Upper Cretaceous Planktonic Foraminifera from the Zubair - Rumaila Fields, Basrah Area, Southern Iraq.

by

S.A. Darmoian, B.Sc.

Thesis submitted for the Degree of Doctor of Philosophy of the University of London.

May 1971.

C O N T E N T

		Page
Abstract		4
Acknowledgement		6
Chapter 1	Introduction	8
Chapter 2	Stratigraphy	14
	Aruma group	14
	I - Zubair well No. 8	15
	II - Rumaila well No. 18	28
Chapter 3	Micropaleontological zonation and Age determination	37
Chapter 4	The Foraminiferal Biofacies and Depositional Environment	63
Chapter 5	Systematic description	85
Chapter 6	Summary and Conclusion	271
Bibliography		278
Plates		324

Illustrations

Fig. 1	Map of S. Iraq	13
Fig. 2	Correlation of the Upper Cretaceous Formations in S. Iraq	36
Fig. 3	Planktonic Foraminifera zonation in S. Iraq	41
Figs. 4-7	Correlation of the planktonic foraminiferal zones in S. Iraq with the corresponding zones in N. Africa, Central Europe, Carribian and N. America	58-62
Fig. 8	An idealized Heterohelix	83
Fig. 9	An idealized Sigalia	84
Fig. 10	Suggested Phylogeny of some species of Heterohelix	92

		Page
Fig. 11	Suggested phylogeny of some species of Pseudoguembelina and Pseudotextularia	123
Fig. 12	Suggested phylogeny of the species of Sigalia and Ventilabrella	144
Fig. 13	Suggested phylogeny of the species of Globigerinelloids	158
Fig. 14a, b	Suggested phylogeny of some species of Globotruncana	195, 246
Encl. 1	Stratigraphic Column (Zubair 8) ...	Pocket
Encl. 2	Stratigraphic Column (Rumaila 18) ...	"
Encl. 3	Biostratigraphic correlation in Zubair-Rumaila Fields	"
Encl. 4	Paleoecologic curves	"
Encl. 5	Probable depth of Upper Cretaceous basin in Zubair Field	"
Encl. 6	Distribution of Planktonic Foraminifera in Zubair well No. 8	"
Encl. 7	Distribution of Planktonic Foraminifera in Rumaila well No. 18	"
Encl. 8	Distribution of benthonic Foraminifera in Zubair 8 and Rumaila 18	"

A B S T R A C T

The Upper Cretaceous succession (Aruma group) of the Zubair and Rumaila fields, southern Iraq is examined. A total of 120 species and varieties of planktonic Foraminifera from 16 genera and 4 families are described and illustrated, including 9 species, 4 varieties new to science. 121 species and varieties of benthonic Foraminifera used for the interpretation of the paleoecology also are identified and their ranges given.

The sequence has been subdivided into 4 concurrent-range zones and 2 subzones which are correlated with the stages of the European standard. In addition, two intervals which either are devoid of fossil or contain only rare or indeterminable specimens have been recognized.

In the quantitative paleoecologic study, the Upper Cretaceous subsurface section of the Zubair well no.8 is subdivided into 5 stratigraphically separate foraminiferal biofacies. It is belived that the lowermost part of the Khasib formation was deposited under warmer, shallow water conditions of low salinity and in restricted or narrow connection with the open sea. The remainder of the Khasib, Tanuma and lower part of the Sadi formations were laid down in deep, warmer water in direct connection with the open sea. The upper part of the Sadi and the lower part of the Hartha formations were laid down in shallow, colder water in restricted connection with the open sea. Most of the upper part of the Hartha formation was deposited under lagoonal conditions, while its uppermost part and the lower part of the Qurna formations were deposited in deep, colder water in direct connection with the open sea.

In general, there are indications of a gradual deepening of the basin from the Khasib to the Sadi formations, and a shallowing from the

A B S T R A C T

The Upper Cretaceous succession (Aruma group) of the Zubair and Rumaila fields, southern Iraq is examined. A total of 120 species and varieties of planktonic Foraminifera from 16 genera and 4 families are described and illustrated, including 9 species, 4 varieties new to science. 121 species and varieties of benthonic Foraminifera used for the interpretation of the paleoecology also are identified and their ranges given.

The sequence has been subdivided into 4 concurrent-range zones and 2 subzones which are correlated with the stages of the European standard. In addition, two intervals which either are devoid of fossil or contain only rare or indeterminable specimens have been recognized.

In the quantitative paleoecologic study, the Upper Cretaceous subsurface section of the Zubair well no.8 is subdivided into 5 stratigraphically separate foraminiferal biofacies. It is belived that the lowermost part of the Khasib formation was deposited under warmer, shallow water conditions of low salinity and in restricted or narrow connection with the open sea. The remainder of the Khasib, Tanuma and lower part of the Sadi formations were laid down in deep, warmer water in direct connection with the open sea. The upper part of the Sadi and the lower part of the Hartha formations were laid down in shallow, colder water in restricted connection with the open sea. Most of the upper part of the Hartha formation was deposited under lagoonal conditions, while its uppermost part and the lower part of the Qurna formations were deposited in deep, colder water in direct connection with the open sea.

In general, there are indications of a gradual deepening of the basin from the Khasib to the Sadi formations, and a shallowing from the

Sadi to the uppermost part of the Hartha formation.

There are also indications of a remarkable decrease in water temperature from the Coniacian to the Middle Maestrichtian.

The first transgression of the Upper Cretaceous sea started at the base of the Khasib formation, the first regression at the base of the middle part of the Sadi formation and the first Maestrichtian transgression in the uppermost Hartha formation.

This is the first detailed account of the Cretaceous Foraminifera from southern Iraq.

- 0 -

ACKNOWLEDGEMENT

The present research was carried out under the constant guidance of Mr. D.J. Carter of Imperial College, to whom the writer expresses his deep appreciation. He also would like to thank all the staff and colleagues of the Imperial College for their valuable help towards the completion of this study.

The writer is indebted to all staff of Basrah Petroleum Company and Iraqi Ministry of Oil and Natural Resources for their collaboration in delivery of rock samples, kind hospitality and assistance during his field work.

The writer would like also to thank Prof. T. Birkelund and Mr. Hans J. Hanson of the Mineralogical-Geological Museum, University of Copenhagen for their help and advice during his stay at the Institute. Prof. Husfeld of Rig hospital Copenhagen was directly responsible for the writer obtaining a scholarship from the Danish Ministry of Foreign Affairs, to whom he expresses his special thanks.

Acknowledgements are likewise extended to Mr. E. Harth, Iraqi Petroleum Company, London for his invaluable information on the Cretaceous lithostratigraphy and biostratigraphy of Iraq and the Middle East; Mr. D.J. Shearman of Imperial College for his suggestions concerning the sedimentalogy; Dr. A.H. Smout of British Petroleum for his suggestions concerning the behaviour and distribution of larger Foraminifera in the Upper Cretaceous of the Middle East and Europe, Mr. D. Bayless of British Museum (Nat.Hist.) London, for illustrations of various biostratigraphic aspects of Upper Cretaceous Foraminifera of Jordan and Palestine and the distribution of genus Sigalia; and Dr. C.G. Adams of British Museum (Nat. Hist.) who gave the writer the opportunity to examine the foraminiferal

collections of the Museum.

Acknowledgement is also due to the following people for their help in various ways: Dr. H.M. Bolli, Prof. M. Bullard, Mr. H.V. Dunnington, Dr. R. Gandolfi, Prof. L. Hottinger, Dr. H.A. Latif, Dr. M. Muir, Dr. E.A. Pessagno, Prof. J. Sigal and Dr. E. Stenestad.

Thanks must also go to those who have helped me financially with grants and loans; these are Caloust Gulbenkian Foundation Armenian Affairs, Dr. S.A. Najarian (Physician), Mr. V. Alexandrian, Mr. H. Al-Hashimi and the Imperial College.

Finally the writer must thank his parents, sisters and brother for their continual encouragement both spiritually and financially and without whose help this study would not be completed. He must also thank Mr. Gee and his staff of Imperial College, Messrs. V. Mihranian, V. Vartanian and Miss S. Yergation for their valuable help technically.

- 0 -

CHAPTER I

INTRODUCTION

Zubair and Rumaila fields lie in southern Iraq, 20 and 25 miles south-west of the Basrah city, in the area between Latitudes 920°N - 970°N and Longitude 1720°E - 1770°E, in the Ad Dibdibba gravel and sand region (Dibdibba formation). This area is one of flat, low, dried out marshes irrigated by rain fall.

Regarding the lithologic composition of the area, Macfadyen (1938) stated, "mainly sand and gravel of Igneous rocks including pink granite, various liver-coloured and slate-grey intrusives, dolerites .... etc., and white quartz pebbles." During field work (1961, 1965, 1969) the writer examined samples from the Zubair and Rumaila fields and found them generally to consist of grit, gravel of Igneous origin, sand, sand-stone, marl, slate of different colours, pebbles and gypsum.

The region is bounded on the east and north-east by the Shat Al-Arab, Euphrates and Tigris rivers, on the south and south-west by the Arabian Gulf, Jabal Sanam and Iraq-Kuwait boundary, on the north by Howr Al-Hammar and on the west by Abughar and Al-Busaiya. Close to the Iraq-Kuwait boundary Jabal Sanam stands as a solitary hill. It is about 500 ft. high in a low-lying region whose altitude elsewhere ranges between 50-150 ft. above sea level (Al-Naqib 1967 p.G5.).

In the past, southern Iraq has attracted the attention of many scientists not only because of its geological interest and oil producing potential but also for its richness in archaeological remains. Interest in the geology advance in step with the increasing demand for oil. The first field was discovered in southern Iraq at Zubair in 1948, and the Rumaila field was discovered a few years later. To date 78 wells

have been drilled, 39 in each field, to penetrate the Aruma group.

Inspite of this huge number of drilled wells, nothing of consequence has been published on the paleontology and stratigraphy of the area. The only available paper is that of Owen and Nasr (1958) in which Smout gives a summarized range chart of typical fossils of the Basrah area. These same fossils later were mentioned by Dunnington, Wetzel and Morton (1959, in Lexique Stratigraphique International, Asie, Iraq).

Saiab and Kurayshi (1969) published a brief erroneous, and somewhat misleading study of the Upper Cretaceous Foraminifera and their stratigraphic distribution in southern Iraq.

However, none of the above authors has dealt with even the commonly abundant Foraminifera found in the Aruma group, placed them in a detailed stratigraphic and systematic framework, attempted to determine their geographical distribution or their paleoecological implications. Neither INGRA (1963) nor Al-Naqib (1967) have produced anything new in the stratigraphic and paleontological fields. The first concentrated on hydrological problems, while the second simply summarized and condensed information given by Owen and Nasr (1958) and Dunnington et.al. (1959).

Al-Naqib (op.cit.) made a tentative attempt to determine the major sedimentary cycles of Mesozoic, Tertiary and Quaternary, but all the information in this paper is from unpublished I.P.C. and B.P.C. reports, or worked out by different geologists in other oil companies. His paleoecologic interpretation was based entirely on sedimentology.

In the literature the lack of interest shown in the Aruma group in southern Iraq is probably due to its subsurface stratigraphic position,

its hard lithology and oil production from stratigraphically shallower or deeper levels.

By the courtesy of the B.P.C. authorities, the writer had opportunity to examine all the members of the Aruma group from the following eight subsurface rock cutting sections; Zubair wells nos. 3, 8, 19 and 24, Rumaila wells nos. 1 and 18, Ratawi well no. 1 and Nahrumar well no.2. Only Zubair well no. 8 and Rumaila well no.18 were used for the detailed micropaleonrologic studies. These two wells yielded sufficient numbers of foraminiferal and other fossils. The paleoecological analysis was based mainly on Zubair well no.8.

Planktonic Foraminifera were found to be very abundant in the Khasib, Tanuma, lower half of the Sadi, uppermost part of the Hartha and lower half of the Qurna formations facilitating biostratigraphic zonation.

The successions were often found interrupted by strata devoid of planktonic Foraminifera. The completely barren intervals were placed according to their positions between known biozones.

The samples were received from the Basrah Petroleum Company (B.P.C.) in 1967 and 1969. 283 samples (20 gms. of each) from Rumaila well no.18 and Zubair well no.8 were processed for foraminiferal analysis using standard techniques differing according to the nature of the rock. In each case the residue was dried and passed through sieves of 30, 60, 90, 100, 120 and in rare cases 200 meshes.

All the planktonic, benthonic and larger Foraminifera, fossil Ostracod, Megafossils, Bryzoa, Charophytes and other fossils were picked out, sorted and counted. The planktonic Foraminifera were sorted

separately, described in detail and figured (except for the rare forms or poorly preserved specimens where photographing was found impossible). Its vertical and geographical distributions were worked out and range charts constructed. The identification is principally by comparison with previously published figures and descriptions, topotypes and/or holotypes if available.

A summarized range chart was constructed for the well preserved and commonly abundant benthonic Foraminifera (excluding larger Foraminifera).

The percentages of planktonic, benthonic and arenaceous Foraminifera in the fossil populations were used as aids in paleoecological interpretation.

All illustrations, except a few of the Maestrichtian and Campanian species, are stereoscan photographs by Dr. M. Muir and Mr. P. Grant.

The purpose of the present investigation can be summarized as follows;

1. A detailed investigation of the vertical distribution of the planktonic Foraminifera in the rocks of southern Iraq.
2. A detailed systematic study of the planktonic Foraminifera in southern Iraq, their taxonomy, morphology, phylogeny and geographical distribution.
3. An attempt to reconstruct the past depositional and paleo-environmental conditions during Upper Cretaceous time, using the planktonic percentage distribution chart of Grimsdale and Morkhoven (1955) and the bathymetric zones proposed by Bandy (1960).

4. The zonation and correlation of the sequence in southern Iraq with the type European Upper Cretaceous stages.
5. A summarized revision of the previously described stratigraphic succession.

- 0 -

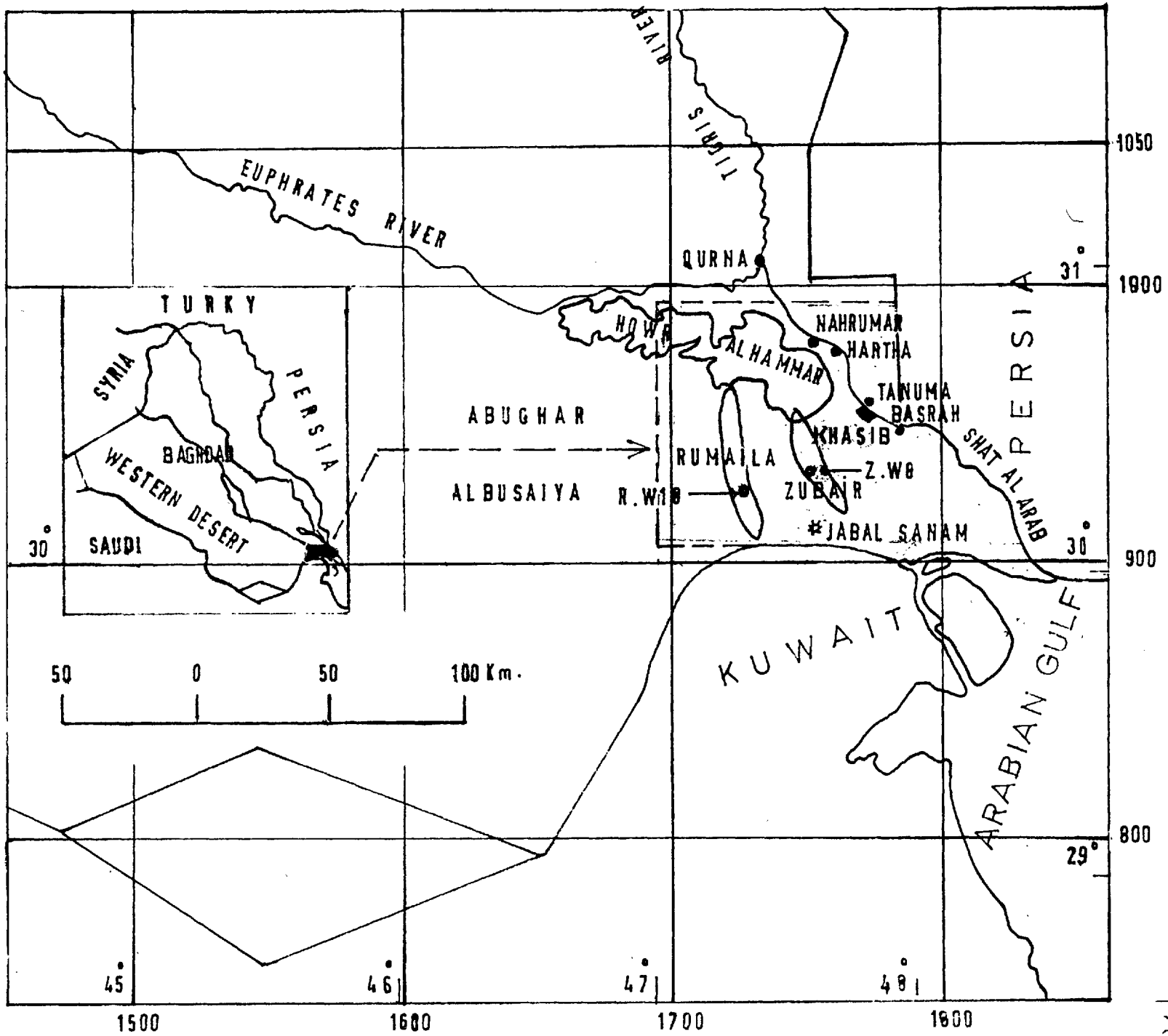


Fig. 1 — Map of southern Iraq

CHAPTER 2

STRATIGRAPHY

Aruma Group

The term "Aruma" was first applied by Steineke and Bramkamp (1952) to a single formation of Campanian-Maestrichtian age, outcropping in the "Al-Aramoh" plateau in Saudi Arabia. Later Steineke, Bramkamp and Sander (1958) dated most of the Aruma formation Maestrichtian on the basis of its Ammonite contents.

Lithologically it is composed of dolomite and calcareous shale, and argillaceous dolomite with minor interbedded limestones and dolomites.

Beyond the limit of the type locality, in Kuwait and southern Iraq, a similar stratigraphic sequence was divided by Owen and Nasr (1958) into several formations which were placed together in the "Aruma group".

In south-eastern Kuwait the Aruma group comprises three formations (the Gudair, Bahra and Tayarat) and in north-eastern Kuwait and south-eastern Iraq six formations (the Khasib, Tanuma, Sadi, Hartha, Qurna and Tayarat).

In northern Iraq the Aruma group is not recognised. In Masjid Sulaiman, Iran, the group is divided into the Gurpi and Ilam formations, and in Dukhan, Qatar into the Laffan, Ruilat and Simsima formations (Harth 1967).

The group is underlain by the Wasia formation in Saudi Arabia (type section), by the Mishrif formation in southern Iraq and Qatar, the Magina formation in Kuwait and the Sarvak formation in Iran. It is overlain by the Umm Er Radhuma formation in the type section, Iraq, Kuwait and Qatar, and the Pebdeh formation in Iran.

The stratigraphic thickness of this unit at its type locality is approximately 140 metres (Powers, Ramirez, Redmond and Elberg 1966). In southern Iraq the thickness reaches 2,852 ft. in Zubair well no.8 and 3,151 ft. in Rumaila well no.18.

Two stratigraphic sections were used to interpret the stratigraphy of the Aruma group in southern Iraq;

1. Zubair well no.8.
2. Rumaila well no.18.

I. Zubair well no.8

The section in this well consists of the following formations; the Khasib, Tanuma, Sadi, Hartha, Qurna and Tayarat formations. All these, except the Tayarat were originally established by Rabanit (1952) in B.P.C. well no.3, Latitude 30° 23' 01" N. and Longitude 47° 43' 29" E. (in Lexique 1959). The Tayarat formation was established by Henson (1940) from Jabal Tayarat, 21 miles south of Rutbah town, Latitude 32° 46' N. and Longitude 40° 17' E. The first formal reference and detailed descriptions of these formations from their type sections were those of Owen and Nasr (1958). These were followed by those of Dunnington, Wetzel and Morton, in the Lexique Stratigraphique International (IRAQ), and of Al-Naqib (1967).

No one so far has made any attempt to describe these formations as developed outside their type localities.

It is hoped that the present work will serve as a basis for future detailed stratigraphic investigations of facies changes and lateral variations of these formations. However, as a stratigraphic study is beyond the scope of this thesis, only a summarized report is given.

Locality and co-ordinates; Zubair field, 20 miles south of Basrah city, in the area between Latitude 1751 E. and Longitude 932.290 N.

1. Khasib formation

Thickness; 179 ft., drilled depths 7,230-7,410 ft.

