN, CADET, RICOU and ZANINETTI, 1973
Pl. 3, fig. 22-24, 25?

See synonymy *in* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982, and add

1980? *Galeanella* sp.
DULLO, pl. 12, fig. 1
1982. *Galeanella panticae*.
ZANINETTI, ALTINER, DAĞER and DUCRET, pl. 1, fig. 1-3, 4?, 5-11.
1982. *Galeanella panticae*.
SENOWBARI-DARYAN, SCHÄFER and ABATE, pl. 24, fig. 15, 21.

In the Seram material, sample CC 10, occur specimens of a *Galeanella* which we identified as *Galeanella panticae*, the type of which is from the Upper Triassic of the Dinarids. The thin sections show an early streptospiral enrollment and a complex type of perforations (pl. 3, fig. 22-24).

Galeanella sp. 1
or overgrown *Galeanella panticae* ZANINETTI and
BRONNIMANN, 1973
Pl. 2, fig. 5, 6, 9, 10

The specimens occurring in sample CC 10 and illustrated by pl. 2, fig. 5, 6, 9, 10 have been separated from *Galeanella panticae* (see pl. 3, fig. 22-24, 25?) from which they differ by the thick wall, the small chamber lumen and possibly by the uncoiling of the test.

However, it is possible that the thick wall and the small lumina are the result of calcite overgrowth. Such a secondary thickening cannot be excluded in view of the strong recrystallization of the test. As also in *Galeanella panticae* some sort of uncoiling was observed (BRÖNNIMANN, CADET, RICOU and ZANINETTI, 1973, pl. 2, fig. 6, 21), the above mentioned differences might be of secondary nature. In this case *Galeanella* sp. 1 would have to be placed into *Galeanella panticae*.

Milioliporinae ZANINETTI, ALTINER, DAĞER and DUCRET, 1982
Miliolipora BRONNIMANN and ZANINETTI *in* BRONNIMANN, ZANINETTI, BOZORGNIA, DASHTI and MOSHTAGHIAN, 1971
Miliolipora cuvillieri BRONNIMANN and ZANINETTI *in* BRONNIMANN, ZANINETTI, BOZORGNIA, DASHTI and MOSHTAGHIAN, 1971
Pl. 2, fig. 1-4, 7, 8, 14; pl. 3, fig. 8?, 12?, 13?

See synonymy *in* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982, and add

1982. *Miliolipora cuvillieri*.
ZANINETTI, ALTINER, DAĞER and DUCRET, pl. 4, fig. 14; pl. 6, fig. 16?, 20-22.

The sections of *Miliolipora cuvillieri* illustrated by pl. 2, fig. 1-4, 7, 8, 14 are identical with those of the type of the species which is from the Upper Triassic of Iran (BRONNIMANN, ZANINETTI, BOZORGNIA, DASHTI and MOSHTAGHIAN, 1971). The species is remarkable for its large size, by which it is clearly distinguishable from species of *Agathammina*, the thickness of the wall, and the perforations. The latter are well exhibited by the individual shown by pl. 2, fig. 1.

Rotaliina DELAGE et HEROUARD, 1896
Involutinacea BUTSCHLI, 1880
Involutinidae BUTSCHLI, 1880

This family is well represented in the Seram material. The Involutinids form an association distinct from that of the porcelaneous foraminifera. The most common species is *Triasina hantkeni* which may be associated with other involutinids.(*Aulotortus communis*, *A. sinuosus sinuosus*, *A. sinuosus pragsoides*, *A. tumidus*, *A. gaschei*, *A.* ex gr. *impressus* or *tenuis*), or other foraminifera, such as *Agathammina austroalpina*, *Duotaxis birmanica*, ammodiscids, trochamminids (?),

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Explanation to the plates

Plate 1

Association of Involutinidae in the Upper Triassic of Seram.