Paleoecology; lowermost part in the Inner shelf zone. Porcellaneous biofacies. Transgressive. The remainder of the formation in the Outer shelf - Upper bathyal zone.

Age; Coniacian. G. renzi/H. pseudogeumbeliniformis zone.

Lithology; The formation consists of the following lithologic units;

(a) Marl, marly limestone, greyish and pyritic. (Top)

(b) Shale, bluish-black, fissile and pyritic.

(c) Marl, light grey.

(d) Shale, bluish-black and fissile.

(e) Marl, marly limestone, grey to white and buff. (Bottom)

Remarks

The basal part of this formation is the lowest unit in the Upper Cretaceous of southern Iraq. The underlying Mishrif formation is characterised by the occurrence of abundant fossil Charophytes and is devoid of Foraminifera. Owen and Nasr (1958), Dunnington et.al.(1959) and Al-Naqib (1967) considered that the Khasib formation lies disconformably on the Mishrif formation. The contact is marked by the change from fresh-water limonitic limestone with Charophyta below, to oligosteginal shale above.

In Zubair well no.8, the Charophytes were found associated with a marine fauna and extended up into the lower part of the Khasib formation.

However, the absence of a foraminiferal fauna from the uppermost part of the Mishrif formation, its near shore conditions of deposition and the occurrence of subsidence during the deposition of the overlying Khasib formation make it difficult to locate the contact exactly.

The Khasib formation is overlain by the Tanuma formation. The contact is conformable.

Fossils (See benthonic fossils chart.)

Smout (1958) reported the following fossils from the type locality at B.P.C., Zubair well no.3; Cyclammina sp., Monolepidorbis sanctaepelae, Inoceramus cf. inconstans, Oligostagina sp. and Bigenerina sp.

Dunnington et.al.(1958) followed by Al-Naqib (1967) recorded G. lapparenti sub.sp. and G. leupoldi Bolli from Zubair well no.1 and G. stuarti (de Lapparent) from Nahrumar well no.1. Unfortunately none of these specimens could be located. (According to Dr. Smout (personal communication) specimens were deposited with the Basrah Petroleum Company Basrah, but were destroyed by the fire in 1957?)

However, examination of samples from Zubair well no.1 and Nahr Umr well no.1 reveals that; G. leupoldi Bolli belongs in G. renzi Gandolfi, G. lapparenti sub.sp. belongs in G. linneiana linneiana and G. stuarti (d'Lapparent) probably belongs in G. schneegansi Sigal.

The following planktonic forms occur only in the Khasib formation; Heterohelix moremani (Cushman), Hedbergella gautierensis (Bronnimann), Hd. brittonensis Loeblich and Tappan, Hd. amabilis Loeblich and Tappan, Globigerinelloides bentonensis (Morrow), Globotruncana schneegansi Sigal, G. pseudolinneiana Pessagno, G. linneiana obliqua Herm and Clavihedbergella simplex (Morrow).

2. Tanuma formation

Thickness; 112 ft. drilled depth 7,120-7,230 ft.

Paleoecology; Upper bathyal - Middle bathyal. Lower planktonic/ open sea biofacies.

Age; Coniacian - lowermost Santonian. G. renzi/ H. pseudoguembeliniformis zone to S. carpatica zone, G. concavata subzone.

Lithology;

(a) Shale of dark blue and chocolate colour. (Top)

(b) Oolite of creamy colour and a calcite matrix.

(c) Shale, blue-grey with chocolate coloured shale at the base. (Bottom)

Remarks

The 110 ft. thick Tanuma formation is a dark, fissile, marine shale with occasional thin, detrital limestone partings. It is overlain by the Sadi formation. The contact is conformable and gradational, showing a change from blue-grey shale below to marly limestone above.

The contact (7,110-7,120 ft.) is a short interval of partially dolomitized limestone. The sample is glauconite-bearing and oolitic. Some sectioned ooliths show pyritic or glauconitic internal moulds.

The Tanuma formation is underlain by the Khasib formation, the contact is conformable and placed at the change from grey marl and marly limestone below to dark blue and chocolate coloured, fissile shale above.

The Tanuma and Khasib formations probably have their equivalents in the lower part of the Gudair formation in Kuwait.

Fossils (See benthonic fossils chart.)

Smout (1958) reported the following fossils from southern Iraq; Rotalia skourensis Pfender, Globotruncana linnei (d'Orbigny), Guembelina spp., Monolepidorbis sanctapelagica and Inoceramus cf. inconstans. (See remark under the Khasib formation.)

The following planktonic Foraminifera occur only in the Tanuma formation; Guembelitria aff. harrisi Tappan, Heterohelix aff. barnardi (Ansary), Gublerina? reniformis (Marie), Planomalina sp.A. sp.nov. Globigerinelloides sp.aff. Gl. japanica (Takayanagi) and Globotruncana? pura Hofker.

3. Sadi formation

Thickness; 960 ft. drilled depths 6,160-7,120 ft.

Paleoecology;

(a) Lower part, Middle bathyal - ? Lower bathyal.
Lower planktonic/open sea biofacies.

(b) Upper part, Inner shelf - Outer shelf.
Calcareous benthonic/closed sea biofacies.

Age; Santonian - Campanian. S. carpatica zone. Indeterminable interval to G. stuartiformis/G. stephensoni zone.

Lithology;

(a) Interval 6,160-6,770 ft. Limestone marly and chalky, partially dolomitized and recrystallized with an abundance of glauconite and with shaley intercalations. The chalk and glauconite more specifically concentrated in upper part of interval. (Top)

(b) Interval 6,770-6,960 ft. Marl, soft and grey. Lower 60 ft. relatively harder with thin shale partings. The interval 6,910-6,920 a thin pyritic and oolitic limestone.

(c) Interval 6,960-7,120 ft. Limestone, slightly dolomitized in its lowermost portion, light grey, white, chalky and marly. Marl soft. (Bottom)

Remarks

The Sadi formation is overlain conformably by the Hartha formation, the change is very slow and gradational from marly and chalky limestone below to soft marl with streaks of chalk above.

The same sequence was also reported by Owen and Nasr (1958). However, Dunnington et.al.(1959) followed by Al-Naqib (1967) stated that the contact is an erosional unconformity, corresponding with that already noted between the Bahra and Gudair formations in Kuwait.

The formation is underlain conformably by the Tanuma formation.

Fossils (See benthonic fossils chart.)

Smout (1958) reported the following fossils from the type locality; Omphalocyclus macropora, Monolepidorbis sactaepelagiae, Praealveolina sp. Inoceramus cf. inconstans, G. linnei and Guembelina varians.

Dunnington et.al.(Ibid) recorded the presence of Cuneolina cylindrica Henson and Pseudodomia complanata Eames and Smout, while Al-Naqib (Ibid) listed the occurrence of G. sigali Reichel and G. concavata (Brotzen). Examination of samples from the type section, Zubair well nos.24, 19 and 8, Rumaila well nos.18 and 1, reveals that, G. linnei is actually G. linneiana linneiana (d'Orbigny), G. sigali belongs in G. angusticarenata Gandolfi and the so-called Guembelina

varians is actually a strongly compressed Heterohelix striata (Ehrenburg).

The following planktonics occur only in the Sadi formation; Praeglobotruncana wilsoni Bolli, Globotruncana angusticarenata Gandolfi, Biglobigerinella sp.1, sp.nov., B. algeriana Ten Dam and Sigal , B. multispina (Lalicker), Gublerina glaessneri Bronnimann and Brown, Gb. sp.A., Rugoglobigerina plana Belford, and Pseudoguembelina zubairensis sp.nov and G.contusa (Cushman)

The assemblages contain, in addition to larger and smaller Foraminifera, the following fossils; Bryozoa, Inoceramus spp., Brachythere spp., Cytherella spp. and Bairdia spp.

4. Hartha formation

Thickness; 500 ft., drilled depths 5,660-6,160 ft.

Paleoecology;

(a) Embayment. Calcareous benthonic/closed sea biofacies. Regressive. (Lower part)

(b) Lagoonal. Non-fossiliferous biofacies.

(c) Middle bathyal. Upper planktonic/open sea biofacies. Transgressive. (Upper part)

Age; Campanian - Lower Maestrichtian. G. stuartiformis/ G. stephensoni zone to non-fossiliferous interval.

Lithology;

(a) Interval 5,660-5,920. Dolomite, light brown, non-fossiliferous with occasional evaporite stringers. Uppermost 10 ft. buff and grey, detritol, dolomitic limestone with an abundance of chalky streaks and planktonic Foraminifera. (Top)

(b) Interval 5,920-6,100 ft. limestone, detrital, grey to creamy, partially dolomitized, glauconitic and pyritic. Upper portion of this interval terminated by a thin, dark coloured, shaley parting.

(c) Interval 6,100-6,160 ft. Marl, soft with streaks of chalk.

(Bottom)

Remarks

The Hartha formation is overlain by the Qurna formation. According to Owen and Nasr (1958) the contact is disconformable. Al-Naqib (1967) stated that this contact is conformable, without further comment.

In Zubair well no.8 and all other sections studied the contact is conformable, showing a change from marly, chalky, detrital limestone with abundant planktonic Foraminifera below to grey marl with abundant planktonic Foraminifera above.

The Hartha formation is underlain by the Sadi formation. The contact is believed to be conformable (see under Sadi formation).

The Hartha formation was deposited in three different depositional environments; shallow, lagoonal and bathyal conditions. The change from shallow to lagoonal condition is gradational. The change from the lagoonal to deep bathyal condition is abrupt, suggesting a sudden subsidence due to major tectonic movement.

The Safawi formation was established by Al-Naqib (1960) to include the evaporite facies in the Upper Campanian and Maestrichtian. In its type section at B.P.C. well Safawi no.1, the formation was said to consist predominantly of white, compact and hard, crystalline anhydrite, with subordinate brown, hard, crystalline dolomite and buff to grey,

soft marl. No fossils have been found in it to date. So far only rare evaporite stringers were observed in the Zubair, Rumaila and Nahr-umarfield sections.

However, judging from the description given by Al-Naqib (1967), the Safawi formation was deposited under very shallow and closed, near shore conditions, and could be equivalent to the dolomitic, non-fossiliferous interval in the Hartha formation. Unfortunately, the writer had no opportunity to examine samples from the type section.

Fossils (See benthonic fossils chart.)

Smout (1958) reported the following important fossils from the B.P.C. well no.3, Basrah; Cuneolina pavonia, Monolepidorbis sanctaepelagiae, Pseudeodomia complanata and Globotruncana stuarti (de Lapparent).

Al-Naqib (1967) listed the following forms; Omphalocyclus macropora (Lamark), Orbitoides media, Siderolites heracleae (Arni) and Cuneolina cylindrica.

5. Qurna formation

Thickness; 580 ft., drilled depths 5,080-5,660 ft.

Paleoecology; Middle bathyal. Upper planktonic/open sea biofacies.

Age; Middle Maestrichtian. G. gansseri zone.

Lithology;

(a) Interval 5,080-5,350 ft. Dolomite and limestone bands, dark grey, increasingly dolomitized upward with streaks of marl and sparse bands of grey chert alternating with the dolomite in the upper portion. Poorly fossilifereous.

(Top)

(b) Interval 5,350-5,660 ft. Marl, ash grey with occasional dolomitic and limestone bands. Very fossiliferous.

(Bottom)

Remarks

The Qurna formation is overlain by the Tayarat formation. The contact is conformable and shows a change from poorly fossiliferous dolomite, streaks of marl and chert nodules below, to poorly fossiliferous dolomite above. The change is slow and the beds involved very poorly fossiliferous, making it difficult to recognize the exact Qurna-Tayarat contact. However, it was found convenient to use the last occurrence of the chert nodules for this purpose.

The formation is underlain by the Hartha formation. The contact is believed to be conformable (see under Hartha formation).

Owen and Nasr (1958) stated that, "Toward south-eastern Kuwait these marls (of the Qurna formation) seem to pass into white to grey, dense, microcrystalline limestones, commonly with grey chert nodules, and the unit is represented in part or whole by the Bahra formation". Then they added, "the Unit (Bahra formation) is divisible into upper and lower members ..... the upper member is dominantly composed of whitish, dense, microcrystalline limestone with some chert, whereas the basal member includes detrital and oolitic limestone and black shale".

In the section under study, the Qurna formation can be divided into;

(a) an upper dolomite and dolomitic limestone member, with alternating chert nodules in its upper part, and

(b) a lower marl member, with occasional dolomite or limestone bands.

The two members also can be separated on their planktonic fossil content.

Fossils (See benthonic fossils chart.)

Smout (1958) recorded the following important fossils from the B.P.C. well no.3; Buliminella laevis, Textularia cretosa.

The following planktonic Foraminifera occur only in the Qurna formation; Heterohelix ultimatumida (White), Pseudoguembelina palpebra Bronnimann and Brown, Ps. punctulata (Cushman), Gublerina cuvillieri Kikoine, Globotruncana hilli Pessagno, G. convexa Sandidge, G. aegyptiaca duwi Nakkady, G. fareedi El-Naggar, G. leupoldi Bolli, G. subpennyi (Gandolfi) and Trinitella scotti Bronnimann.

6. Tayarat formation

Thickness; 510 ft., drilled depths 4,570-5,080 ft.

Paleoecology; Not certain, sea floor probably shallowing.

Age; Middle Maestrichtian - ? Upper Maestrichtian?

G. gansseri zone.

Lithology;

(a) Dolomite, with abundant marly intercalations and rare evaporitic nodules. (Top)

(b) Dolomite, cream to buff, in part porous and with mollusc fragments.

(c) Dolomite, hard and recrystallized, buff-grey and saccharoidal with a few chalky particles and traces of bitumenous material. (Bottom)

Remarks

The Tayarat formation is overlain by the Umm Er Radhuma formation which is believed to be Tertiary. The contact, according to Owen

and Nasr (1958) is conformable. They added, "the deposition in this area was essentially continuous across the Tertiary/Cretaceous time line".

In the type locality this contact has been completely removed by erosion.

In Zubair well no.8, it was found very difficult to recognize the exact contact, (see under Rumaila field).

In the type locality at Jabal Tayarat, south Rutbah, the Tayarat formation is underlain by the M'sad formation. The contact is an erosional unconformity, taken at the base of a localized conglomerate.

According to Dunnington et.al.(1959) "passing northwards from Jabal Tayarat through Jabal Thoba and towards the western rim of the Gaara depression, the Tayarat limestone is cut out progressively by the erosion of its upper parts. ..... In the section of "Hill 270" and Khasm Mulussa the formation is absent, the paleocene Umm Er Radhuma formation resting discordantly on eroded M'sad formation ..... at Ras Semhat, the Umm Er Radhuma rests directly on Triassie Gaara sandstone".

The writer, who visited these areas in the field seasons of 1960, 1962/1963 and 1965, found these observations correct. The Turonian, Coniacian, Santonian, Campanian, Lower Maestrichtian and probably Middle Maestrichtian also, are unrepresented in the Rutbah, Jabal Tayarat area, and the M'sad formation is considered of Cenomanian age according to Dunnington and Harth (personal communication).

Regarding the paleoecology of this formation, Owen and Nasr (Ibid) stated, "The Tayarat formation is of shallow water deposition".

Al-Naqib (1967) under the "Regional Sedimentary pattern and History" stated; "Towards the end of the Maestrichtian the area apparently underwent a regressive period whereby the neretic Tayarat limestone migrated eastward".

However, as stated above, there is a possible gradual shallowing of the basin from the upper member of the Qurna formation towards the Cretaceous/Tertiary contact, or to further up in the Umm Er Radhuma formation. This hypothesis is supported by the presence of bituminous material and anhydrite.

Nevertheless, further paleoecological studies are needed if the exact environmental conditions during the deposition of this formation are to be reconstructed.

Fossils (See benthonic fossils chart.)

Smout (1958) recorded the following important fossils from southern Iraq; Loftusia morgani, L. minor, L. elongata, Omphalocyclus macropora, Rotalia skourensis, Pyrgo sp. and Globotruncana stuarti.

In addition, Al-Naqib (1967) reported the occurrence of the following fossils from sections other than the type; Orbitoides media, O. opiculata, Ogivalia parisiensis, Rotalia trochidiformis, Lepidorbitoides socialis and Globotruncana spp.

So far, non of examined sections in the Zubair or Rumaila fields has yielded Loftusia. In a verbal communication Dr. Smout stated that the occurrence of this form in southern Iraq is doubtful.

Nevertheless, the writer has a good collection of this fossil from its type locality at the Jabal Tayarat.

The relatively well preserved planktonic Foraminifera from the Tayarat formation are; Hedbergella holmdelensis Olsson, Guembelitria cretacea (Cushman), Heterohelix striata (Ehrenberg), H.cf. glabrans, Pseudoguembelina excolata (Cushman), Ps. constulata (Cushman), Hedbergella hessi Pessagno, Globotruncana gagnebini Tilev, G. gansseri Bolli, G. aegyptiaca var.1 Nakkady, G. fornicata fornicata Plummer, G. fornicata cesarensis Gandolfi and Globigerinelloides asperum (Ehrenberg).

The following planktonic Foraminifera occur only in the Tayarat formation; Hedbergella holmdelensis, Guembelitria cretacea and Globotruncana aegyptica var.1.

II. Rumaila well no.18

Description; as for Zubair well no.8.

Locality and co-ordinates; Rumaila field, about 40 miles south of Basrah city, in the area between Latitude 1.730.373.80 E., and Longitude 915.741.80 N.

1. Khasib formation

Thickness; 140 ft., drilled depths 7,100-7,240 ft.

Age; Coniacian. G. renzi/H. pseudoguembeliniformis zone.

Lithology;

(a) Alternations of shale with rare particles and grey marl. (Top)

(b) Greyish-green shale and white, recrystallized and pyritic, chalky limestone.

(c) Shale, marly and limey, dark grey to green and fissile. (Bottom)

Remarks (See under Zubair well no.8)

The Khasib formation is underlain by the Mishrif formation. The contact is drawn at the level of first appearance of the genus Globotruncana.

The formation is conformably overlain by the Tanuma formation.

Fossils (See benthonic fossils chart.)

The following planktonic Foraminifera occur only in the Khasib formation; Hedbergella amabilis Loeblich and Tappan, Ventilabrella cf. eggeri Cushman. The formation is also characterized by the presence of; Lamellibranchiata, Echinoderms (?Genus Cidaris), Cythrella, Paracytries, Cythretta and other Ostracod.

2. Tanuma formation

Thickness; 110 ft. drilled depths 6,990-7,100 ft.

Age; Coniacian. G. renzi/H. pseudoguembeliniformis zone.

Lithology; Shale, black to grey, fissile and pyrite bearing. The shale is partially marly and limey in its upper portion.

Remarks (See under Zubair well no.8)

The Tanuma formation is overlain by the Sadi formation. The contact is conformable and placed at the change from black-grey shale below to marly limestone above. It is underlain by the Khasib formation, the contact is conformable and placed at the change from grey marl and shale below to black-grey and fissile shale above.

The formation is probably equivalent to the lower part of the Gudair formation in Kuwait.

Fossils (See benthonic fossils chart)

3. Sadi formation

Thickness; 1,220 ft. drilled depths 5,770-6,990 ft.

Age; Santonian-Campanian. S. carpatica zone, indeterminable interval to G. stuartiformis/G. stephensoni zone.

Lithology;

(a) Interval 5,770-6,120 ft. Limestone, chalky Pseudodomia complanata and Lamellibranch bearing, buff, partially recrystallized and porous with rare quartz grains and gypsum. Uppermost 50 ft. dominently chalky to chalky limestone, hard and slightly glauconitic at the top. Interval very poorly fossiliferous. (Top)

(b) Interval 6,120-6,420 ft. chalk, white, pure, soft and limestone, chalk content increasing upwards. Larger Foraminifera and other benthonics more abundant than below.

(c) Interval 6,420-6,630 ft. limestone, marly and chalky, grey to cream, recrystallized, porous, pyritic and anhydritic. Chalky materials more concentrated in the upper part of the interval.

(d) Interval 6,630-6,980 ft. Marl soft and grey to marly, pyritic and oolitic limestone. Interval very fossiliferous with abundant planktonic Foraminifera.

(e) Interval 6,980-6,990 ft. limestone, marly dark grey.(Bottom)

Remarks (See under Zubair well no.8)

The Sadi formation is overlain by the Hartha formation, the contact is conformable and is placed at the change from white chalk and chalky

limestone below to grey, marly limestone above. The marl is soft and the limestone partly dolomitized.

The boundary is also marked by the sudden increase in the number of larger Foraminifera and other benthonics.

Fossils (See benthonic fossils chart.)