1-3, 5, 6	*Triasina hantkeni* MAJZON, 1954; 1, with *Aulotortus sinuosus sinuosus* WEYNSCHENK, 1956.
4, 7?, 8?, 13?	*Aulotortus sinuosus pragsoides* (OBERHAUSER, 1964).
9, 10, 14	*Aulotortus communis* (KRISTAN, 1957); 14, eroded specimen.
11, 12	*Aulotortus tumidus* (KRISTAN-TOLLMANN, 1964).
15, 16	*Aulotortus* ex gr. *impressus* (KRISTAN-TOLLMANN, 1964), or *tenuis* (KRISTAN, 1957).
17-22	*Aulotortus gaschei* (KOEHN-ZANINETTI and BRONNIMANN, 1968) or *Glomospirella friedli* KRISTAN-TOLLMANN, 1964.
23	*Aulotortus* ex gr. *sinuosus* WEYNSCHENK, 1956.

1, 2, 5-8, 12, 15, 22, sample 12-9 ; 3, 4, 20, sample CER 20 ; 9, 14, 17, 23, sample CC 85 ; 10, sample 21-1 ; 11, sample CER 45 ; 13, sample CER 19 ; 16, sample 13-1 ; 18, 19, 21, sample 12-4.

1, 2, 5-8, 13, 14, 65x ; 3, 4, 35x ; 9, 110x ; 10, 180x ; 11, 15, 16, 80x ; 12, 170x ; 17, 18, 22, 100x; 19, 50x ; 20, 21, 70x ; 23, 16x.

Plate 2

Association of porcelaneous foraminifera in the Upper Triassic of Seran

1-4, 7, 8, 14 *Miliolipora cuvillieri* BRONNIMANN and ZANINETTI, 1971.

5, 6, 9, 10 *Galeanella* sp. 1 or overgrown *Galeanella panticae* ZANINETTI and BRONNIMANN, 1973.

11 *Galeanella* ? sp.

12, 13, 20 *"Sigmoilina" schaeferae* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982.

15-19, 21-24 *Planiinvoluta carinata* LEISCHNER, 1961.

25 *Ophthalmidium* sp.

1-4, 7, 8, 11-25, sample CC 13 ; 5, 6, 9, 10, sample CC 10.

1-4, 7, 8, 12-25, 200x ; 5, 6, 9-11, 135x.

Plate 3

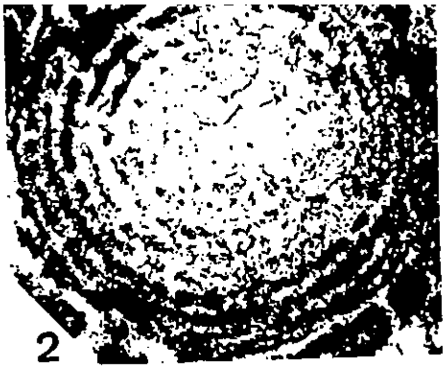
Association of porcelaneous foraminifera in the Upper Triassic of Seram.

1, 2	*Spiriamphorella* ? sp.
3-7, 28-30	*Ophthalmidium* spp.
8, 12, 13	*Miliolipora cuvillieri* BRONNIMANN and ZANINETTI, 1971 ?
9, 10, 11?, 14, 15?, 16?	*Agathammina austroalpina* KRISTAN-TOLLMANN and TOLLMANN, 1964.
17-20, 21?	*Galeanella* ? *laticarinata*, n. sp.; holotype fig. 18.
22-24, 25?	*Galeanella panticae* ZANINETTI and BRONNIMANN, 1973.
26	*"Sigmoilina" schaeferae* ZANINETTI, ALTINER, DAĞER and DUCRET, 1982 ?
27	*Agathammina* sp.
31	*Planiinvoluta carinata* LEISCHNER, 1961.

1, 2, 5, 8-13, 15, 17, 26, 30, 31, sample CC 13 ; 3, 19, sample 13-1 ; 4, sample CC 28 ; 6, sample CC 85 ; 7, 18, 20-25, 28, 29, sample CC 10 ; 14, sample CER 45 ; 16, sample 12-9 ; 27, sample 21-1.

1, 28-30, 180x ; 2, 9, 11, 20, 210x ; 3, 6, 310x ; 4, 630x ; 5, 750x ; 7, 90x ; 8, 17, 200x ; 10, 14, 18, 245x ; 12, 27, 220x ; 13, 26, 280x ; 15, 27, 220x ; 16, 130x ; 19, 260x ; 21, 235x ; 22, 23, 135x ; 24, 60x ; 25, 165x ; 26, 280x ; 31, 170x.