The following planktonic Foraminifera occur only in the Sadi formation; Globotruncana coldreriensis Gandolfi, G. concavata concavata (Brotzen), G. marginata (Reuss), G. linneiana linneiana (d'Orbigny), G. coronata Bolli, G. fornicata plana var.nov., G. linneiana obliqua Herm, G. concavata reparda (Bolli), Heterohelix planata (Cushman), H. cf. globocarinata (Cushman), Biglobigerinella spp., Praeglobotruncana wilsoni Bolli, Rugoglobigerina bulbosa Belford, R. macrocephala macrocephala Bronnimann, Ventilabrella ornatissima Cushman and Church, Schackoina sp. and Guembelitria trilocula (Marie).

4. Hartha formation

Thickness; 570 ft., drilled depths 5,200-5,770 ft.

Age; Campanian-Lower Maestrichtian. G. stuartiformis/G. stephensoni zone to non-fossiliferous interval.

Lithology;

(a) Interval 5,200-5,310 ft. Dolomite, buff, dense and crystalline, in part saccharoidal with alternations of planktonic, chalky to marly limestone in upper 40 ft. Dolomites completely non-fossiliferous. (Top)

Tentative ecologic study of this interval reveals the presence of a sudden subsidance due to a major tectonic movement which separate its non-fossiliferous, lagoonal portion from the

highly fossiliferous, deep water upper portion. All the micropaleontological and paleoecological evidences confirm that this break corresponds to that already noted between the Calcareous benthonic/closed sea biofacies and Upper planktonic/open sea biofacies in Zubair well no.8.

(b) Interval 5,310-5,540 ft. Lower 120 ft. showing limestone-chalky limestone alternations. Upper part grey/buff, pseudo-oolitic, partly dolomitized with evaporites; dolomitization increasing upwards. Interval non-fossiliferous.

(c) Interval 5,540-5,600 ft. Dolomite, brown and saccharoidal, non-fossiliferous with evaporite particles.

(d) Interval 5,600-5,770 ft. Limestone, grey marly partly dolomitized with fossil debris and abundant larger Foraminifera and other benthonics. Interval terminated by brownish, ruby and calcitic limestone.

Remarks (See under Zubair well no.8.)

The Hartha formation is overlain by the Qurna formation. The contact is conformable at the change from dolomite, marly and chalky with abundant planktonic Foraminifera below to grey marl with abundant planktonic Foraminifera above.

The formation is underlain by the Sadi formation.

Fossils (See benthonic fossils chart.)

Globigerinelloides messinae messinae (Bronnimann) is the only planktonic Foraminifera restricted to this formation.

5. Qurna formation

Thickness; 265 ft., drilled depths 4,940-5,200 ft.

Age; Middle Maestrichtian. G. gansseri zone.

Lithology;

(a) Interval 4,940-5,080 ft. Marly, dolomitc limestone, dark grey in colour with light red (limonite coated) quartz grains increasing in quantity upwards. Interval very poorly fossiliferous.

(b) Interval 5,080-5,200 ft. soft, ash grey marl with occasional dolomitic particles (probably contamination from younger successions). Interval also characterized by the occurrence of rare quartz grains and pyrite, and abundant planktonic Foraminifera.

Remarks (See under Zubair well no.8.)

The Qurna formation is overlain by the Tayarat formation. The contact is conformable at the change from dark grey, marly and poorly fossiliferous dolomite limestone to poorly fossiliferous, buff grey and saccharoidal dolomite above.

In Rumaila well no.18 this change is very slow and the chert nodules, which conveniently mark the upper boundary in the Zubair field sections, are absent from this and all other Rumaila field sections, thus the exact Qurna-Tayarat boundary cannot be drawn with exactitude.

The writer tentatively uses the change in colour and slight lithologic differences to differentiate between these two formations.

Fossils (See benthonic fossils chart.)

Hedbergella holmdelensis Olsson and Gublerina cuvillieri Kikoine are the only planktonic Foraminifera restricted to this formation.

6. Tayarat formation

Thickness; 860 ft., drilled depths 4,080-4,940 ft.

Age; Middle Maestrichtian - ? Upper Maestrichtian?
G. gansseri zone.

Lithology;

(a) Interval 4,080-4,160 ft. Dolomite, marly and limey. Marly dolomite dark grey colour, in part finely saccharoidal and increasing in proportion upwards. Interval characterized by the occurrence of limonite coated, red quartz grains and iron oxides, more specifically concentrated in its uppermost portion and a great variety of debris (mud, clay, wood particles, iron oxides and other oxidized particles). (Top)
(It is suspected that the variety of debries together with limonite coated quartz grains indicate an unconformity.)

(b) Interval 4,160-4,740 ft. Dolomite, cream to buff, in part porous, limey and chalky with mollusc fragments.

(c) Interval 4,740-4,940 ft. Dolomite buff/grey, dark, hard and saccharoidal, in part limey and recrystallized with free dolomite and calcite crystals. (Bottom)

Remarks (See under Zubair well no.8.)

The Tayarat formation is overlain by the Tertiary Umm Er Radhuma formation. The contact is believed to be an erosional unconformity (see above).

Fossils (See benthonic fossils chart.)

Trinitella scotti Bronnimann is the only planktonic species restricted to this formation.

- 0 -

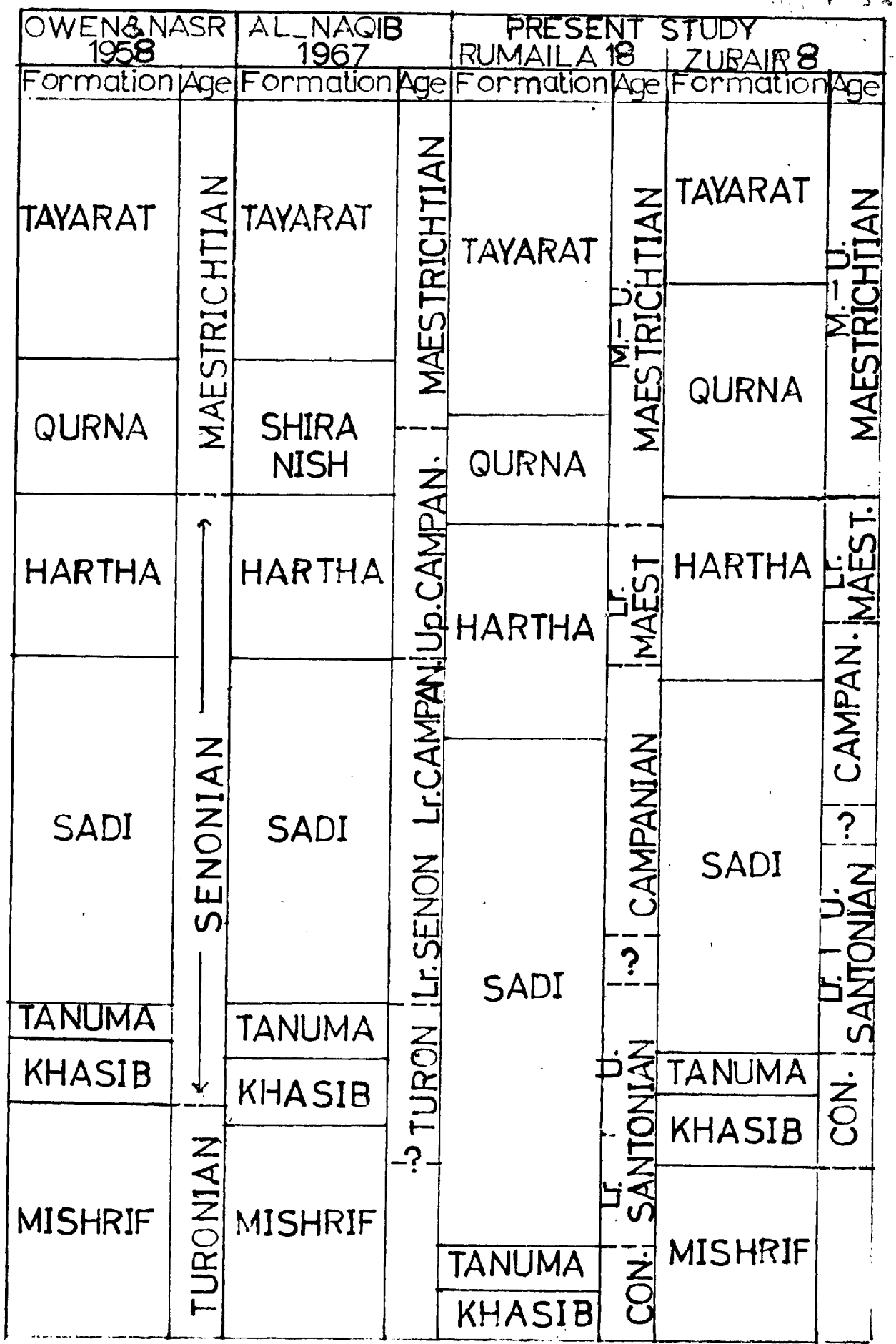


Fig.2 - Litho/Biostratigraphic correlation of the Upper Cretaceous succession in southern Iraq.

CHAPTER 3

Micropaleontological Zonation and Age Determination

Amongst the Foraminifera, the planktonic forms are now considered as valuable as the Ammonites for interregional correlation. Thalmann (1932) was the first who demonstrated the significance of this bionomic group for world wide correlation. Since this date many different contributions dealing with the taxonomy, stratigraphic and lateral distribution of the planktonic Foraminifera have appeared. Amongst those worthy of mention are publications by Renz (1936), Gandolfi (1942), Bolli (1945, 1951), Cita (1948), Sigal (1952), Bronnimann (1952), Marie (1936, 1937), de Klasz (1953) and Nakkady (1949, 1951).

On the basis of the destribution of Globotruncana and the benthonic Foraminifera, Marie (1938) proposed four Campanian-Maestrichtian zones to the Paris basin. However, it is only in the last fifteen years that the micropaleontological studies of the Cretaceous have resulted in the establishment of well characterized zones and horizons based entirely on planktonics.

Dalbiez (1955) successfully introduced the first pure and full scale Cretaceous planktonic biozones based on his studies in northern Africa (Tunisia). He divided the Cretaceous succession into eleven zones based on Ticinella, Thalmanninella and Rotalipora for the Lower Cretaceous Albian, Cenomanian and Lower Turonian, and Globotruncana for the Upper Cretaceous. He justifiably considered the single keeled forms (Globotruncana elevata elevata and G. elevata stuartiformis) to represent a new stage of development in the Campanian, and considered G. elevata elevata as the zonal marker for this stage. The Turonian

was divided into an Upper Turonian Helvetica zone and Lower Turonian Rotalipora zone. It is worthy to mention here that the G. helvetica zone is considered to be the most stable in Upper Cretaceous zonation history. However, Bolli (1957, 1959) used the G. inornata zone for the Upper Turonian of Trinidad, but later adopted the G. helvetica zone of Dalbiez.

Sigal (1955) established a different scheme of zonation. Among his proposed eight zones that of G. concavata is considered the most stable in the Senonian stage. However, the exact age of G. concavata is not fixed since confusion has been introduced by misidentification, the inclusion of G. repanda Bolli and G. ventricosa White in its synonymy, and local facies control. (See also Van Hint 1969(67)) As a result such authors as Bolli (1957, 1959, 1966), Sigal (1955), Lehmann(1962, 1966), Van Hint (1963) and others considered it as Lower Santonian. Some workers went to extremes and extended its range into the Campanian or even Maestrichtian stages. Amongst those are Herm (1965).

The writer shares with Van Hint (1969(67)) the view that the over splitting of species and consequent neglect of interspecific variation is the real reason for the discrepancies between many zonal schemes. The presence or absence of a double keel on the last chambers, the degree of surface ornamentation, of convexity, or the development of many other morphologic features are probably subject to environmental control.

Another stable zone in Senonian successions is the G. calcarata zone. It was first established by Herm (1962 as zone (C)) in the

Alpine region, and was thought to represent the Upper Campanian stage.

This zonal marker has not been found so far in southern Iraq. In northern Iraq, G. calcarata Cushman is represented in the middle part of the Shiranish formation (Al-Kassab, verbal communication). The writer has a feeling that the absence of this form is due to facies control, as this part of the Aruma group (lower part of Hartha formation) was deposited under very unfavourable shallow-water conditions. (See under Calcareous benthonic/closed sea biofacies.)

Elsewhere, G. calcarata occurs in N. Africa, Europe, the Caribbean, Gulf and on the Atlantic coasts.

Recently, Van Hinte (1965, 1966, 1967), Bolli (1966), Mohler (1966), Sigal (1967), Bandy (1967) and Pessagno (1967, 1969) have accepted this species as a zonal marker.

The fourth well defined zonal marker is Abathamphalus myaroansis (Bolli) which is restricted to the Upper Maestrichtian. The zone was first established by Bolli (1957) in Trinidad. Most recent authors have accepted the validity of this zone. The species so far has not been found in the Upper Maestrichtian of southern Iraq. (The uppermost Upper Maestrichtian probably is missing below an unconformity with the Tertiary.)

Among the species of Globotruncana of Middle Maestrichtian age deserving consideration as zonal markers is G. gansseri Bolli. The G. gansseri zone is accepted only by a few workers, namely Van Hinte (1965, 1966 not 1967), Pessagno (1962, 1967, 1969) and El-Naggar (1966).

In southern Iraq G. gansseri makes its first appearance associated with Pseudoguembelina excolata (Cushman), Ps. punctulata (Cushman) and Globotruncana aegyptiaca duwi Nakkady.

In the proposed zonation the species with short stratigraphic ranges and represented by the highest number of individuals are believed to be most significant. On these criteria the following planktonic species must be considered the most important "key fossils" in the Upper Cretaceous stratigraphy of southern Iraq. Globotruncana renzi Gandolfi, G. fornicata fornicata Plummer, G. concavata concavata (Brotzen), G. stuarti stuarti (de Lapparent), G. stuarti stuartiformis Dalbiez, G. gansseri gansseri Bolli, G. aegyptiaca aegyptiaca Nakkady, Praeglobotruncana wilsoni (Bolli), Pr. inornata (Bolli), Heterohelix pseudoguembeliniformis sp.nov., Pseudoguembelina excolata (Cushman), Ps. punctulata (Cushman) and Sigalia carpatica Salaj and Samuel.

The planktonic foraminiferal successions under study are often interrupted by beds devoid of planktonics, particularly in the upper part of the Sadi formation, most of the Hartha and upper Qurna formations, and throughout nearly the whole of the Tayarat formation. At these levels benthonic Foraminifera were used whenever necessary and possible.

The sequence has been subdivided into 4 zones and 2 subzones. In addition, two other intervals which are either devoid of fossil or contain rare indeterminable forms have also been recognised. The suggested zones and subzones in ascending order are as follows;

1. G. renzi/H. pseudoguembeliniformis zone.
2. S. carpatica zone
   (a) G. concavata subzone
   (b) G. fornicata subzone
3. The Indeterminable interval
4. G. stuartiformis/G. stephensoni zone

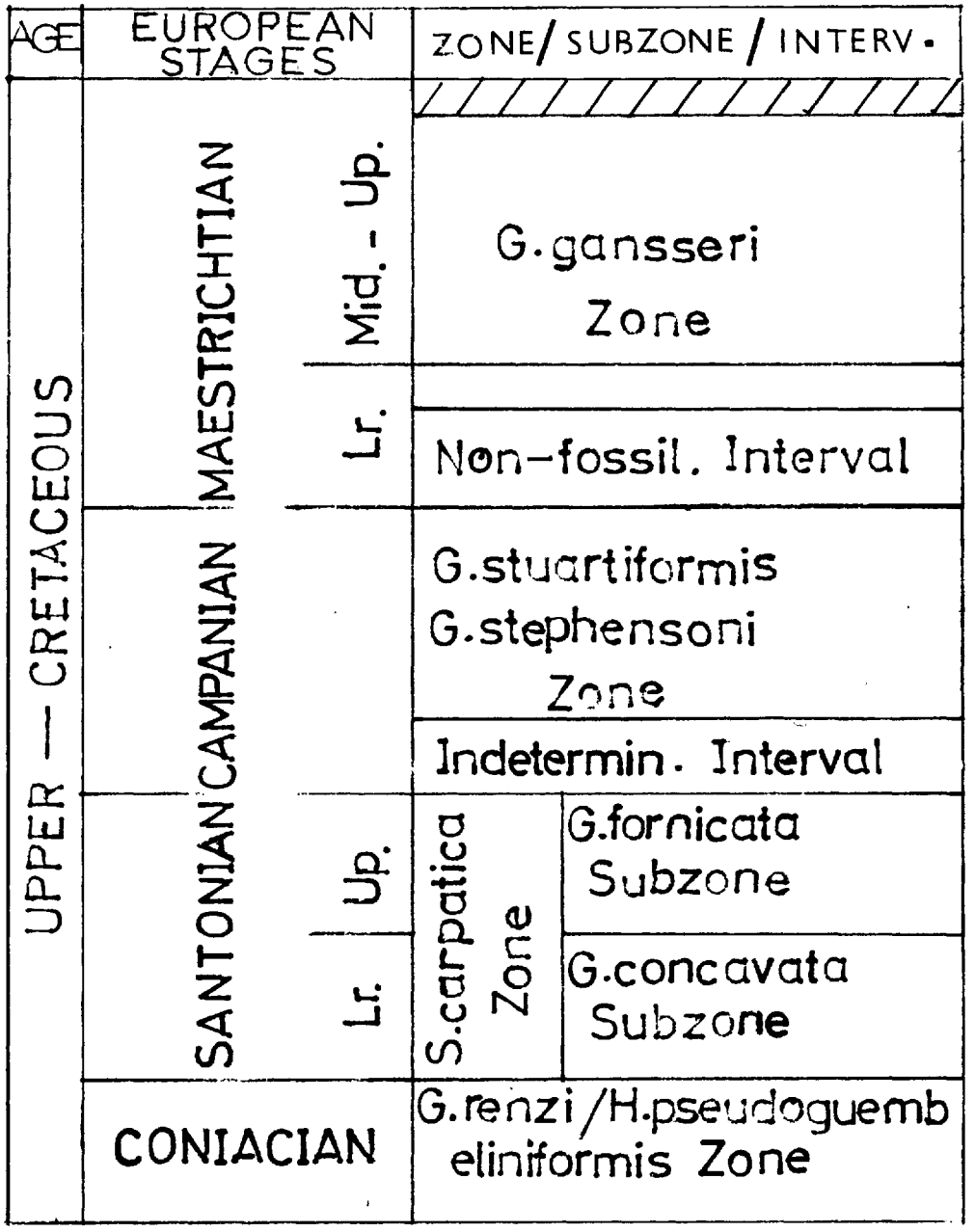


Fig.3– Planktonic Foraminifera zonation in S. Iraq compared to European stages.

5. The Non-fossiliferous interval

6. G. gansseri zone

The term "zone" is in the sense of "concurrent range zone" as defined in the Code of Stratigraphic Nomenclature, i.e. "a zone defined by overlapping ranges of specific taxa from one or more of which it takes its name", "The concurrent range zone is one of the most useful kinds of zones, it is the principal basis of time correlation of strata. The specific taxa are only those that form a distinctive association because their ranges overlap; that is, some taxa range no higher than the zone, others range no lower, and taxa maybe confined to it....". (American commission on stratigraphic nomenclature 1961, article 23.)

Frequency curves were used to determine the dominant species; where two or more species appeared in the same abundance, priority was given to that internationally accepted as a zonal indicator.

The European standard stage terminology was applied to the zonation because it is well known and widely employed.

1. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone

The lower unit of this zone is the lowest in the Upper Cretaceous of southern Iraq. The Mishrif formation underlying it is devoid of planktonic Foraminifera but it contains abundant, well preserved fossil Charophytes. The lower stratigraphic boundary of the zone was placed at the depth of 7,410 ft. in the lowermost Khasib formation in Zubair well no.8. It is marked by the first appearance of double-keeled Globotruncana..

In Rumaila well no.18 this boundary was placed at the depth of 7,240 ft.

Hitherto, fossil Charophyta were known only from Zubair field sections.

Out of the 24 planktonic species and varieties which make their first appearance at the lower limit of the zone, 10 are restricted to the zone and 14 range upward into younger ones. In addition to the above mentioned species the zone is marked by the first appearance of another 30 planktonics in its lower and middle portions, 8 of which are confined within it and 22 extend upward. Another 17 species appear in its upper portion, 6 of which are confined to it.

Only 15 species of benthonic Foraminifera have been counted from the lower part of the zone and 16 from its upper part. There is a general increase in the number of individuals in the assemblages from 269 at its lower limit into 865 in the upper limit. The following planktonics were selected for the upper boundary determination and age correlation;

1. Globotruncana renzi Gandolfi

This form makes its first appearance in the Turonian and becomes typically abundant in the Coniacian. It does not range higher than the Coniacian,(Bolli (1957, 1959), Van Hinte(1965, 1966), Salaj and Samuel (1966), Pessagno (1967, 1969) and Schebnerova (1969)).

2. Hedbergella paradubia (Sigal)

This species was described by Trujillo (1960), Takayanagi (1965) Douglas (1969) and Schebnerova (1963, 1969) as Rugoglobigerina kingi Trujillo, and said to make its last appearance in the Coniacian stage.

3. Heterohelix moremani (Cushman)

This species does not occur higher than the upper limit of the Coniacian according to Bandy (1967).

4. Globotruncana concavata primitiva Dalbiez

This form makes its first appearance in the middle or upper Coniacian and is confined within this stage according to Dalbiez (1955), Salaj and Samuel (1966) and Schebnerova (1969).

5. Globotruncana imbricata Mornod

According to Takayanagi (1965), in the light of the present knowledge Globotruncana imbricata is thought to disappear at about the middle of the Coniacian. Schebnerova (1969) stated "In the original paper by L. Mornod (1949) the stratigraphical range of this species was not very clear ..... . Revisional studies showed that Praeglobotruncana imbricata occurs in the typical Coniacian locality in association with Globotruncana concavata primitiva.

In southern Iraq these two forms are also associated;

6. Sigalia deflaensis (Sigal)

This species makes its first appearance in the Coniacian stage according to Sigal (1955, not 1952), Bettenstaadth and Wicher (1955), Samuel(1962),Oberhauser(1965),Alexandrowicz, Birken, Major and Geroch (1962), Alexandrowicz (1966) and Salaj and Samuel (1966).

In southern Iraq, all the above mentioned forms except Sigalia deflaensis (Sigal), which extends up into younger beds, are confined within the G. renzi/H. pseudoguembeliniformis zone. The combined occurrence of these forms suggests that the zone is correlative with the Coniacian of the European standard sequence.

Globotruncana renzi Gandolfi and Heterohelix pseudoguembeliniformis sp.nov. show the highest number of individuals within the zonal assemblages appear and become extinct together, are confined to the zone and therefore are used to designate it.

The same criteria are followed in the terminology of the other zones and subzones, unless otherwise stated.

The upper limit of this zone is marked by the disappearance of Globotruncana renzi Gandolfi, Heterohelix pulchra (Brotzen), H. pseudoguembeliniformis sp.nov. and the first appearance of Praeglobotruncana wilsoni (Bolli). The forms Globotruncana concavata concavata (Brotzen) and Sigalia carpatica Salaj and Samuel were found to overlap with the former three forms over an interval of about 50 ft.

All the species indicated above last occur in combination at a depth of 7,130 ft. in Zubair well no.8. In Rumaila well no.18, the boundary was drawn at the depth of 6,990 ft. for the same reason.

The stratigraphic thickness of this zone is about 280 ft. in the Zubair well, and about 250 ft. in the Rumaila well. It includes the whole of the Khasib and Tanuma formations.

2. Sigalia carpatica zone

The lower limit of this zone has already been discussed. The upper boundary was drawn at a depth of 6,530 ft. in Zubair well no.8. The zone is characterized by the presence of abundant Sigalia carpatica Salaj and Samuel and Globotruncana concavata concavata (Brotzen), the first appearance of Sigalia decoratissima (de Klasz) and Praeglobotruncana wilsoni (Bolli) and the absence of Globotruncana concavata primitiva Dalbiez, G. renzi Gandolfi, Heterohelix pulchra (Brotzen) and Heterohelix pseudoguembeliniformis sp.nov.

(a) The Globotruncana concavata subzone

The lower limit of this subzone has been described above. It is marked by the first appearance of 3 planktonic forms, 2 of which

The same criteria are followed in the terminology of the other zones and subzones, unless otherwise stated.

The upper limit of this zone is marked by the disappearance of Globotruncana renzi Gandolfi, Heterohelix pulchra (Brotzen), H. pseudoguembeliniformis sp.nov. and the first appearance of Praeglobotruncana wilsoni (Bolli). The forms Globotruncana concavata concavata (Brotzen) and Sigalia carpatica Salaj and Samuel were found to overlap with the former three forms over an interval of about 50 ft.

All the species indicated above last occur in combination at a depth of 7,130 ft. in Zubair well no.8. In Rumaila well no.18, the boundary was drawn at the depth of 6,990 ft. for the same reason.

The stratigraphic thickness of this zone is about 280 ft. in the Zubair well, and about 250 ft. in the Rumaila well. It includes the whole of the Khasib and Tanuma formations.

2. Sigalia carpatica zone

The lower limit of this zone has already been discussed. The upper boundary was drawn at a depth of 6,530 ft. in Zubair well no.8. The zone is characterized by the presence of abundant Sigalia carpatica Salaj and Samuel and Globotruncana concavata concavata (Brotzen), the first appearance of Sigalia decoratissima (de Klasz) and Praeglobotruncana wilsoni (Bolli) and the absence of Globotruncana concavata primitiva Dalbiez, G. renzi Gandolfi, Heterohelix pulchra (Brotzen) and Heterohelix pseudoguembeliniformis sp.nov.

(a) The Globotruncana concavata subzone

The lower limit of this subzone has been described above. It is marked by the first appearance of 3 planktonic forms, 2 of which

are confined within it, the appearance of others in its lower and middle portions, 6 of which are confined within it and 3 extending upward into younger beds, and the appearance of 4 forms in its upper portion of which are confined within it.

In all, 31 planktonic species were found to die out in this subzone. The maximum number of individual planktonic Foraminifera found in an assemblages was 44, from just above the middle portion. Associated with these were 14 benthonic species. The minimum number of planktonic individuals in any assemblage was 14, associated with 14 benthonics, from the uppermost portion of the subzone.

There is an increase followed by a decrease in the total number of individuals in the assemblages from bottom to top, from 1,834 ft. at its lower limit to 7,124 ft. at just above the middle portion, and to 520 ft. towards the top of the subzone.

The upper limit of the subzone is marked by the abundant occurrence of Globotruncana fornicata fornicata Plummer and the last occurrence of Rugoglobigerina bulbosa Belford, Praeglobotruncana wilsoni (Bolli), Globotruncana coronata Bolli and Sigalia deflaensis (Sigal).

The species Globotruncana concavata carinata Dalbiez, G. concavata repanda Bolli and G. fornicata manaurensis Gandolfi were found to overlap the above mentioned species over about a 40 ft. interval. In addition, Heterohelix cf. globocarinata (Cushman) makes its first appearance at this limit.

All these species have their last combined occurrence at the depth of 6,850 ft. in Zubair well no.8. In Rumaila well no.18, the boundary was drawn at a depth of 6,690 ft.

The stratigraphic thickness of this subzone is about 280 ft. in the Zubair well, and about 300 ft. in the Rumaila well. It includes the lower part of the Sadi formation.

The following forms were selected for the age determination;

1. Globotruncana concavata concavata (Brotzen)

This species appears in the Upper Coniacian as a rare form but becomes abundant in the Lower Santonian (Pessagno (1967, 1969)). However it is said to make its last appearance in the Lower Santonian (Alexandrwicz (1966), Bandy (1967) and Sigal (1967)), and to be confined within it. (Dalbiez (1955), Sigal (1955), Bolli (1957, 1966), Lehmann (1963) and Mohler (1966)).

In the light of the records given above G. concavata concavata appears to be restricted to the Upper Coniacian-Lower Santonian stages.

In southern Iraq, it makes its first rare appearance in the uppermost G. renzi/H. pseudoguembeliniformis zone and becomes abundant to flood at its upper border.

2. Praeglobotruncana wilsoni (Bolli)

This is confined to the Lower Santonian and makes its last appearance in the middle of Santonian (Bolli (1957), Bandy (1967)).

3. G. concavata repanda Bolli

This form makes its first appearance in the Santonian (Bolli (1957)). Judging from the range chart given by Bandy (1967) it overlaps Pr. wilsoni Bolli and G. concavata concavata (Brotzen) just in the middle of the Santonian.

In southern Iraq, G. concavata concavata disappears at the same time as Pr. wilsoni, and they both overlap with G. concavata repanda

over about a 40 ft. interval. The joint occurrence of the first two forms throughout the subzone and their overlap with G. concavata repanda in its uppermost portion suggests that the subzone is correlative with the Lower Santonian of the European standard succession.

(b) Globotruncana fornicata subzone

The lower limit of this subzone has been described above. The subzone is marked by the occurrence of small numbers of planktonic Foraminifera, a decrease in their percentage and number of individuals in the assemblages. In addition, only 5 species make their first appearance in this subzone, 2 of which are confined within it and 3 extending upward into younger beds. Moreover, 9 planktonic species were found to die out in this subzone.

The maximum number of individuals of planktonic Foraminifera found in an assemblages was 11, associated with 18 benthonic. The minimum number in an assemblage was 3, associated with 13 benthonic.

There is a decrease in the total number of individuals in the assemblages from 500 to 231 at its lower limit to 23 towards the top of the subzone.

The upper limit is marked by the last appearance of Praeglobotruncana inornata Bolli and Sigalia decoratissima (de Klasz).

In fact, the upper limit should be drawn at the depth of 6,570 ft. at which Globotruncana concavata corinata Dalbiez, G. fornicata manaurensis Gandolfi, Sigalia carpatica Salaj and Samuel and Ventilabrella ornatissima make their last appearance. However, it is prefered to place this limit at the depth of 6,530 ft. at which Sigalia decoratissima and Praeglobotruncana inornata last occur (each species is represented by a single specimen). In Rumaila well no.18 the boundary was drawn

at the depth of 6,390 ft.

The stratigraphic thickness of this subzone is about 320 ft. in the Zubair well, and about 300 ft. in the Rumaila well. It includes the middle portion of the Sadi formation. The following forms were selected for age determination;

1. Globotruncana fornicata fornicata (Plummer

This form makes its first appearance in the Late Turonian or Coniacian and extend to the Campanian or Maestrichtian (Bolli (1957, 1959, 1966), Edgell (1957), Graham and Clark (1961), Barr (1962), Pessagno (1962, 1967), Sigal (1966, 1967), Bandy (1967)).

In southern Iraq it appears in the Late Coniacian as a rare form but becomes typically abundant in the Upper Santonian and then extends upwards in greatly decreased numbers.

2. Globotruncana concavata carinata Dalbiez

Almost all recent Cretaceous workers agree that Globotruncana concavata carinata can be used as an Upper Santonian index fossil. (Dalbiez (1955), Caron (1966), Mohler (1966) and Lehmann(1963)) According to Oberhauser(1963),Schebnerova (1969) it occurs throughout the Santonian.

In southern Iraq it makes its first appearance 40 ft. below the lower limit of the subzone and dies out in the uppermost portion.

3. Sigalia decoratissima (de Klasz)

This species makes its last appearance in the uppermost Upper Santonian (Bettenstaedt and Wicher (1955), Salaj (1967), Salaj and Samuel (1966)).

4. Sigalia carpatica Salaj and Samuel

This species last occurs in the uppermost Upper Santonian (Salaj and Samuel (1966), Salaj (1967)).

5. Sigalia deflaensis (Sigal)

This species last occurs in uppermost Upper Santonian (Bettenstaedt and Wicher (1955), Salaj and Samuel (1966), Salaj (1967)).

6. Globotruncana fornicata manaurensis Gandolfi

This form makes its first appearance in the lowermost part of the Upper Santonian. (Salaj and Samuel (1966) and Salaj (1967).

7. Heterohelix cf. globocarinata (Cushman)

This form makes its first appearance in the Upper Santonian and extends to the Campanian (Bandy (1967).)

8. Globotruncana concavata reparda Bolli

This ranges from the Upper Santonian to the Campanian. It makes its first appearance just below the lower boundary of the former.

In southern Iraq, G. concavata carinata, S. carpatica and S. deflaensis disappear simultaneously.

The combined occurrence of these forms in absence of G. concavata concavata (Brotzen) and Pr. wilsoni (Bolli) suggests that the zone is correlative with the Upper Santonian of the European standard sequence.

3. The Indeterminable Interval

The lower limit of this zone has already been discussed. It was placed at a depth of 6,390 ft. in Rumaila well no.18, at the last occurrence of Sigalia decoratissima and Praeglobotruncana inornata. The interval is poorly fossiliferous and devoid of planktonic Foraminifera except for two broken specimens.

The upper limit is marked by the first appearance of single-keeled Globotruncanae and Gavelinopsis bembix (Marsson) which was taken from a depth of 6,120 ft. in Rumaila well no.18. In Zubair well no.8 the boundary was placed at a depth of 6,410 ft. Though the fossil content is poor, there is a slow but remarkable increase in the number of benthonic species and individuals towards the next younger zone.

None of the determined benthonic forms give useful age determinators.

4. Globotruncana stuartiformis/Globotruncana stephensoni zone

The lower limit of this zone was drawn at a depth of 6,120 ft. in Rumaila well no.18, and at 6,410 ft. in Zubair well no.8. It is marked by the first appearance of Globotruncana stuarti stuartiformis Dalbiez, G. elevata (Brotzen), G. gagnebini Tilev, G. rosetta (Carsey), G. subcircumnodifer (Gandolfi), G. contusa Cushman and G. stephensoni Pessagno. The first and last of these species are the most abundant and are used to designate the zone.

The zone gives poor yields of planktonic Foraminifera but it is rich in benthonic forms, especially in its lower part. However, many portions were found to be devoid of fossils.

The increase in the number of species and individuals reaches its maximum at the depth of 6,330 ft. These numbers then gradually decrease towards the uppermost part where the zone is almost devoid of fossils.

The upper boundary is tentatively placed at the base of the non-fossiliferous interval.

Van Hint (1965) studied the rare planktonic foraminiferal assemblage of the type Campanian from Aubeterre, France. The following forms were reported by him from the lower half of this stage;

Globotruncana arca (Cushman), G. cretacea (d'Orbigny), G. fornicata Plummer, G. linneiana (d'Orbigny), G. marginata (Reuss), G. linneiana tricarinata (Querea), cf. G. plummerae Gandolfi, G. calciformis Vogler and Heterohelix elegans (Rzehak) = Pseudotextularia elegans (Rzehak).

According to his sampling schedule, G. arca occurs at localities 818 and 819 (lowermost unit G) from the lowermost portion of the type Campanian.

Van Hinte (Ibid) stated, "The Aubeterre fauna with its G. cretacea - marginata - linneiana association and with early G. calciformis in the G. fornicata population probably belongs to the G. stuartiformis zone". This statement refers to his G. stuartiformis zone which is apparently equivalent to the lower two thirds of the Campanian stage.

In southern Iraq G. cretacea (d'Orbigny), G. fornicata Plummer and G. arca (Cushman) are associated with the first occurrence of G. stuartiformis Dalbiez, G. stephensoni Pessagno, G. gagnebini Tilev, G. rosetta (Carsey), G. subcircumnodifer (Gandolfi) and G. contusa (Cushman).

However, Van Hinte's G. calciformis is probably G. contusa or a highly convex G. fornicata form.

Pessagno (1969) also discussed the fauna of the type Campanian in detail. Like Van Hint, he arrived at the conclusion that the lower most part of this strato type is not older than the Archaeoglobigerina blowi subzone of his G. fornicata-stuartiformis assemblage zone. This subzone is equivalent of Lower Campanian stage. He also concludes that G. rosetta (Carsey), G. stephensoni Pessagno, G. stuartiformis Dalbiez and Ps. elegans (Rzehak), limit the lower boundary of this assemblages zone.

In southern Iraq, all the above named forms except Ps. elegans (Rzehak), make their first appearance at the lower limit of the G. stuartiformis/G. stephensoni zone.

Douglas (1969) correlated this part of the type Campanian with his G. stuartiformis subzone which is equivalent of the Lower Campanian.

Moreover, the majority of recent workers (Dalbiez (1955), Pessagno (1962, 1967, 1969), Oberhauser(1963), Lehmann(1963), Van Hint (1965, 1966, 1967), Salaj and Samuel (1966), Salaj (1967(69)), Douglas (1969) and Casati Tomai (1969)) accepted the idea that the single-keeled species of Globotruncana, such as G. stuarti group or G. elevata start at the lower boundary of the Campanian. Consequently, the micropaleontological evidence presented above indicates a Lower Campanian age for this zone.

This correlation does not mean that the Upper Campanian is not represented in southern Iraq. The absence of Globotruncana calcarata and other planktonic forms from the upper part of this zone is not an indication of erosion, but is due to facies control, as discussed under a separate chapter.

For the reasons mentioned above, the Upper Campanian portion of the section was found very difficult to define. The well preserved benthonic, calcareous and arenaceous forms which characterize the whole G. stuartiformis/G. stephensoni subzone, consist mainly of species whose stratigraphic ranges are unknown.

To arrive at a satisfactory solution, samples from Nahrumar well no.2, as well as from seven wells in the Zubair and Rumaila fields were examined. The faunal sequences were found similar in the rare but widely distributed occurrence of Globorotalites Brotzen, Stensioina

Brotzen and Quadrimorphina Finlay.

The more important species of these genera and their reported stratigraphic ranges in western Europe and the Carpathians are listed below.

1. Globorotalites hiltermani Kaever, Upper Campanian.
2. Globorotalites alabaminensis (Sandidge), Campanian - Maestrichtian. (Sandidge (1932), Kaever (1961))
3. Globorotalites michelinianus (d'Orbigny), Campanian. (Schijfsma (1946), Hofker (1958), Witwicka (1958), Reiss (1959, 1960, 1963), Kaever (1961))
4. Stensioina pommerana Brotzen, Upper Campanian - Maestrichtian. (Hagn (1953), Pozaryska (1954), Hofker (1956, 1957), Witwicka (1958), Scheibnerova 1969))

The genus Globorotalites Brotzen has its most common occurrence in the Campanian of western Europe, the Carpathians and the U.S.S.R. However, it is not restricted to this stage for it also has been recorded from younger, as well as older sediments.

In southern Iraq, the joint occurrence of the afore-named species of Globorotalites in association with Stensioina pommerana Brotzen and Quadrimorphina allomorphinoides (Reuss) suggests an Upper Campanian age for the upper part of the G. stuartiformis/G. stephensoni zone. This would include the lowermost part of the Hartha formation and probably the uppermost part of Sadi formation.

For the sake of simplicity, the writer suggests that this zone should not be split into subzones but correlated as a whole with the European type Campanian. Moreover, the Campanian - Maestrichtian boundary is not well marked. (See under succeeding zone.)

5. The Non-Fossiliferous interval

The lower limit of this interval is drawn at a depth of 5,600 ft. in Rumaila well no.18 and at 5,920 ft. in Zubair well no.8. It is marked by the first appearance of samples devoid of fossils. The upper limit is marked by the first occurrence of Globotruncana stuarti stuarti, G. aegyptiaca aegyptiaca and other forms. It is drawn at a depth of 5,230 ft. in Rumaila well no.18 and at 5,740 ft. in Zubair well no.8. It includes the upper two thirds of the Hartha formation.

1. Globotruncana stuarti stuarti (de Lapparent)

This species was reported from the Maestrichtian stage by Vogler (1941), Reichel (1951), Dalbiez (1955), Herm (1962), Oberhauser (1963), Bolze and Sigal (1964), El-Naggar (1966), Casati and Tomai (1969) and Scheibnerova (1969), from the Upper Campanian and Maestrichtian by Bolli (1945), Cita (1948), Sigal (1952), and Ansary and Tewfik (1966) and from the Upper Maestrichtian by Berggren (1962), Pessagno (1962, 1967, 1969), Olsson (1964), Funnell et.al. (1969).

2. Globotruncana aegyptiaca aegyptiaca Nakkady

This form makes its first appearance in the Lower Maestrichtian according to Nakkady (1950), El-Naggar (1966) and Ansary and Tewfik (1969).

The joint occurrence of the above two forms suggests correlation with the Lower Maestrichtian of the European standard succession.

The position of the non-fossiliferous interval, between undoubted uppermost Campanian and Lower Maestrichtian indicates either an Upper Campanian or Lower Maestrichtian age. The writer on the whole favours a Lower Maestrichtian age.

6. Globotruncana gansseri zone

The lower limit of this zone is marked by the first appearance of Globotruncana gansseri gansseri Bolli, G. aegyptiaca duwi Nakkady, Pseudoguembelina excolata (Cushman) and P. elegans (Rzehak)[1]. Globotruncana linneiana tricarinata (Quereau), G. cretacea (d'Orbigny) and G. ventricosa White make their last appearance in the lowermost portion of this zone; they were found to overlap with the afore-mentioned new forms over an interval of about 40 ft. All these species appear together at a depth of 5,670 ft. in Zubair well no.8 and at 5,200 ft. in Rumaila well no.18.

In addition, the zone is characterized by the appearance of various other species; from the lower boundary, one species extends upwards, 10 are found in the lower part of the zone, 2 extending upwards and 4 in the middle portion.

There is a sudden increase in the number of planktonic species and individuals especially in the lower part of the Qurna formation.

Most parts of the Tayarat formation are devoid of Foraminifera owing to the recrystallization and dolomitization.