1



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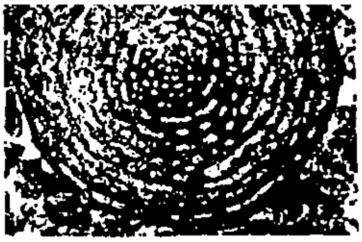

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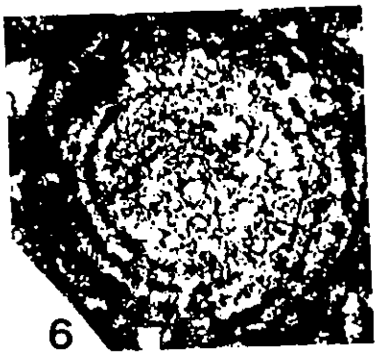

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PLATE 1

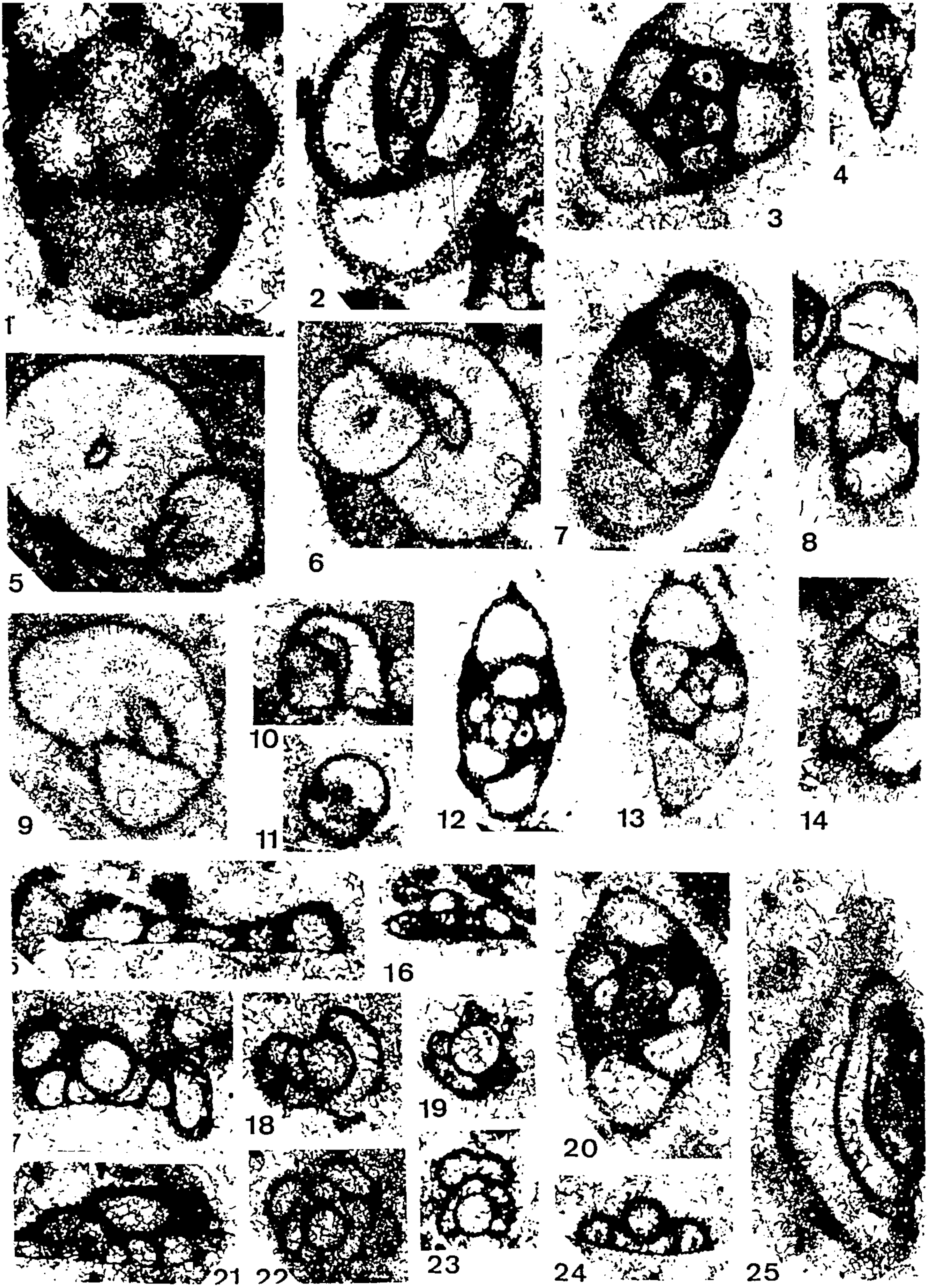

PLATE 2


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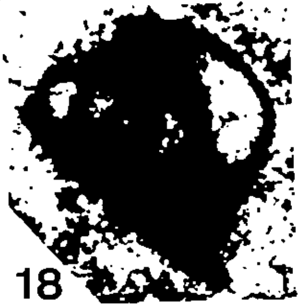
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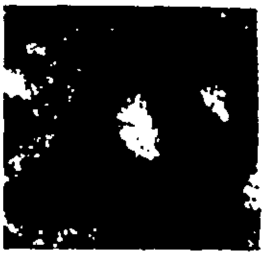
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PLATE 3

Arch. Sc. Geneve, Vo. 35, Fasc. 2, PP. 137-142, 1982

Triasina hantkeni MAJZON, 1954 (Foraminifère), dans le Trias supérieur de la Téthys (Europe et Asie).

Shaiban AL-SHAIBANI[1], Demir ALTINER[2], Paul BRONNIMANN[3], David J. CARTER[1] et Louisette ZANINETTI[4]

Une synthèse des données portant sur une vingtaine d'années de recherches dans le domaine de la micropaléontologie du Trias a montré que *Triasina hantkeni* MAJZON, 1954, possède une vaste distribution dans le Trias supérieur [Norien supérieur (Rhétien)] alpin d'Europe (ZANINETTI, 1976, p. 173), tandis qu'en province téthysienne asiatique l'espèce restait inconnue vers l'Est, au-delà de la Turquie. On avait cependant déjà mentionné l'existence de Triasines dans le Caucase (EFIMOVA, 1974), mais seule l'espèce *Triasina oberhauseri* KOEHN-ZANINETTI et BRONNIMANN, 1968, y aurait été observée jusqu'ici. Ailleurs encore, *Triasina hantkeni* avait été signalée dans l'Atlas tunisien oriental (SALAJ et STRANIK, 1970).