1. According to the recent records, G. gansseri gansseri Bolli is a Middle Maestrichtian zonal marker (Bolli (1951, 1957, 1959, 1966), Nakkady and Osman (1954), Gandolfi (1955), Dalbiez (1955), Bronnimann and Brown (1956), Olsson (1960), Pessagno (1960, 1967, 1969), Berggren (1962), El-Naggar (1966), Van Hinte (1966, 1969), Bandy (1967) and Casati and Tomai (1969)) There are also records from the Lower to the Upper Maestrichtian (see under systematic description).

2. Globotruncana aegyptiaca duwi Nakkady is recorded from the Middle to Upper Maestrichtian of Egypt and the western hemisphere (El-Naggar

(1966), Pessagno (1967, 1969) and Bandy (1967).

3. Guembelitria cretacea Cushman has a Middle to Upper Maestrichtian range (Olsson (1960), Bandy (1967), Pessagno (1962, 1967, 1969)).

4. The zone is also characterized by the presence of Rugoglobigerina pustulata, Ticinella scotti, Globotruncana convexa, G. leupoldi, G. fareedi, G. aegyptiaca var.1, G. subpennyi, Heterohelix ultimatumida, Pseudoguembelina palpebra, Pseudotextularia elegans, Gublerina cuvillieri and Hedbergella holmdelensis which are restricted to it. The first three are typical Middle to Upper Maestrichtian fossils in most parts of the world (Bronnimann (1952), Bronnimann and Brown (1956), Bolli (1957), Herm (1962), Berggren (1962), Olsson (1960, 1967), El-Naggar (1966) and Bandy (1967).)

According to the above records, G. gansseri zone is correlative with the Middle - Upper Maestrichtian of the European standard succession.

The following species were recorded from the type Maestrichtian (Maestricht - Holland) by Visser (1951), Hofker (1956, 1966) and Berggren (1962); Globotruncana contusa, G. stuarti, G. havanensis, G. petaloidea, Pseudotextularia elegans, Racimiguembelina fructicosa, Abathomphalus intermedia, A. mayaroensis, Globigerinelloides messinae, Rugoglobigerina rugosa and Hedbergella monmouthensis. It is thus concluded that this association should be assigned to the Upper Maestrichtian.

It was found difficult to define a separate Upper Maestrichtian zone owing to the barren character of the Tayarat formation and the absence of the typical zonal markers such as Abathomphalus mayaroensis, Pseudotextularia fructicosa, Globigerinelloides messinae subcarinata, Rugoglobigerina rotundata ..... etc.

The upper boundary of this zone is the top of the uppermost unit in the Upper Cretaceous of southern Iraq, and is marked by an unconformity. The top is overlain by the Umm Er Radhuma formation.

- 0 -

STAGE	S. IRAQ	TUNESIA DALBIEZ(1955)	TUNESIA SALAJ(1966)	MAROCCO LEHMANN(1966)	ALGER SIGAL(1967)	NILE VALLEY EL NAGGAR(1966)
MAESTRICHTIAN	G.gansseri Zone	G.contusa	Racemiguembelina varians		mayaroensis & contusa	G.esnehensis
			G.falsostuarti			G.gansseri
		G.arca			stuarti & coniques	G.fornicata
					calcarata	
CAMPAN.	G.stuartiformis/ G.stephensoni Zone	G.elevata	G.rugosa			
			G.arca		elevata & stuartiformis	
SANTON.	S. carpatica Zone: G.fornicata Subzoe	G.ventricosa	S. carpatica: G.fornicata manaurensis	G.concavata		
	S. carpatica Zone: G.concavata Subzone		Güblerina decoratissima		concavata	
			G.concavata			
CON.	G.renzi H.pseudo guembeliniformis Zone	G.schneegansi	G.angusticarinata	" Grandes Rosalines "	" Grandes Rosalines plate "	
TURON.		G.helvetica	G.schneegansi	G.helvetica	helvetica seule	
		Upper Rotalipore	Pr. biconvexa / Pr.oraviensis	" Grandes Globigerines "		
			Pr. imbricata			

Fig. 4 – Correlation of some N. African planktonic Foraminifera zones with S. Iraq.

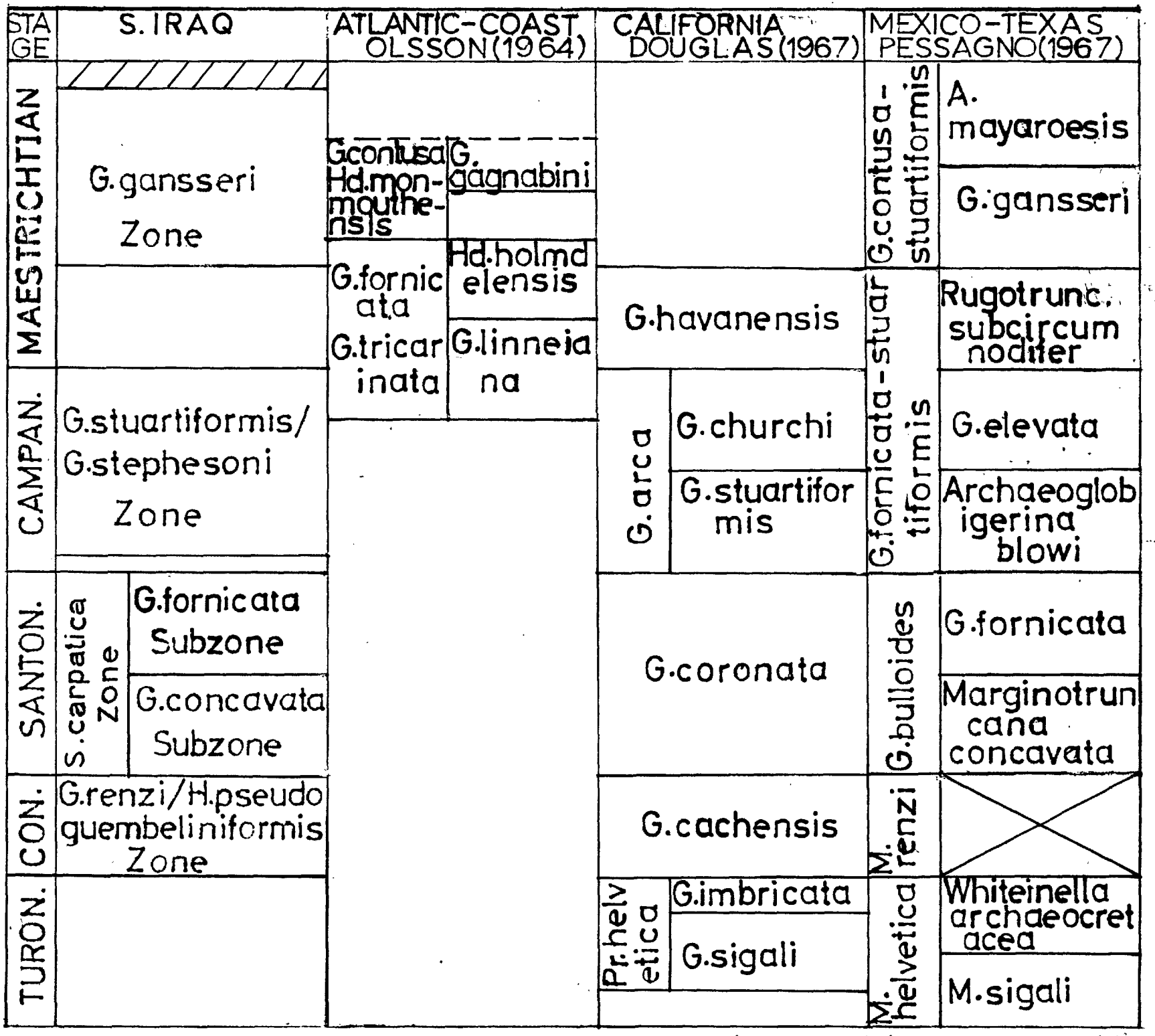


Fig.5 – Correlation of some N.American planktonic Foraminifera zones with S.Iraq.

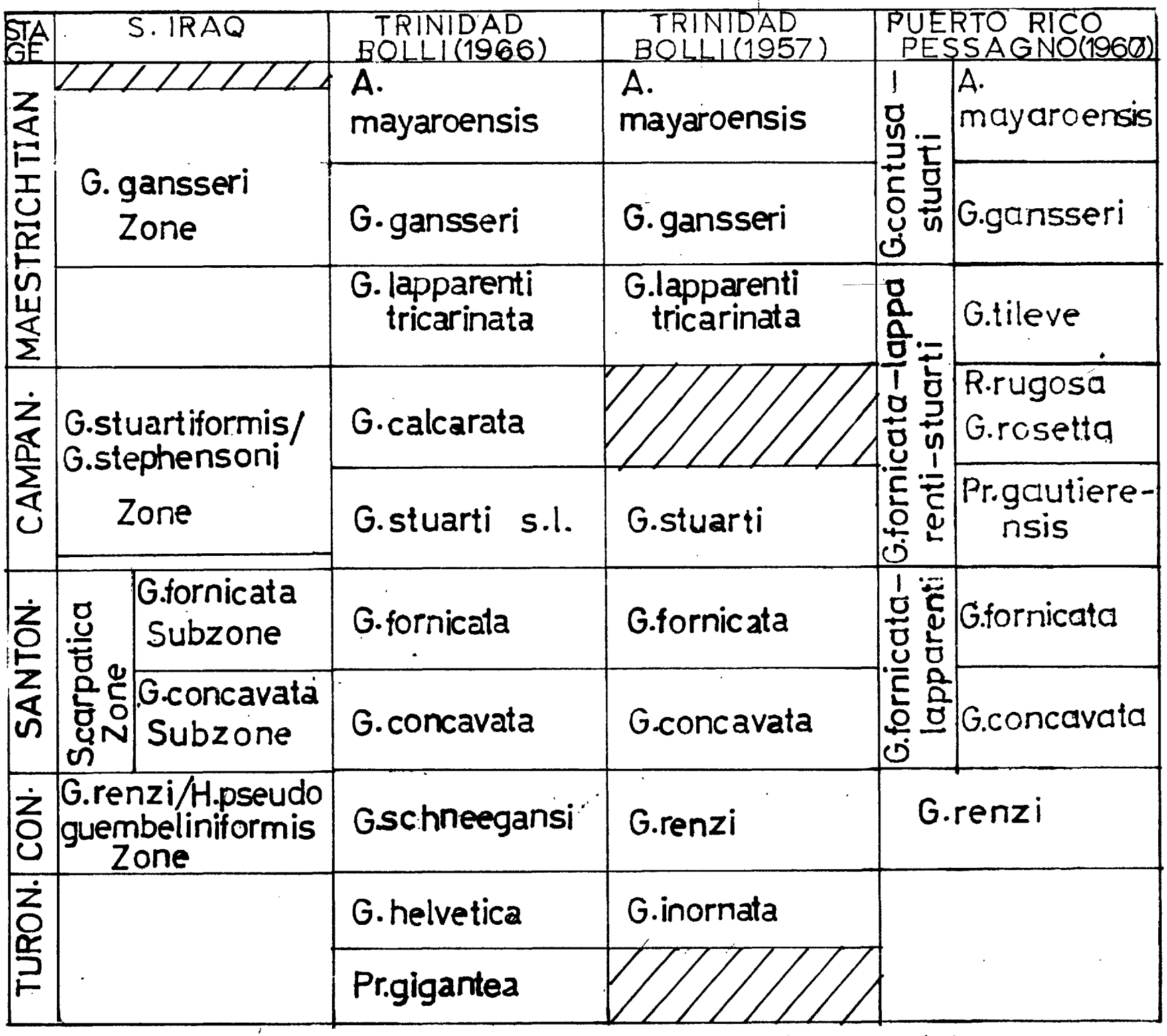


Fig. 6 – Correlation of some Caribbean planktonic Foraminifera zones with S. Iraq.

STAGE	S. IRAQ	N.ALPS-SALZBURG HERM (1962)	SWITZERLAND HERB (1965)	RATURA VAN HINTE (1965)			CENT.SWISS.ALPS MOHLER (1966)	S.ALPS — ITALY CASATI & TOMAI (1965)
MAESTRICHTIAN	G. gansseri Zone	F		G. gansseri	G. stuarti	G. contusa	G. mayaroensis	A. mayaroensis
		E						
		D				G. calciformis	G, contusa contusa	G. stuarti
CAMPAN.	G. stuartiformis G. stephensoni Zone	C	G. elevata elevata	G. calcarata			G. calcarata	G. elevata G. stuartiformis
		B		G. stuartiformis			forms of Globotruncana thalamani flexuosa group	
SANTON.	S. carpatica G. fornicata Subzone		G. concavata carinata	G. elevata			G. concavata carinata	G. carinata
	S. carpatica G. concavata Subzone	A		G. concavata	G. sigali	G. renzi	G. concavata concavata	G. concavata
CONIAC	G. renzi / H. Pseudo guembeliniformis Zone		G. concavata carinata	G. schneegansi			forms of Globotruncana lapparenti group	G. sigali G. renzi
			Pr. schneegansi	G. helvetica			G helvetica	G. helvetica
TURON.			Pr. helvetica	Hedbergella gigantea				

Fig. 7 — Correlation of some European planktonic Foraminifera zones with S. Iraq.

CHAPTER 4

The Foraminiferal Biofacies and Depositional Environments

The foraminiferal faunas of the Tanuma, Khasib, Sadi, Hartha, Qurna and Tayarat formations in Zubair well no.8 are variable; specifically, generically and in number of individuals represented. The majority are extinct forms, hence their ecologic relationships cannot be worked out precisely. However, measurements of planktonic percentages together with other statistical data prove useful for the establishment of past-depositional and environmental conditions in southern Iraq.

The majority of recent ecologists relate the distribution of recent species to sea bed depth. Murray (1897) noted that planktonic Foraminifera decrease shoreward and that they are generally absent near-shore throughout the world.

Phleger (1954) suggested that terrestrial run off restricted the approach of oceanic plankton to coastal areas. This phenomenon also has been demonstrated by Lipps and Warme (1966) who suggested that the increase in numbers of planktonic skeletons in sediements of the deeper basins farther from shore is probably due to a lower rate of terrigenous sedimentation and possibly a higher rate of planktonic production in the overlying waters.

The planktonic/benthonic ratio and its relation to the depth of deposition has been considered by Grimsdale and Morkhoven (1955), Smith (1955), Hay (1960) and Funnell (1964).

Nearly all ecologists agree that there is a general progressive increase in the percentage of planktonic Foraminifera with the depth.

Generally speaking, the planktonic Foraminifera are ecologically sensitive and they are restricted to water masses having distinct

physical and chemical properties (Johnson and Brinton (1963)). The controlling factors suggested, include oceanic currents, turbidity, temperature, salinity, acidity, etc.

Phleger (1960 p.102) gave the following as the most important factors governing the depth distribution of recent Foraminifera; temperature, salinity, food supply, water chemistry, hydrostatic pressure, turbidity, turbulance, substrata currents and biological competition or disease.

However, the effects of the majority of these factors are not yet understood and many others remain undescribed.

Johnson (1960) illustrated that the death assemblages may be altered or destroyed on or just below the sediment surface during deposition according to the composition of the substrata.

Barr (1962) assigned the low percentage and poor preservation of planktonic Foraminifera in some English Upper Chalk samples to "selective destruction". He believed that the removal of the most fragile skeletons was due to this process.

In southern Iraq, the poor preservation of the planktonic Foraminifera from some deep water samples and the presence of pyritic internal moulds and pyritized specimens indicate that "selective destruction" was operative.

However, other unknown processes also may be involved here. ZoBell (1942) stated "Depending upon the number and kinds of micro-organism present, the substrata and environmental condition (bacteria) might increase the acidity or decrease it". He (1946) also stated, "the PH of most sediments was found to increase with depth".

Moore and Shepard (1955) found that the PH of marine sediments is slightly higher than neutral at the surface and increases slightly with depth.

James Mello (1969) reported that the presence of pyrite in the Pierre shale and in the lower part of the Fox Hills sandstone as indicative of "reducing conditions", and the presence of pyrite or siliceous internal moulds in calcareous Foraminifera of removal of caco3.

Tourtelot (1962) gave the following interpretation; "the bacterial or chamical reduction of sulphate also promoted acidic as well as reducing conditions, some Calcium Carbonate and other compounds were increasingly dissolved and were either cycled back to the overlying sea water or were segregated as diagenetic concretions in favourable microenvironments within the zone of diagenesis".

Kaplan, Emery and Rittenberg (1963) and Degens (1965) refering to the benthonic Foraminifera concluded that the reducing environments are created by the decomposition of protein around a freshly imbedded and decaying soft body in which the pyrite then precipitates as a cast of the shell or of the wormhole.

Different interpretations of pyrite formation have been discussed in great detail by Michael (1968).

Destruction of planktonic forms can also be due to decreasing water temperatures and pressure, facilitating carbonate solution (Seibold (1964)), by the hydrous solution of H_2S which dissolves the carbonates (Mosebach (1952)), or by wave action and transportation.

The following ecologic criteria were used;

1. Percentage of planktonic, benthonic and arenaceous (including siliceous) Foraminifera in the fossil Foraminifera population.

Most workers confirm that in recent sediment;

(a) The percentage of planktonic forms increases with increased distance from the shore.

(b) Abundance of planktonics is indicative of open sea conditions.

2. Foraminiferal number, i.e. the number of Foraminifera for one gram of dry sediment.

(a) The number of Foraminifera increase with increased distance from the shore. This reflects the rate of sedimentation.

(b) The rate of sedimentation is inversely related to the distance from shore.

3. Number of genera and species.

(a) These are directly related to the distance from the shore and to the increasing depth of water.

(b) Warm waters support a greater number of genera and species but fewer individuals than cold waters.

4. The presence or absence and the abundance of arenaceous, porcellaneous, larger Foraminifera and Bryozoa fragments.

In the paleoecological interpretation of depth of deposition, Grimsdale and Morkhoven (1955) have been followed. The bathymetric zonation used is that of Bandy (1960).

The analysis of the paleoecological curves (Fig.9) of Zubair well no.8 reveals the presence of 5 foraminiferal biofacies. However, in view of the lack of information concerning oceanographic conditions during the Upper Cretaceous, the questionable practice of including the Heterohelicids in the planktonic count and including only certain

fractions (30, 60, 90), the study provides only a general approximate picture of the conditions of deposition and depth and it is likely to be subject to errors.

To simplify the study, each biofacies is subdivided as required.

A. Porcellaneous Biofacies

The lower limit of this biofacies is also the lower boundary of the G. renzi/H. pseudoguembeliniformis zone. The underlying Mishrif formation is a freshwater Charophyte and Ostracod bearing limestone (Owen and Nasr (1958)). The porcellaneous biofacies includes the interval 7,410-7,385 ft., and is developed as marly limestone. The foraminiferal assemblages are characterized by;

(a) Low foraminiferal numbers.

(b) Low planktonic percentages (43-50 per cent).

(c) Moderate numbers of species.

(d) Moderate numbersof genera.

(e) Relatively high numbers of porcellaneous Foraminifera.

(f) High numbers of Charophytes, Ostracods, Lamellibranchs and Echinoides.

The interval is also characterized by the presence of small, poorly developed arenaceous species belonging to the genera Glomospira, Textularia and Gaudryina. The porcellaneous forms (mainly Quenquiloculina) were observed to increase in abundance towards sample 7,385.

Some of the more common calcareous, benthonic genera are Discorbis, Cibicides, Valvulineria, Planulina, small sized Gyroidina (including Gyroidinoides) and small sized and smooth Rotalia and Nonnionella.

The planktonic Foraminifera gradually increase towards the upper

limit of the interval.

Most of the benthonic species and, to a lesser extent, the planktonics, have small tests. This reduction in size is probably indicative of low salinity (Myers 1943).

The presence of moderate numbers of genera and species and low foraminiferal numbers suggest warmer water conditions.

From the data summarised above it can be concluded that the deposition of these beds was in shallow water. The presence of low planktonic percentages suggests a restricted or narrow connection with the open sea.

According to Bandy (1960), the association of Textularia, Quinqueloculina, Cibicides and Planulina suggest "Inner shelf condition". Similar conclusions were reached by Lowman (1949) who recorded the occurrence of Rotalia and Miliolids in an "Inner neretic environment". Both authors report brackish water conditions.

Grimsdale and Morkhoven's (1955) depth distribution chart suggests 95-150 metres as the depth of deposition for these samples. Bandy (1960) places this depth range within his "Central shelf zone". This rather deep water determination probably is due to inclusion of high numbers of Heterohelicidae in the planktonic count in the present work. The fossils Charophytes were probably derived from the fresh water part of the Cenomanion Mishrif formation, or were drifted in from the coast.

B. Lower Planktonic/Open Sea Biofacies

This biofacies is characterized by the high percentages of planktonic Foraminifera in its assemblages. The lower boundary is drawn at a depth of 7,385 ft. just above the last occurrence of Miliolidae and Charophytes and at a marked increase in planktonic percentages.

The upper limit is drawn at a depth of 6,890 ft., in the middle of a short transitional interval between the open sea and succeeding closed sea biofacies. A marked lithologic change is noticeable at this level.

The stratigraphic thickness of the biofacies is 535 ft., including the whole of the Khasib and Tanuma formations as well as the lower part of the Sadi formation

1. The Interval from 7,385 - 7,305 ft.

This interval is developed as marl with lenses of shale, and the foraminiferal assemblages are characterized by;

(a) Moderate foraminiferal numbers.

(b) High planktonic percentages. (73-82 per cent.).

(c) Low numbers of genera.

(d) Low numbers of species.

(e) Negligible numbers of arenaceous Foraminifera.

The data suggests that the deposition of this interval occured under rather deep water conditions in direct connection with the open sea. The low numbers of genera and species indicate a colder water environment. The interval yields some samples containing low planktonic percentages and poorly preserved specimens. This probably suggests the occurrence of some destruction of the fauna.

Barr (1962) ascribed a similar phenomenon in the English upper chalk to "selective destruction". (See above.)

In southern Iraq destruction mainly affects the delicately constructed Heterohelicidae. Parker and Athearn (1959) believe that the alteration of the test or its complete solution occurs immediately below the sediment surface, as here the environment is acidic owing to the presence of decaying vegetation.

However, the present author believes that this is not the case in southern Iraq as all the benthonic forms were found to be well preserved.

Grimsdale and Morkhoven's (1955) depth distribution chart suggests 870-970 metres as the depth of deposition for this interval. Bandy (1960) places this depth range in his "Middle bathyal zone". However, the common occurrences of Planulina, of small-sized Epistominella and the fairly low number of Foraminifera suggests rather the "Outer shelf to Upper bathyal" zone.

The following genera appear for the first time in this interval; Dentalina, Gavelinella, Lenticulina, Epistominella, Osangularia and Bathysiphon.

Genera present in the previous interval but absent here include; Epistominoids, Fissoelphidium, small smooth Gyroidina, Anomalinoids, Nonionella, Spirotecta? and Miliolidae.

2. The Interval from 7,285 - 7,110 ft.

This interval is developed as marl, shale and in the uppermost sample, oolite. The foraminiferal assemblages are characterized by;

(a) Moderate foraminiferal numbers.

(b) Very high planktonic percentages (85-96 per cent).

(c) High numbers of species.

(d) High numbers of genera.

(e) Negligible numbers of arenaceous Foraminifera.

The data suggests that the deposition of this interval occurred in rather deeper water conditions than the previous one, and in direct connection with the open sea. The few arenaceous Foraminifera may be

considered as exotic (Bandy 1960). The presence of considerable amounts of oolite in samples 7,135-7,110 at the uppermost part of the interval, is of great importance, as such oolites are abundant on shores exposed to extensive wave action (Erdlays opinion (1931) in Twenhofel (1950), Mr. Shearman, D.J. personal communication). The ooliths sometimes have pyritic or glauconitic internal casts.

The interval contains abundant small particles of glauconite. Takahashi (1939) considered the appearance of this mineral in stratigraphic sections as an indication of reducing conditions. He added that bacterial action plays a part in it. (See also Hendricks and Ross 1941).

Haddings (1932) has emphasized that glauconite forms only when accumulation of sediment is very slow.

All these facts suggest reducing conditions and a marine origin for this part of the Tanuma formation.

The writer can see neither a break nor any other evidence of unconformity between the Tanuma and Sadi formations.

The foraminiferal percentages in this interval suggest a depth of 1,120-1,250 metres (Grimsdale and Morkhoven, Ibid.) in the "Middle bathyal zone" (Bandy Ibid).

However, the "Upper bathyal zone" is proposed for most parts of this interval because of the presence of the same ecologic indicators as in the previous interval, and the "Middle bathyal zone" for the uppermost portion on the basis of the common occurrence of rounded-edged Gyroidina (sometimes with globular tests), thin walled Cibicides, Osangularia and large numbers of incompletely planispiral Planulina (Bandy Ibid.).

The interval is also characterized by the presence of smooth and well polished Marsonellae.

Hada (1957) found that depth plays a role in determining the form of the arenaceous Foraminifera. Shallow water specimens were usually found to have coarse textures, whereas the smoothly finished forms characterize deeper water.

The following genera appear for the first time in this interval; large sized Rotalia, Marsonella, cf. Bulbofragmium, Astocolus, Smoutina, Trochomina and Cibicidoides.

3. The Interval from 7,110 - 6,890 ft.

This interval consists of limestone, marly, with pure marl in the upper portion, and terminates with oolitic limestone and pyrite. Its assemblages are characterized by;

(a) Very high foraminiferal numbers.

(b) Very high planktonic percentages (96-98 per cent).

(c) High numbers of species.

(d) High numbers of genera.

(e) Considerable numbers of smooth arenaceous Foraminifera.

The interval differs from the previous one in lithologic composition and in having higher data values. It was deposited under very deep water conditions and in direct connection with the open sea. This is the deepest water biofacies found in the area under study. The planktonic foraminiferal percentage suggests a depth of at least 1,300 metres.

Grimsdale and Morkhoven (1955) discussed sediments containing more than 90 per cent. of planktonic Foraminifera and concluded in the text that the depth should be at least 700 metres. On the other hand, their depth distribution chart Encl.5 indicates a minimum depth

of deposition of 1,200 metres. Hay (1960) also gives a minimum depth of 700 metres, while Funnell (1964) proposed 650-700 metres.

According to Bandy (1960), depths of deposition of more than 1,200 metres fall into his "Middle bathyal" or "Lower bathyal" zone.

The presence of pyrite suggests reducing conditions. Spiroloculina and Marginulina are the only genera found here not represented below. Osangularia, cf. Bulbofragmium, Smoutina, Astocolus and Cibicidoides, which are found below, do not occur in this interval.

C. Calcareous Benthonic/Closed Sea Biofacies

This biofacies is characterized by low planktonic and higher calcareous benthonic percentages, low to moderate foraminiferal numbers, arenaceous Foraminifera, larger Foraminifera and Bryozoa. The low number of species and genera might be related to the absence or low numbers of planktonics and/or unfavourable conditions for the productivity of calcareous Foraminifera.

The lower boundary was drawn at the marked faunal change at a depth of 6,890 ft. where predominently planktonic assemblages give place to predominently benthonic ones, and there is a lithologic change from hard, marly limestone to pure, soft marl. The upper limit falls at a depth of 5,920 ft., and is marked by the appearance of the first barren samples. The stratigraphic thickness of this biofacies is about 970 ft. It includes the middle and the upper parts of the Sadi formation and the lower half of the Hartha formation.

1. The Interval from 6,890 - 6,760 ft.

This interval consists of marl, and the assemblages show;

(a) Very low numbers of Foraminifera.

(b) Low planktonic percentages (24-30 per cent)

(c) Low numbers of genera.

(d) Low numbers of species.

(e) Considerable numbers of arenaceous Foraminifera.

Since the planktonic percentages are low the deposition of this interval occurred in shallow water. It is possible that a basin with restricted connections with the open sea occupied the area at this time.

The occurrence of shallow water conditions may be due to uplift in the basin or the onset of much faster deposition. The presence of considerable numbers of roughly finished arenaceous forms, of larger Foraminifera and Bryozoan fragments give weight to the hypothesis of a shallow water origin.

The planktonic percentages suggest a depth of 30-85 metres in the "Inner and Outer shelf zone". This is supported by the complete absence of Planulina and Valvulineria. In addition, the interval is characterized by the absence of Gaudryina and Bathysiphon, and by the first appearance of Globorotalites, Hoglandina and Gavelinopsis.

2. The Interval from 6,730 - 6,690 ft.

These beds consist of marly limestone and the foraminiferal assemblages show;

(a) Moderate numbers of Foraminifera

(b) Low planktonic percentages (40-42 per cent)

(c) Moderate numbers of species

(d) Moderate numbers of genera

(e) Considerable numbers of arenaceous Foraminifera.

This interval differs from the previous one in showing higher data values. The significant genera are; Anomalinoides, Gyroidina, Rotalia, Leticulina (including Robulus), Marginulina, Planularia, Cibicides,

Gavelinella, Bathysiphon, Gaudryina and Marsonella

The planktonic foraminiferal percentage of this interval suggests a depth of 400-500 metres.

3. The Interval from 6,650 - 6,410 ft.

This interval like the one below, consists of marly limestone. Its foraminiferal assemblages show;

(a) Low foraminiferal numbers.

(b) Low planktonic percentages (2-22 per cent)

(c) Low numbers of species.

(d) Low numbers of genera.

(e) Negligible numbers of arenaceous Foraminifera.

This interval is more or less similar to that between 6,890 and 6,760 ft. in its depositional environment. It was laid down under rather shallower water conditions. This is indicated by the presence of considerable numbers of larger Foraminifera and Bryozoa. The absence of arenaceous forms is probably due to destruction during burial and subsequent compaction of the sediment. The planktonic foraminiferal percentages suggest a depth of deposition of 25-65 metres in the "Inner shelf zone".

4. The Interval 6,370 - 5,920 ft.

This interval consists of limestone, marly and chalky, partly dolomitized. Most of samples contain considerable amounts of glauconite.

The foraminiferal assemblages are characterized by;

(a) Moderate foraminiferal numbers. These decrease towards the upper limit of the interval.

(b) Very low planktonic percentages. (1-0 per cent)

(c) Moderate numbers of species.

(d) Moderate numbers of genera.

(e) The arenaceous Foraminifera increasing moderately in number towards the upper limit of the interval.

(f) A great increase in the number of larger Foraminifera, Bryozoa and Rotalia and the presence of Inoceramus.

The above data suggest that the deposition of this interval occurred in continuously shallowing water. Since the planktonic percentages show extremely low values, it is probable that there was extremely limited connection with the open sea.

For percentages of 0-1 of planktonic Foraminifera, Grimsdale and Morkhoven (1955) suggested a 0-15 metres sea bed depth. For 5% or less planktonics, Lowman (1949) suggested 125 ft. or less water depth.

Parker (1948) shows that off the west coast of the United States, in waters less than 150 ft. in depth, planktonic Foraminifera can be neglected.

Bandy (1960), in his bathymetric zonations, suggested "Inner shelf zone" for this sea bed level.

Amongst the better represented arenaceous genera are; Bathysiphon, Balbophragmium, Schizammina, Haplophragmoides, Marsonella and Glomospira. The more common calcareous benthonics include; Gavelinopsis, Gavelinella, Nodosaria, Rotalia, Rotalia (small and smooth), Epistominella, Osangularia, Discorbis, Linticulina, Conorboides, Pararotalia. Other genera such as Alabamina, Quadrimorphina, Stensioina, Globorotalites and Triloculina are of rare occurrence and restricted to the upper portion of the interval. The genera most abundantly represented throughout are Rotalia, Gavelinella and Conorboides.

A gradual decrease in the foraminiferal number, in the number of species and genera and in the size of specimens takes place towards the

upper portion of the interval.

Most of the small sized forms have a very thin and delicate shell structure.

The test size reduction was ascribed by Myers (1943) and Gleasner (1945) to low salinity. Walton (1964) stated "the small, thin shelled forms appear to be limited to bays, sounds and shelf areas that are near the influence of large rivers, and it is believed that they result from the increased difficulty of precipitating calcium carbonate in waters of lower than normal salinity".

For these reasons and the statistical data produced above, the lower part of the interval is believed to have been deposited under very shallow water conditions in the "Inner shelf zone". This contention is supported by the presence of coarsely ornamented arenaceous forms, and the lack of Quinqueloculina and Triloculina and arenaceous brackish index genera such as Ammobaculites, Saccamina .....etc. Haplophragmoides, which is also represented in brackish water assemblages, is rare and scattered in the section.

The upper part of this interval is believed to have been deposited in an unfavourable environment. Assemblages consist largely of Gavelinopsis, Conorboides, Rotalia and arenaceous genera. Others, such as Alabamina, Quadrimorphina, Stensioina, Triloculina, Quinquiloculina and Globorotalites are rare and of sparse occurrence.

This portion of the interval is also characterized by the presence of large numbers of larger Foraminifera and Bryozoan fragments.

Amongst the arenaceous Foraminifera the following were well preserved and important; Marsonella, Bathysiphon, Dorothia, Ammobaculites? and Trochammina.

In samples nos. 6010-6050 the number of arenaceous Foraminifera reaches its maximum. According to Renz (1942) and Stainforth (1948, 1952), strong turbidity is a major contributing factor in the development of arenaceous faunas.

In the above named samples, when the percentage of arenaceous Foraminifera exceeds 33, the numbers of calcareous benthonic specimens decrease to their minimum values. This follows a decrease in the total number of benthonic Foraminifera.

These facts indicate rapid deposition, conditions unfavourable for the high productivity of calcareous Foraminifera and a suitable environment for the development of arenaceous forms.

According to Walton (1964) a decrease in the number of calcareous benthonic species is both off the continental shelf and towards the shore. In the former case the decrease is offset by an increase in numbers of planktonic specimens.

It is concluded that deposition of the upper part of the interval occurred in an area of restricted circulation, in an abnormal environment at moderate sea bed depth but in shallower water than below.

Summary The statistical and other data relevant to the calcareous benthonic/closed sea biofacies indicate a gradual shallowing during deposition. The lower microfaunas indicate narrowing and widening of the basin connection with the open sea. The noticeable variations in the ecologic data may result from unstable basin conditions.

The uppermost microfaunas indicate a closed sea environment in very shallow water.

D. The Non-Fossiliferous Biofacies

This biofacies is completely devoid of fossils. The lower boundary was drawn at a depth of 5,920 ft. and the upper at 5,740 ft., where it is followed abruptly by the appearance of flood planktonic foraminiferal assemblages attributed to sudden subsidence.

The stratigraphic thickness of this biofacies is about 150 ft. it includes most of the upper half of the Hartha formation. It is composed of whitish, pale brown and grey dolomite and limestone containing large numbers of sand grains and stringers of evaporites.

The presence of barren beds overlying those indicating very shallow water is normal in the depositional environment. The lithological data suggests that this biofacies was deposited under very shallow, lagoonal conditions. (D.J. Shearman, verbal communication)

E. Upper Planktonic/Open Sea Biofacies

This biofacies is characterized by the high planktonic percentages, of its foraminiferal assemblages, by the complete absence of Bryozoa and larger Foraminifera. Marsonella oxycana, which represents the only arenaceous fauna in the lower part of the Qurna formation, is rare and sparsely distributed.

The lower limit of the biofacies was placed at a depth of 5,740 ft. The upper boundary could not be drawn since dolomitization and recrystallization has damaged or destroyed the fossil fauna of the upper part of the Qurna and the whole of the Tayarat formation. The stratigraphic thickness cannot be estimated.

However, the biofacies definitely includes the uppermost Hartha and the lower half of Qurna formation.

1. The Interval from 5,740 - 5,660 ft.

These beds consist of limestone, partly dolomitized, containing glauconite. The microfaunas show;

(a) Low foraminiferal numbers.

(b) High planktonic percentages (60-90 per cent).

(c) Moderate numbers of species.

(d) Low numbers of genera.

The data suggest that the deposition of this interval occurred in rather deep water in direct connection with the open sea.

The relatively low number of genera and species may be due to the presence of cold water currents during this period. The low numbers of planktonic forms, which are mainly poorly preserved, appears due to selective destruction. This hypothesis is supported by the preservation of the calcareous benthonic forms, which is good.

Walton (1964) stated that "the zone of maximum numbers of benthonic species of Foraminifera occurs in areas on the continental shelf where there is relatively little dilution of population by detrital sediments". Then he added "Seaward of the shelf edge the number of benthonic species decrease".

The deposition of this interval is thought to have taken place off the continental shelf.

The more common and well preserved benthonic genera found are; Gavelinopsis, Stensioina, Globorotalites, Gyroidina (of large size), Bulimina, Osangularia and Rotalia (of large size).

According to Bandy (1960) the association of the last four genera may suggest bathyal conditions. On the other hand, for the percentages of 60-90 planktonic Foraminifera, Grimsdale and Morkhoven (1955) suggested

680-1,200 metres as the depth of the deposition. This falls in the "Middle bathyal zone" of Bandy (Ibid).

At the Qurna-Hartha contact, samples 5,660 and 5,665 are of hard recrystallized limestone, nearly devoid of fossils, except very poorly preserved, small, juvinil, benthonic forms. The occurrence of such a barren interval during the deposition of this deep water biofacies may be due to an uplift in the basin.

It is believed that a second subsidence of the basin occurred after the deposition of this barren section.

2. The Interval from 5,650 - 5,350 ft.

These beds consist of marl, soft and ash grey in colour. The microfossil assemblages are characterized by;

(a) Low foraminiferal numbers.

(b) High planktonic percentages (69-80 per cent).

(c) Rather low numbers of species.

(d) Low numbers of genera.

(e) The sparse and rare occurrence of Marsonella, which is the only arenaceous representative.

The interval is characterized by assemblages containing relatively higher numbers of benthonic species and individuals than the beds below. These increases are accompanied by small but noticeable decreases in the numbers of planktonic species and individuals. This suggests a shelfward movement of the basin and its continued connection with the open sea.

For percentages of 69-80 of planktonic Foraminifera, Grimsdale and Morkhoven (1955) suggested 900-700 metres as the depth of deposition. This depth falls in the "Middle bathyal" environment.

The more common and well preserved benthonic genera are; Stensioina, Globorotalites, Gavelinopsis, Gyroidina (large size), Osangularia, Bulimina (smooth), Anomalina, Gavelinella, Lenticulina, Eponides, Rotalia and Cibicides. Other genera occur rarely and are sparsely distributed.

The remaining upper part of the Qurna and Tayarat formations are composed of dolomitic rocks which are mostly recrystallized. The planktonic Foraminifera which were sparsely distributed and rare, were collected from less than 200 mesh fruction. For this reason it was found very difficult to reconstruct the past depositional and environmental conditions of these formations.