Or durant ces 5 dernières années, plusieurs localités asiatiques contenant *Triasina hantkeni* ont été découvertes, qui viennent combler une lacune dans les connaissances, alors même qu'une disparition complète de l'espèce dans l'ensemble du domaine téthysien à l'Est du Taurus n'apparaissait plus guère concevable.
Des Triasines en effet ont été observées récemment en différentes régions d'Asie moyenne et de l'Extrême-Orient: dans la péninsule de Malaisie (GAZDZICKI et SMIT, 1977), dans l'archipel des Philippines (FONTAINE, BEAUVAIS, POUMOT et VACHARD, 1979), en Chine méridionale (HE YAN, 1980), dans quelques sites de l'Himalaya (NE Kumaun, Ladahk, Spiti, GAZDZICKI et GUPTA, 1981), dans l'île de Seram en Indonésie (AL-SHAIBANI, CARTER et ZANINETTI, à paraître).

En d'autres régions encore de la Téthys orientale, des Triasines douteuses ont été vues en Afghanistan par MONTENAT et VACHARD (1980), qui précisent (p. 707) ne pas en avoir "trouvé d'exemplaires typiques", mais qui ajoutent que "WITTEKINDT (1973) dénombre *Triasina* cf. *hantkeni* dans son inventaire bibliographique."

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Enfin en Birmanie et en Thaïlande, aucune Triasine ne semble encore avoir été mise en évidence. Ni GRAMMANN, LAIN et STOPPEL (1972), pour la Birmanie, ni KEMPER, MARONDE et STOPPEL (1976) pour la Thaïlande, n'en ont fait mention, pas plus que BRONNIMANN, WHITTAKER et ZANINETTI (1975), bien que les microfaunes vues par ces derniers auteurs dans le Trias supérieur de Birmanie soient très proches de celles de l'île de Seram (AL-SHAIBANI, CARTER et ZANINETTI, à paraître).

La première observation de Triasines dans le Trias supérieur alpin semble bien revenir, comme l'admet MAJZON (1954), à HANTKEN (1878) qui rencontra ce Foraminifère dans le Calcaire de Dachstein en diverses localités des Carpates hongroises. HANTKEN (1878, p. 208) décrivit les circonstances de cette découverte en ces termes: ..."Der Dachsteinkalk ist im Allgemein arm an mit freiem Auge wahrnehmbaren organ. Resten. (...) Seine Dünnschliffe zeigen eigenthümliche, mikroskopische Körperchen, welche gewiss organischen Ursprunges und wahrscheinlich Foraminiferen sind. Die Durchschnitte diese Körperchen sind kreisförmig und bestehen anscheinend aus gekammerten Gewinden; dieselben verleihen dem Gesteine eine sehr auffallende mikroskopische Structur, durch welche es sicher von dem äusserlich sehr ähnlichen Lias-Kalkstein unterschieden werden kann."

Plus tard, HANTKEN (1884, fide MAJZON, 1954, p. 243) modifia substantiellement son opinion et, s'exprimant à nouveau sur les Triasines, revint sur ses premières conclusions en considérant ces Foraminifères comme "most probably vegetal organic corpuscules, lending a very remarkable microscopic texture to the rock".

Il faudra donc attendre plus d'un demi siècle pour que la description de Triasina hantkeni soit finalement donnée par MAJZON (1954), l'auteur ayant également reconnu l'identité des Triasines avec les "corpuscules" décrits par HANTKEN, et définitivement rétabli ces micro-organismes dans les Foraminifères.
Pourtant, une dizaine d'années avant la publication de MAJZON, un autre auteur s'était déjà trouvé en présence de Triasina hantkeni au cours de ses recherches. Il s'agit de VALK (1945) qui observa cette forme dans des calcaires du Trias supérieur de l'île de Seram (Seran) en Indonésie, et qui donna même une illustration de Triasina hantkeni (VALK, 1945, pl. 1, fig. 3) sous le nom de ?? Cymbalopora sp., reconnaissant ainsi qu'il s'agissait bien d'un Foraminifère.

Dans l'association étudiée par VALK, se trouvaient également d'autres Foraminifères, notamment des Involutines (groupe Aulotortus sinuosus WEYNSCHENK), que l'auteur ne reconnut toutefois pas et identifia à des Hydrozoaires (?? Hydrozoans, VALK, 1945, pl. 1, fig. 7-10). *

La figuration de Triasina hantkeni (= ?? Cymphalopora) dans la planche de VALK est à notre connaissance la plus ancienne parue dans la littérature, de même que cette découverte de l'espèce serait la première concernant non seulement la province extrême-orientale de la Téthys, mais de tout le domaine mésogéen asiatique.
La redécouverte des Triasines de Seram, et en même temps de la publication de VALK, s'est faite dans le cadre d'une étude géologique et micropaléontologique de cette île (AL-SHAIBANI, Thèse Imperial College, Londres, en préparation), dans laquelle le Trias supérieur, richement microfossilifère (AL-SHAIBANI, CARTER et ZANINETTI, à paraître) est de faciès carbonaté récifal à périrécifal.
Certains niveaux en effet contiennent en abondance des Triasines et des Involutines, permettant un rapprochement sûr de ces Foraminifères avec les microfaunes vues par VALK en 1945, tandis que d'autres ont livré le cortège désormais classique (voir les travaux de l'Ecole d'Erlangen) des espèces triasiques supérieures récifales: Galeanella panticae ZANINETTI et BRONNIMANN, mentionnée ici pour la première fois en province téthysienne extrême-orientale, Galeanella sp., Milioliporo cuvillieri BRONNIMANN et ZANINETTI, Spiriamphorella sp., Ophthalmidium spp., "Tetrataxis" sp., Duotaxis birmanica BRONNIMANN WHITTAKER et ZANINETTI, des "Trochamminidae", des Duostaminidae, des Nodosariidae, etc... (voir AL-SHAIBANI, CARTER et ZANINETTI, à paraître).