- 0 -

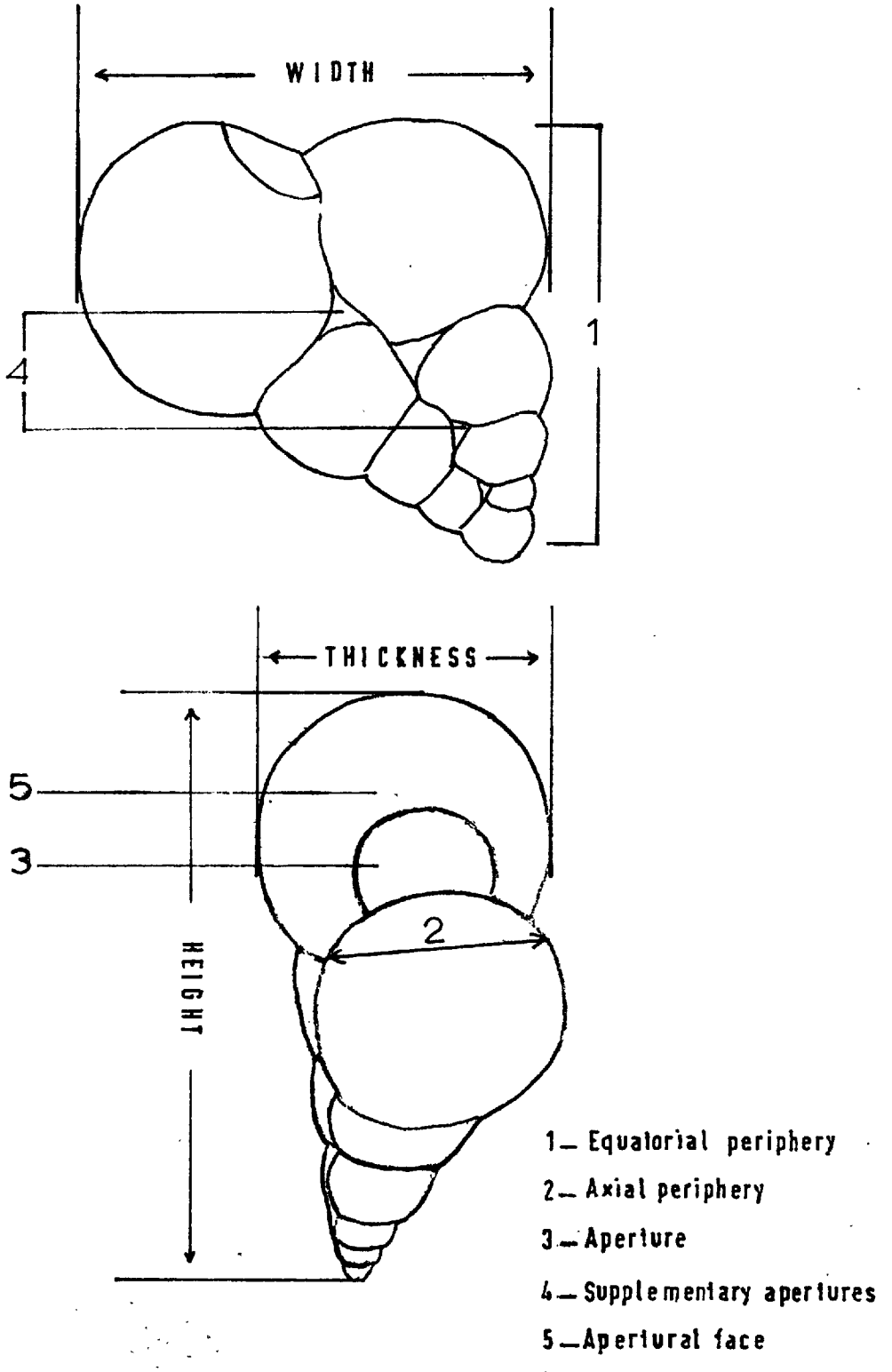
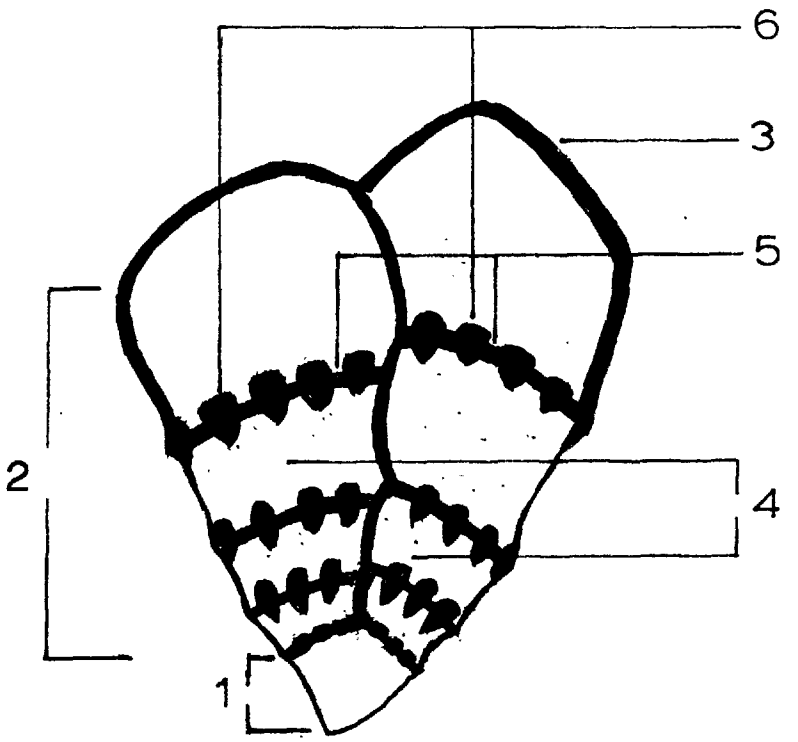


Fig.8— An idealized Heterohelix.



1 – Entire periphery

2 – Serrated periphery

3 – Truncated axial periphery

4 – Subrecangular chambers

5 – Granular sutures

6 – Longitudinal knobs

Fig.9 – An idealized Sigalia.

CHAPTER 5

Systematic Description

The classification employed here, with slight modification, is taken from the "Treatise on Invertebrate Paleontology, Part C Protista", Loeblich and Tappan (1964). Departures from this classification include the recognition of the genus Sigalia Reiss (1957) and Ventilabrella Cushman (1928).

The identification is based principally on comparison with previously published figures and description, topotypes if accessible and holotypes available at the British Museum of Natural History, London. When the original publications were not available, reference was made to the "Catalogue of Foraminifera", compiled by Ellis and Messina (1940-1969).

Among the total of 4 families, 16 genera, 94 species and 26 varieties of planktonic Foraminifera determined, 9 species and 4 varieties are described as new.

All, except for a few poorly preserved or rare forms are described and figured.

Order	FORAMINIFERIDA	Eichwald 1830
Superfamily	GLOBIGERINACEAE	Carpenter, Parker & Jones 1862
Family	HETEROHELICIDAE	Cushman 1927
Subfamily	GUEMBELITRIINAE	Gallitelli 1957
Genus	Guembelitria	Cushman 1933
Type species	Guembelitria cretacea	Cushman 1933

Guembelitria cretacea Cushman

pl.1, fig.1

1933	Guembelitria cretacea Cushman.	pp.37 - 38, pl.4 figs.12a-b
1938	Guembelitria cretacea Cushman.	Cushman. p.19, pl.3 figs.14a-b
1946	Guembelitria cretacea Cushman.	Cushman. p.103, pl.44 figs.14a-b
1957	Guembelitria cretacea Cushman.	M.Gallitelli. p.136, pl.31 figs. 1a-b
1960	Guembelitria cretacea Cushman.	Olsson. pp.27 - 28, pl.4 fig.8
1964	Guembelitria cretacea Cushman.	Said and Sabry. p.390, pl.3 fig.32
1965	Guembelitria cretacea Cushman.	Perlmutter and Todd, p.13, pl.2, fig.8
1966	Guembelitria cretacea Cushman.	Ansary and Tewfik, pp.38 - 39, pl.3, figs.13a-b
1967	Guembelitria cretacea Cushman.	Bandy. p.23, fig.12(6) (two figures)
1967	Guembelitria cretacea Cushman.	Pessagno. p.258, pl.87, figs.1-3

Remarks and Occurrence. A few large, triserial and rapidly tapering specimens with large and rapidly increasing chambers, highly arched apertures and smooth tests are here referred to Guembelitria cretacea Cushman. The specimens are poorly preserved and restricted to the Middle and Upper Maestrichtian rocks of the Qurna and Tayarat formations.

Guembelitria cretacea Cushman was originally described from the Upper Navarro group, Texas and was recorded from the same region by M. Gallitelli (1957).

Olsson (1960) reported the occurrence of Guembelitria cretacea in the Upper Cretaceous rocks of the Redbank and Lower New Egypt formations, New Jersey; Said and Sabry (1964) in the Lower Maestrichtian of the Gebel Aweina, Egypt; Perlmutter and Todd (1965) from the Late Cretaceous of the Monmouth group, New York; and Ansary and Tewfik from the Campanian-Maestrichtian of the Ezzel Orban Calk, Egypt. However their specime

from the Campanian need checking. Pessagno (1967) reports it from the Middle Maestrichtian of Corsicana marl, Escondido formation, Texas and in the Arkadelphia marl, south western Arkansas. All reliable records show that the present species ranges throughout the Maestrichtian and is largely confined to the Middle and Upper Maestrichtian.

Guembelitria aff. harrisi Tappan

1940	Guembelitria harrisi	Tappan.	p.115, pl.19, figs.2a-b
1954	Guembelitria cretacea	Cushman.	Stelck and Wall. p.68, pl.2 figs.23 - 24
1967	Guembelitria harrisi	Tappan.	Bandy. p.22, 23, (no figure)
1967	Guembelitria harrisi	Tappan.	Pessagno. p.258, pl.48, figs.12-13

Remarks and Occurrence. A few triserial, small, thin, elongate and slowly tapering specimens with low, slightly arched apertures and smooth tests are here assigned to Guembelitria harissi Tappan. These characters serve to differentiate it from Guembelitria cretacea Cushman.

The few specimens of this species found in the uppermost Khasib formation are believed to have been reworked from the eroded Cenomanian or Turonian part of the Mishrif formation.

The evolutionary history of Guembelitria harrisi is not clearly understood. It might be a triserial offshoot of Heterohelix moremani (Cushman) although no direct evidence of this was recorded.

Guembelitria harrisi was originally described by Tappan (1940) from the Lower Cretaceous rocks of the Crayson formation, Texas. Stelck and Wall (1954) also described Guembelitria cretacea Cushman from the Lower Turonian of the middle Kaskapau formation, western Canada. Pessagno (1967) encountered specimens of this species in the Cenomanian and Albian rocks of the Eagle Ford group and the Crayson formation.

Guembelitria trilocula (Marie)

pl.1, fig.2.

1941 Pseudotextularia trilocula Marie. p.186, pl.28, figs. 278a-d

Occurrence. Rare, in the Tanuma formation. The upper part of the Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous records of occurrence; The Campanian of Paris Basin.

Subfamily	HETEROHELICINAE	Cushman 1927
Genus	Heterohelix	Ehrenberg 1843
Type species	Spiroplecta americana	Ehrenberg 1844

Heterohelix aff. barnardi (Ansary)

pl.1, fig.3.

1955 Guembelina barnardi Ansary. p.77, pl.2, fig.26

Remarks and Occurrence. A single, biserial, roughly triangular specimen with the whole test, except for the last pair of chambers, ornamented by well separated, coarse striae with slightly indented sides, a rounded axial periphery, a zigzag median line and wider than high apertures, is here assigned to H. barnardi (Ansary). The species has 14 biserially arranged, globular chambers with the last pair greatly inflated and enlarged. It was found in the Tanuma formation.

It differs from the holotype in its compressed initial stage, pointed apical end and roughened last pair of chambers.

H. barnardi was originally described from the Upper Eocene of Wady Waseiyif, Sinai, Egypt.

Heterohelix cf. glabrans (Cushman)

pl.27, fig.10.

1938 Guembelina glabrans Cushman. p.15, pl.13, figs. 1, 2
1960 Heterohelix glabrans (Cushman). Olsson. p.26, pl.4, fig.4
1967 Heterohelix glabrans (Cushman). Pessagno. p.259, pl.88, figs.1, 2, 10, 11

Remarks and Occurrence. H. glabrans was first described as Guembelina glabrans by Cushman (1938) from the Navarro group (Campanian - Maestrichtian) of Texas. Pessagno (1967 p.259) stated that H. glabrans has possibly evolved from H. pulchra (Brotzen) during early Maestrichtian time. However, as stated elsewhere, this writer feels that there is no phylogenic relation between these two species, as the true reniform chambers in H. pulchra are unique among the known species of Heterohelix. It is likely that H. glabrans has evolved directly from H. planata by developing a true keel on the early part of the periphery and increasing the height of the aperture. The rudimentary apertural flaps of H. planata are clearly visible in some specimens of H. glabrans.

The species occurs rarely in the Middle and Upper Maestrichtian rocks of the Qurna and Tayarat formations, Globotruncana gansseri zone.

Cushman (1946) noted its occurrence in Alabama and Tennessee. Olsson (1960) reported it from New Jersey; Pessagno (1967) from Mexico, Texas and Arkansas and Ansary from Egypt.

Heterohelix cf. globocarinata (Cushman)

pl.1, fig.4

1938 Guembelina globocarinata Cushman. pp.10-11, pl.2, figs.4a-b,5.
1957 Heterohelix globocarinata (Cushman) M.Gallitelli. p.137,138, pl.31, fig.17
1967 Heterohelix globocarinata (Cushman) Pessagno. p.259,260, pl.86 figs.5,6

Remarks and Occurrence. According to Pessagno (1967) who examined the holotype and the two paratype slides, H. globocarinata (Cushman) is characterized by its inflated, final chambers, carinate periphery in the early portion of the test, large, lowly arched aperture and by the finely striate nature of its test.

The specimens encountered in this study exhibit all the above characters except the early peripheral keel. However, the initial portion of the best preserved specimens are strongly compressed and the periphery of this part is entire, giving the test a carinate appearance.

H. globocarinata was originally described by Cushman (1938) from the Upper Taylor marl of Texas. He later (1946) reported it from Alabama, Arkansas and Mississippi, ranging through beds of Austin to Navaro age.

In southern Iraq, H. cf. globocarinata of author was found rarely and sparsely and found to be confined to the Upper Santonian rocks of the Sadi formation.

Heterohelix moremani (Cushman)

pl.1, figs.5,6

1929	Guembelina globifera (Reuss)	Carman.	p.311, pl.34, fig.3
1934	Guembelina globifera (Reuss)	Morrow.	p.194, pl.29, figs 15a-b 17
1937	Guembelina globifera (Reuss)	Loetterle.	p.34, pl.5, figs.3
1938	Guembelina moremani Cushman		p.10, pl.2, figs.1a-b, 2 (not 3)
1946	Guembelina moremani Cushman	Cushman.	p.103, pl.44, figs 15, 16 (not fig.17)
1948	Guembelina moremani Cushman	Kikoine.	p.18, pl.1, figs.4a-c
1951	Guembelina globulosa (Ehrenberg)	Young.	p.63, pl.14, fig.23
1952	Guembelina moremani Cushman	Bolin.	p.38, pl.2, fig.17
1953	Guembelina moremani Cushman	Shaw.	p.48, pl.1, figs.24, 25
1954	Guembelina moremani Cushman	Frizzell	p.109, pl.15, figs.28, 30 (not fig.29)
1956	Guembelina moremani Cushman	Bolin.	p.290, pl.38, figs.15a-b
1962	Heterohelix moremani (Cushman)	Petri.	pp.88 - 89, pl.11 figs.1, 2a-b
1967	Heterohelix moremani (Cushman)	Pessagno.	p.260, pl.89, figs.1, 2 (not pl.48, figs. 10-11)
1969	Heterohelix moremani (Cushman)	Noel, K. Brown.	pp.35 - 36, pl.1, fig.8

Remarks. Cushman (1938) first discovered this species. In his description he pointed out that the surface of H. moremani is smooth. This is confirmed by Pessagno (1967). Noel, K. Brown (1969) shows very

faint longitudinal costae in H. moremani. He stated "All Heterohelicids have striae on their test with a possible exception of the most primitive H. washitensis (Tappan) late Albian-Cenomanian form". It is possible that all Pessagno's H. moremani specimens were from Cenomanian strata as were Cushman's holotype and paratypes. Actually, Pessagno (Ibid) himself stated, "it is conceivable that specimens of H. moremani occurring in the Turonian portion of the Eagle Ford group have been rewarked from Cenomanian Eagle Ford strata".

Carman (1929), Morrow (1934) and Loetterle (1937) described as Guembelina globifera (Reuss) forms which belong in H. moremani (Cushman). They show slow tapering, slender and parallel outlines. Similarly, the form described by Young (1951) as Guembelina globulosa (Ehrenberg) is actually H. moremani (Cushman). On the other hand, the species described and figured by Cushman (1938. fig.3, 1946. fig.17) and by Frizzell (1954. fig.59) as H. moremani show an aberrant chamber between the last two; they most probably belong in Ventilabrella ventilabrelliformis (Von der Slus).

None of the forms figured by Pessagno (1967. pl.48, figs.8-11) are similar to Cushman's holotype, and may well belong in H. pseudoguembeliniformis sp.nov.

Occurrence. Rare, only found in the Khasib formation, Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence: Texas, Late Cenomanian; Mississippi, Coniacian-Santonian; Gulf Coast, Turonian; Brazil, Turonian.

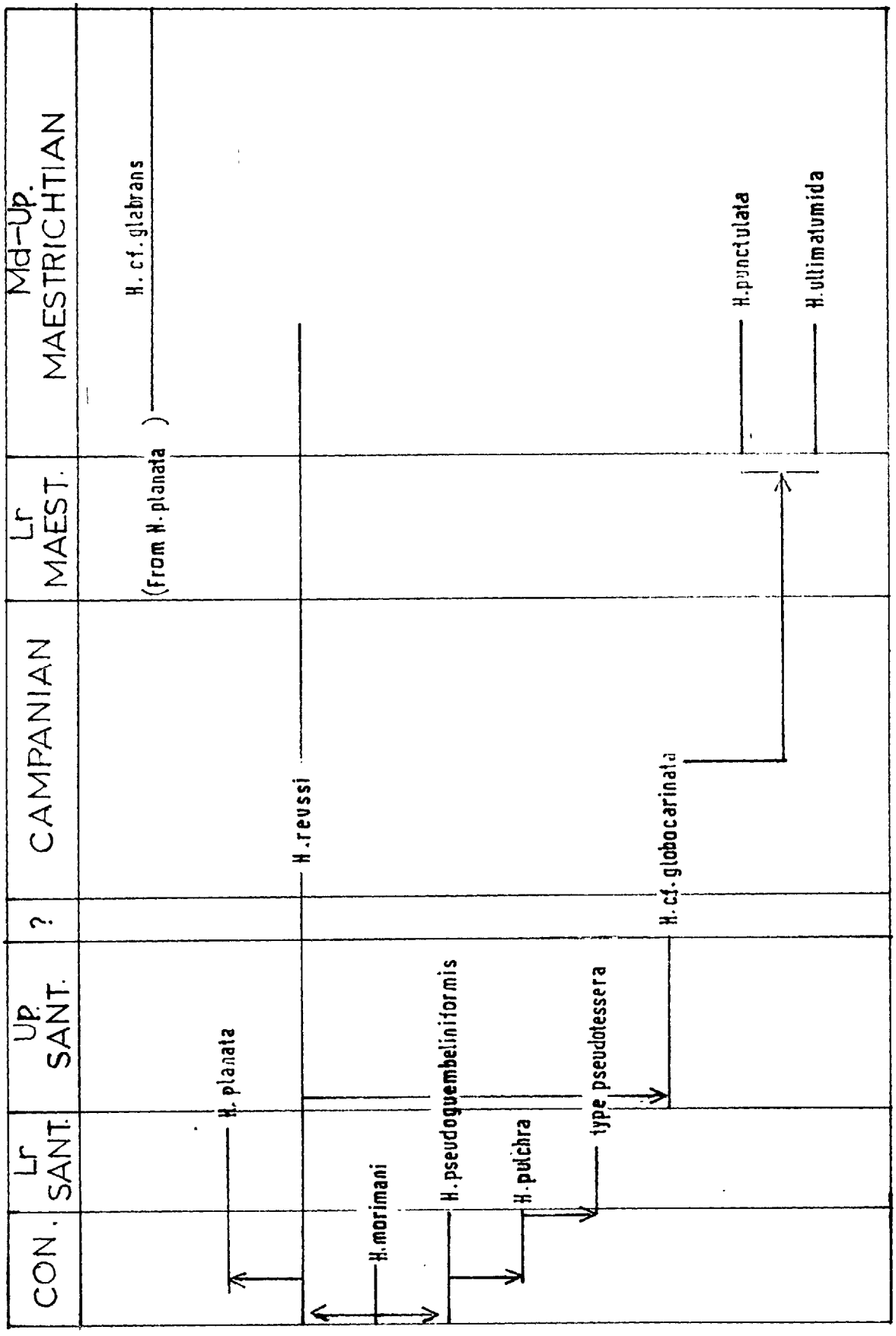


Fig.10 –Suggested phylogeny of some important species of Heterohelix in S. Iraq

Heterohelix nakkadyi sp.nov

pl.1, figs.7-8; pl.2, figs.1-3

Description. Test medium sized, biserial, moderately compressed, gradually expanding; periphery initially slightly and later strongly indented; axial periphery narrowly rounded; chambers initially planispiral, followed 4-5 pairs of biserially arranged, inflated and reniform chambers which increase slowly in size as added; ultimate and penultimate pairs of chambers nearly of the same size and shape, partially separated by narrow, deeply depressed median area; sutures straight to slightly curved and depressed, much deeper in the last portions; wall calcareous, densely perforate; peripheral margins coarsely and constantly striated; lateral surface only finely striated or with perforation arranged in longitudinal lines; aperture a high and narrow opening at the inner margin of the last chamber with prominent, well pronounced and thickened lips extending down to the penultimate chambers.

Remarks. Although the median line in its adult portion is deeply depressed giving the specimens a Gublerina-like appearance, the separation remains incomplete and the two chambers retain their direct connection.

H. nakkadyi sp.nov. is distinguished by its compressed test, early planispiral, later biserial chambers, a tendency to develop diverging adult chambers and its surface ornament.

It is morphologically similar both to Ventilabrella compressa Van der Slus (1950) and Gublerina cuvillieri Kikoine (1948). It is distinguished from both by its gradually tapering test, striated surface, early reniform later as wide as high chambers and by the absence of a true chamber divergence.

Occurrence. Rare in the Tanuma formation, abundant in the lowermost Sadi formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Heterohelix nuttalli (Voorwick)

pl.2, figs.4-9

1937 Guembelina nuttalli Voorwick. p.192, pl.2, figs.1-9
1966 Pseudotextularia nuttalli (Voorwick) Salaj and Samuel. p.232, tab.37, fig.10

Remarks. H. nuttalli was originally described by Voorwick (1937) from Habana, Cuba. He depicted nine poorly drawn specimens, but gave neither a definite type locality, type species nor the location of their depository. All his figures were drawn to show the marginal and lateral views and thus the apertural characters remain uncertain.