Les conditions semblent donc particulièrement favorables aujourd'hui pour retrouver de nouvelles Triasines dans la province asiatique, puisque depuis 5 ans les découvertes n'ont fait que se multiplier à l'occasion d'explorations indépendantes, poursuivies, nous l'avons vu dans un vaste secteur de l'Asie orientale, de l'Inde septentrionale à l'archipel des Philippines en passant par le Sud de la Chine, la Malaisie

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*L'illustration intégrale de VALK est reproduite dans notre pl. 1, pour son intérêt historique, mais aussi scientifique, cette publication ayant été apparemment ignorée de tous les micropaléontologues du Trias jusqu'ici.

et Seram. La mise en évidence des faciès favorables aux Foraminifères recherchés est toujours la solution à ce type d'investigation. Pour ce qui concerne Triasina hantkeni, on sait aujourd'hui que l'espèce est liée au domaine lagunaire de l'arrière récif et qu'il ne serait possible de la retrouver à proximité de celui-ci qu'à l'état transporté. Les extraordinaires accumulations de Triasines de l'Apennin méridional qui font des calcaires du Trias supérieur de véritables "triasinites", se sont en effet déposées, le plus souvent en l'absence totale d'Involutines et de Trocholines, dans des conditions lagunaires de faible énergie (mud facies) qui ne peuvent se concevoir que dans un éloignement assez important d'un complexe récifal plus externe. L'"absence" de Triasina hantkeni en Iran par exemple, s'explique ainsi mieux, pour la raison qu'un Trias supérieur (Norien-Rhétien) marin est, d'une part, absent de la chaîne septentrionale de l'Elbourz, et que d'autre part, en Iran central, cet intervalle est représenté par des formations récifales comportant des édifices construits incompatibles avec le développement des Triasines; ces formations sont par ailleurs souvent interrompues par d'épaisses intercalations détritiques dans lesquelles l'apparition de Triasina hantkeni ne saurait davantage se concevoir (Formation de Nayband, par exemple, en Iran centro-oriental).
Il reste le vaste domaine du Zagros, encore peu exploré sur le plan de la micropaléontologie du Trias, qui, pour la raison de sa continuité géologique avec les Taurides pourrait aussi contenir des niveaux triasiques supérieurs à Triasina hantkeni, à notre connaissance encore ignorés. Mais cette lacune aujourd'hui n'est peut-être plus qu'une hypothèse sur l'existence de Triasines dans ce secteur alpin asiatique, hypothèse qui demain pourrait bien se trouver vérifiée.

La présente étude ayant permis des comparaisons microfauniques et paléoenvironnementales avec le Trias supérieur de l'Apennin, s'insère dans le cadre plus général de recherches sur les Foraminifères du Trias mésogéen et en particulier de l'Apennin septentrional, Projet Fonds National de la Recherche Scientifique Suisse No 2.089-0.81.
La requérante de ce projet (L.Z.) remercie le Fonds National de lui permettre de poursuivre ses travaux biostratigraphiques sur le Trias téthysien.

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Légende de la pl. 1

Reproduction intégrale de la planche de VALK (1945)

1, 2, 4 Nodosariidae.

3 *Triasina hantkeni* MAJZON, 1954

5 *Miliolipora ?*

6 Foraminifère indéterminé.

7-10 *Aulotortus* ex gr. *sinuosus* WEYNSCHENK, 1956.

11 Fragment de mégafossile, indéterminé.

Identifications de VALK:

1, 2, 4 ? *Nodosaria* sp.

3 ?? *Cymbalopora* sp.

5 *Quinqueloculina* sp.

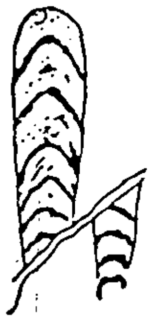
6 ? *Rotalia* sp.

7-10 ?? Hydrozoans

11 Section d'une valve d'*Inoceramus*.

1, 2, 5, 6 environ 70x; 3, 4, 7-10, environ 60x; 11, 40x.


1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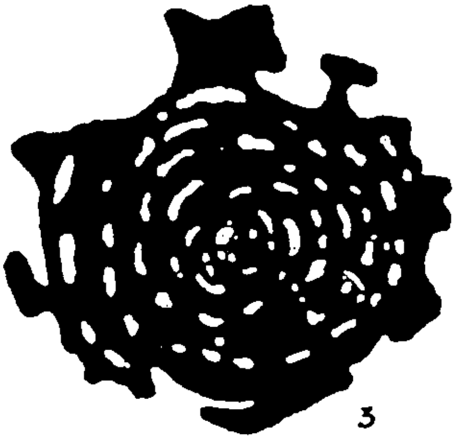
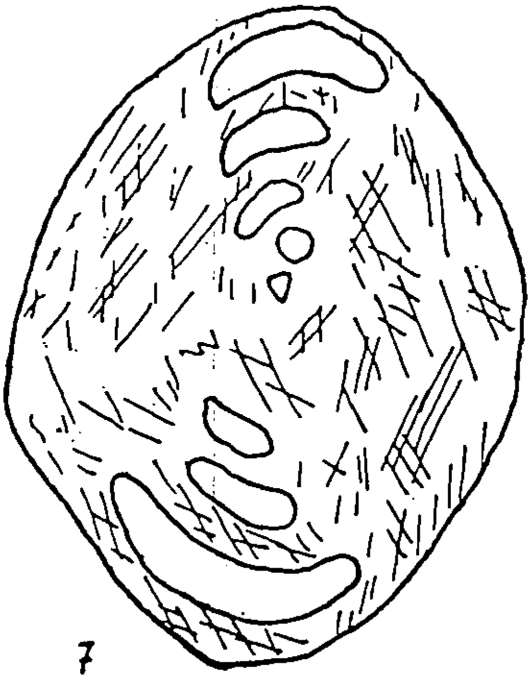

3


4


5


6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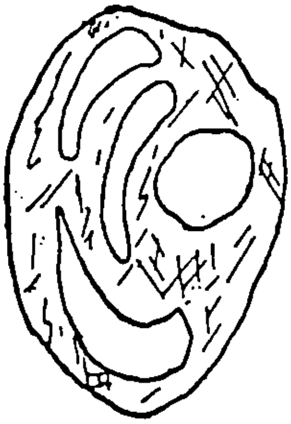
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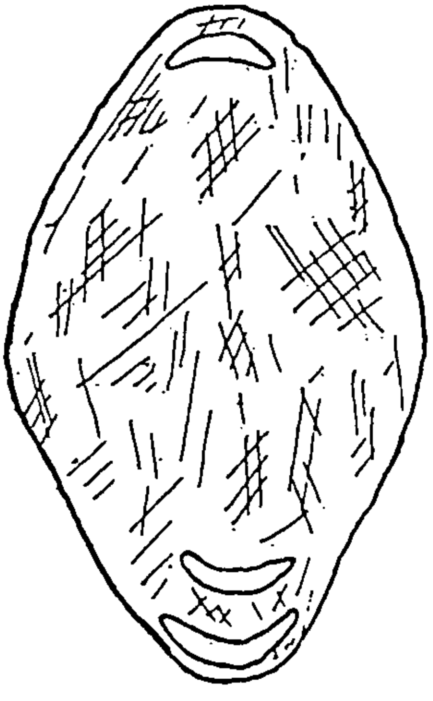
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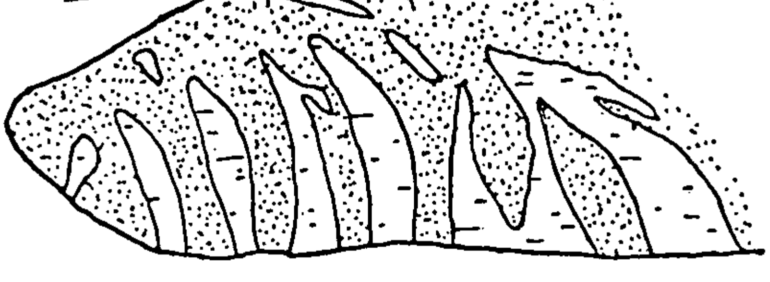

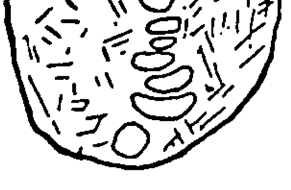
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