H. nuttalli differs both from Pseudotextularia elegans (Rzehak) and Pt. plummerae (Loetterle) in its smaller-sized test, the restriction of the compression of the chambers to one side only and the lack of the Pseudotextularia-type reniform chambers in peripheral view.

Occurrence. Rare in the lower part of Sadi formation. Sporadically found in the middle and upper parts of the Sadi formation, in the Hartha formation and the lower part of the Qurna formation. Upper part of the Globotruncana concavata subzone to Globotruncana gansseri zone.

Previous record of Occurrence. Salaj and Samuel (1966) record it from the Campanian-Maestrichtian rocks of West Carpatian, Slovakie.

Heterohelix planata (Cushman)

pl.3, figs.1,5

1938 Guembelina planata Cushman. p.12, figs. 13,14
1944 Guembelina planata Cushman. Cushman. p.10, pl.2, fig.20
1946 Guembelina planata Cushman. Cushman. p.105, pl.45, figs.6-7
1954 Guembelina planata Cushman. Frizzell. p.109, pl.15, figs.32a-b
?1960 Heterohelix pulchra (Brotzen) Olsson. p.27, pl.4, fig.6

1962 Heterohelix pulchra (Brotzen) Pessagno. p.358, pl.1, fig.3
1967 Heterohelix planata (Cushman) Bandy. p.23, tf.11(12), fig.8
1967 Heterohelix planata (Cushman) Pessagno. p.261, pl.86, figs.3,4, pl.89, figs.6,7

Remarks. The supplementary apertures which are clearly observable in most specimens of H. planata are not covered by apertural flaps, and the species does not belong in Pseudoguembelina. H. planata (Cushman) is morphologically similar to Pseudoguembelina costulata (Cushman), Ps. palpebra Bronnimann and Brown and Ps. excolata (Cushman). It differs by its finely striated surface, more compressed test and in lacking the prominent apertural flaps covering the accessory apertures. However, the morphological characters and stratigraphic distribution of these species suggest that H. planata might possibly have evolved into the above species of Pseudoguembelina. On the other hand, H. planata is believed to have evolved from H. reussi (Cushman) by the development of a compressed test with chambers wider than high, further increase in the surface ornamentation and the development of rudimentary apertural flaps.

Occurrence. Abundant in the Khasib, Tanuma and lowermost Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone to Globotruncana concavata subzone.

Previous record of Occurrence: Texas, Lower Campanian; Gulf Coast, Upper Campanian.

Heterohelix pseudoguembeliniformis sp.nov.

pl.3, figs.2-4

1967 Heterohelix sp. cf. Heterohelix moremani (Cushman) Pessagno pl.48, figs.7-8 (not fig.9)

Description. Test small, biserial, moderately compressed, about as long as broad, rapidly tapering, maximum breadth at the last pair of chambers; median axis not straight; periphery indented throughout; axial periphery

rounded; chambers initially planispiral, followed by 6 pairs of inflated wider than high chambers which increase rapidly in size as added; sutures strongly depressed, staight oblique; wall calcareous, perforate; surface smooth; aperture a low arch on the inner margin of the last chamber bor bordered by well developed apertural flap.

Remarks. H. pseudoguembeliniformis sp.nov. is morphologically similar to H. pulchra (Brotzen), but differs in having a lesser compressed and thicker test, inflated, non-reniform chambers and straight, oblique sutures. It differs from H. moremani (Cushman) in its smaller size, sutural characters, arrangement and shape of chambers which increase regularly in size and in the possession of an apertural flap.

The small specimens described by Pessagno (1967, pl.48, figs.7-8) as having low arched apertures, probably belong in the present species. They have inflated, wider than high chambers, straight oblique sutures and low apertures with flap-like extentions.

H. pseudoguembeliniformis may represent the transitional stage through which H. pulchra evolved from H. moremani.

Occurrence. Abundant in the Khasib and Tanuma formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Heterohelix pulchra (Brotzen)

pl.3, figs.6-9; pl.4, figs.1-4

1936	Guembelina pulchra	Brotzen. p.121, pl.9, figs.2a-3b
1956	Guembelina pulchra	Brotzen. Hofker. p.77, pl.9, fig.69
1957	Heterohelix pulchra (Brotzen)	M.Gallitelli. p.134, pl.31, fig.20
1960 Not	Heterohelix pulchra (Brotzen)	Olsson. p.27, pl.4, fig.6
1964 ?	Heterohelix pulchra (Brotzen)	Martin. p.85, pl.11, fig.2
1965	Heterohelix pulchra (Brotzen)	Takayanagi. p.197, pl.20, figs.3a-b and synonymy.
1965	Heterohelix cf. planata (Cushman)	Takayanagi. p.197, pl.20, fig.2
1965	Heterohelix pulchra (Brotzen)	Perlmutter & Todd. p.114(no fig)
1966	Heterohelix pulchra (Brotzen)	Ansary and Tewfik. p.40, pl.3, figs.8a-b

1967 Heterohelix pulchra (Brotzen) Bandy. p.23, tf.12, fig.7
1967 Heterohelix pulchra (Brotzen) Pessagno. p.262, pl.87, fig.4
1969 Heterohelix pulchra (Brotzen) Douglas. p.158, pl.11, figs.3,14

Description. Test small to medium sized, moderately to strongly compressed, one and half time as long as broad, rapidly tapering; maximum breadth at the last pair of chambers; median line usually zigzag and deeply depressed; periphery lobate throughout; axial periphery rounded; chambers in 5-6 pairs, reniform, regularly inflated, wider than high, increasing in width towards the upertural end, the last pair of chambers 3-3½ times wider than high, constricted near the aperture; sutures slightly curved, depressed in the early part, curved and strongly depressed in the last growth stages; wall calcareous, perforate; surface smooth; aperture a high arch on the inner margin of the last chamber.

Main Variation:

1. Test moderately to strongly compressed, one and half times as long as broad.
2. Periphery either moderately, slightly or non-lobate, axial periphery either broadly, narrowly or acutely rounded.
3. Median line can be slightly, moderately or strongly depressed and, in rare cases show a Gublerina-like appearance.
4. Chambers in 6-8 pairs, reniform to roughly rectangular and inflated, 1½-2 times as wide as high, increasing rather rapidly to very rapidly in size, either biserially arranged throughout or the last one or two pairs of chambers show a Ventilabrella-like appearance.
5. In well developed specimens, the later chambers usually are distinctly set apart by large, depressed, triangular areas and in some rare cases the chambers show flap-like

projections to cover these triangular depressions.

Remarks. The constant characters of this species are; the reniform wider than high and inflated chambers; compressed test; depressed sutures; margins indented throughout; high arched aperture and smooth surface.

H. pulchra was first described by Brotzen (1936) as Guembelina pulchra, from the lowermost Senonian of Eriksdel, Sweden. He (Ibid) clearly illustrated both the regularly arranged biserial chambers and the Gublerina-like appearance of the last one or two pairs in the microspheric forms. So far, no subsequent authors have recorded forms showing such a peculiar Gublerina-like character.

Takayanagi (1965 p.197) was the first to realize that such a tendency can be used for phylogenetic purposes and he stated "this species appears to be close to Gublerina in morphological characters ..... further research on its variation may furnish a key to the genetical interrelationship between Heterohelix and Gublerina".

Following Takayanagi, Pessagno (1967 p.262) assigned this microspheric H. pulchra form to the genus Planoglobulina Cushman without further comment.

In southern Iraq, rare specimens shwoing proliferation of three reniform chambers at the final stage were found, and considered abnormal growths of H. pulchra (Brotzen).

Cushman (1938) noted small, depressed, triangular areas between the chambers of H. reussi, H. planata and Guembelina pseudotessera = H. pulchra. He (Ibid) also mentioned the presence of lateral flanges in the latter two species which run out onto the preceding chambers in H. planata, and are restricted to the aperture in the G. pseudotessera.

Bronnimann and Brown (1953) interpreted these triangular areas as the flaps covering accessory apertures. Pessagno (1967) rejected this interpretation.

In the section under study, forms with triangular, depressed areas, flap-like projections and a strongly deepened Gublerina-like median line were found and considered different transitional stages in H. pulchra's development but still within the limits of the genus Heterohelix.

Recently Noel, K. Brown (1969) in a "Heterohelicidae Cushman 1927, Amended" removed many of the ambiguities regarding the above features. He came to the conclusion that, "the depressed areas are merely the imperforate flaps of the primary apertures extending down both its sides. Later, in Campanian time in a descendant H. pseudotessera (Cushman), the flaps become relatively enlarged and elongated forming depressed panels or gussets". He added, "by tension at the front on faces of the primary chambers a divergent biserial arrangement of primary chambers is produced".

H. pulchra differs from H. planata (Cushman) in its well developed, reniform, much wider than high chambers and smooth test.

The form described by Stenestad (1969) as H. dentata n.sp. is probably a synonym of H. pulchra. It was said to differ from the latter species in the less compressed nature of its test, the shape of its early and late chambers, the slightly keeled to almost straight initial margins and in its surface ornamentation.

The writer considers that the degree of compression has neither specific nor taxonomic importance. The initial coiling is induced by physical rather than genetic factors, thus certain species of Heterohelix and Pseudotextularia may or may not have initial coils (see also Hofker

1957. Noel, K. Brown 1967). For this reason Guembelina Cushman is considered a junior synonym of Heterohelix. Furthermore, in some varieties of H. pulchra it is almost usual to find tests showing the last one or two pairs of chambers lying over each other and inclined to the direction of the biseriality, giving the test margins a serrate or (as used by Stenestad) dentate appearance. Such aberrant forms are at their extreme limit of variability and occur in various Heterohelix species.

In spite of the fact that the keel is not a stable character in H. pulchra and the surface ornamentation considered in isolation is not enough for the specific separation, the figured holotype of H. dentata Stenestad lacks surface markings and its sides are clearly indented throughout.

The specimen described by Olsson (1960) as H. pulchra has a striate surface, lacks the characteristic reniform chambers and belong in H. planata (Cushman). The specimen figured by Pessagno (1962) may belong in a different species.

Forms described by Cushman (1932), Jenning (1936) and Loetterle (1937) as Guembelina tessera (Ehrenberg) and by Cushman (1938, 1944, 1946). Schijfsma (1946), Hamilton (1953), Frizzell (1954) and Bolin (1956) as Guembelina pseudotessara Cushman belong in H. pulchra (Brotzen).

Heterohelix pulchra--form pseudotessara (= Guembelina pseudotessera Cushman) appears to be the sole descendent, so far known, of H. pulchra (Brotzen) formatypica, which seems to have been developed from the H. washitensis -- H. moremani lineage through H. pseudoguembeliniformis ancestor.

Occurrence. Abundant in the Khasib, Tanuma formations, Globotruncana

renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence: Gulf Coast and Western Interior of United States, Coniacian - Maestrichtian. Southern Limburg, Campanian. Italy, Campanian - Maestrichtian. France, Maestrichtian. Sweden, Coniacian - Santonian. Denmark, Upper Maestrichtian. Mid-Pacific, Coniacian - Maestrichtian. Puerto Rico, Santonian - Maestrichtian. Mexico, Campanian - Maestrichtian.. U.A.R., Maestrichtian.

Heterohelix punctulata (Cushman)

pl.4, fig.5

1938 Guembelina punctulata Cushman. p.13, pl.2, figs.15,16
1966 Heterohelix punctulata (Cushman) Ansary and Tewfic. p.40, pl.3 figs.6a-b
1967 Heterohelix punctulata (Cushman) Pessagno. pp.262-263, pl.86, figs.7-10 and synonym
1967 Heterohelix punctulata (Cushman) Bandy. p.24, t.f.12(4)

Remarks. Heterohelix punctulata was first described by Cushman (1938) from the Taylor marl of Texas as Guembelina punctulata. He mentions in his description, "aperture a low, broad, arch with a slight lip; the sides continuing in a flange on to the preceding chambers".

The species was placed in Pseudoguembelina by Bronnimann and Brown (1953, p.154) owing to its supposed frequent possession of sutural supplementary apertures, inspite of their statement "in our specimens .... the flaps which shield the accessory apertures are damaged, or developed only as delicate arched rims".

Judging from their depicted holotype and the description given, the so called "flaps" are slightly thickened rims and they do not represent the true, elongated tube-like projection to cover the supplementary apertures. To correct their error, they later added, "Cushman (1938) stated 'aperture a broad, low arch with a slight lip, the sides continuing

in a flange onto the preceding chambers'. This flange probably represents a flap of an accessory aperture".

However, no true apertural flaps were observed in H. punctulata (see also the synonymy in the Catalogue of Index Smaller Foraminifera, 1969, part 1.). In addition, accessory apertures were occassionally found in some other species of Heterohelix, such as H. striata (Ehrenberg), H. planata (Cushman), H. pulchra (Brotzen) etc., (see also Pessagno 1967, p.262). Finally, as stated by Gallitelli (1957) "It is restricted to include only these forms with strong modification in the shape of the terminal basal part of the chambers and of the apertures ...", and amended by Pessagno (Ibid), "it is only the possession of such distinctive apertural flaps that separate Pseudoguembelina from Heterohelix.

In southern Iraq, the majority of the specimens were found poorly preserved but two specimens found possess supplementary apertures, each with a single opening.

Occurrence. Rare in the lower part of the Qurna formation. Globotruncana gansseri zone.

Previous record of Occurrence: Texas, Campanian - Maestrichtian. Cuba, Late Maestrichtian. Puerto Rico, Campanian - Maestrichtian. Mexico, Campanian - Maestrichtian. U.A.R., Campanian - Maestrichtian.

Heterohelix reussi (Cushman)

pl.4, figs.6-9; pl.5, fig.1

1938		Guembelina reussi Cushman.	p.11, pl.2, figs.6a-b, 7-8, 9a-b
1946		Guembelina reussi Cushman.	Cushman pl06, pl.44, figs.18a-b, 19
1956	Not	Guembelina reussi Cushman.	Said and Kenawy. p.139, pl.3, figs.32a-b
1966		Heterohelix reussi (Cushman)	Ansary and Tewfik. pp.40,41, figs.3, 5a-b
1967		Heterohelix reussi (Cushman)	Bandy. p.22,23 fig.12(2)
1967		Heterohelix reussi (Cushman)	Pessagno. p.263, pl.85, figs.1-9, pl.86, figs.1-2

Remarks. H. reussi is distinguished by its slightly compressed chambers, the presence of triangular depressions between the adult chambers and its finely striated surface.

It was first described by Cushman (1938) from the lower Austin Chalk, Texas and the Planer marl, Bohemia. He stated that its surface is smooth and finely perforate, but Pessagno (1967) who examined the holotype and paratypes, demonstrated the presence of fine costae.

In southern Iraq, as in Texas, Arkansas and Mexico (Pessagno (op.cit.)), H. reussi possesses fine costae wherever it has been observed in the Zubair and Rumaila fields, except in places where preservation was poor. Only this character differentiates this species from H. striata (Ehrenberg). (See also under H. moremani and H. striata.)

Heterohelix reussi (Cushman) may represent the basic stock from which H. planata (Cushman), H. ultimatumida (White) and H. globocarinata (Cushman) evolved. It is believed to have arisen from H. moremani stock.

Occurrence. Abundant in the Khasib and Tanuma formations, the lower part of Sadi and lowermost part of Qurna formations. Rare in the upper part of the Sadi and Hartha formations.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri zone.

Previous records of Occurrence: All reliable records from Texas, Arkansas, Mississippi, Bohemia, Mexico and Egypt show that H. reussi ranges from Turonian to Maestrichtian.

Heterohelix robusta Stenestad

pl.5, fig.2

1967 Pseudoguembelina palpebra Bronnimann and Brown. Pessagno. p.267, pl.89, figs.3-4 (not pl.78, figs.1-3)

1967 Pseudoguembelina sp. aff.P. palpebra Bronnimann and Brown. Pessagno. Ibid., figs.5,12-14

1967 Heterohelix robusta Stenestad. pp.658-659, t.f.13a-c, pl.1, fig.17, pl.2, fig.3

Remarks. A few biserial, thick specimens with early slightly and later moderately, depressed sutures, large, globular chambers increasing rapidly in size and coarse longitudinal coastae are here assigned to H. robusta Stenestad. These specimens differ from the holotype only in their small size.

Pessagno (1967) described as Ps. palpebra and Ps. sp. aff. P. palpebra (see synonomy) forms which most probably belong in this species. They show no trace of supplementary apertures or apertural flaps, but have large, globular chambers which increase rapidly in size as added and coarse, longitudinal costae.

Heterohelix robusta Stenestad originally was described from the Upper Campanian and lowermost Maestrichtian of the white chalk of the Danish Embayment.

Occurrence. Rare in the Khasib, Tanuma and lower part of Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Heterohelix ? semicostata (Cushman)

pl.5, fig.3

1938 Guembelina semicostata Cushman. p.16, pl.3, fig.6

1946 Guembelina semicostata Cushman. Cushman. p.107, pl.46, figs.1a-b

1967 Heterohelix semicostata (Cushman) Pessagno. p.263, pl.98, fig.21

1968 Heterohelix sp. cf. H. semicostata (Cushman) Rasheed and Govindan. p.80, pl.8, figs. 10-11

Remarks and Occurrence. Heterohelix semicostata (Cushman) easily is distinguished by its compressed test, widely spaced, strongly limbate

sutures, well developed curved costae at the peripheral margins and smooth or finely costate lateral parts. However, the present forms show no trace of a peripheral keel in their early growth stages. The septal character on the median line link this species with those of Gublerina.

H. ? semicostata was first described by Cushman (1938) from the Upper part of the Taylor marl. Pessagno (1967) recorded it from the Mendez shale of Mexico and the Neylandville marl. Rasheed and Govindan (1968) have it from the Virdhachalma of south India.

In southern Iraq, it occurs rarely in the Khasib, Tanuma and lower part of Sadi formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Heterohelix ultimatumida (White)

pl.5,ffigs.8,10; pl.6, figs.2-3

1929	Guembelina ultimatumida	White.	p.39, pl.4, figs.13a-b
1938 Not	Guembelina ultimatumida	White.	Cushman. p.13, figs.17-18
1953 ?	Guembelina ultimatumida	White.	Hamilton. p.235, pl.31, figs.1-4
1962	Heterohelix ultimatumida	(White)	Petri. pp.89-90, pl.11, figs.3,4,?5 (not figs.6,7,8)
1963	Heterohelix ultimatumida	(White)	Kavary and Frizzell. pp.62-63, pl.13, fig.3
1966	Heterohelix ultimatumida	(White)	Ansary and Tewfik. pl.3, figs.1a-b
1966	Heterohelix ultimatumida	(White)	Salaj and Samuel. p.225, tab.37, fig.19
1967	Heterohelix ultimatumida	(White)	Pessagno. p.264 (no figure) and synonym.

Remarks. H. ultimatumida (White) differs from H. striata (Ehrenberg) in the greatly inflated and globular nature of the last one or two pairs of chambers; and from H. striata form globulosa (= H. striata) in having faint but well developed striae.

The morphologically similar H. cf. globocarinata (Cushman) is distinguished from H. ultimatumida by its compressed, initial portion, compressed and wider than high chambers and in its larger and relatively

higher apertural opening. On the other hand H. trinidadensis (Cushman and Renz) described from the Eocene of Trinidad was said to have a laterally compressed, small test, straight sutures, smooth or slightly hispid surface and high, narrow apertural opening.

The writer agrees with Pessagno (1967) in considering H. ultimatumida (White) of Cushman (1946, pl.46, figs.6a-b, 7) belongs in another species, but not in Pseudoguembelina palpebra Bronnimann and Brown.

The specimen described by Pessagno (1962) as H. ultimatumida has a broader than long test and larger, higher apertural opening, It probably belongs in H. striata var. aegyptica Ansary and Tewfik (1966).

Occurrence. Rare in the lower part of the Qurna formation. Globotruncana gansseri zone.

Previous record of Occurrence: According to the above references, H. ultimatumida is restricted to the Campanian - Maestrichtian beds of U.S.A, South America, Caribbean, Europe (West Carpathian), U.A.R., Iran and the Mid. Pacific.

Heterohelix striata (Ehrenberg)

pl.5, figs.4-7,9

1840(a)	Textularia striata Ehrenberg.	p.135, pl.4, fig.1 alpha, 1 alpha prime, 2 alpha, 3 alpha
1840(b)	Textularia globulosa Ehrenberg.	p.135, pl.4, figs.2 beta, 4 beta, 5 beta, 7 beta, 8 beta.
1899(1900)	?Guembelina striata (Ehrenberg)	Egger. p.33, pl.14, figs.5-7, 10-11, 37-39
1935	Guembelina striata (Ehrenberg)	Jedlitschka. p.42, fig.11,12 (not figs.13,14,17)
1936 Not	Guembelina striata (Ehrenberg)	Cushman. p.418, pl.1, fig.11a-b
1937	Guembelina striata (Ehrenberg)	Kalinin . pp.37-38, pl.4, fig.56
1937 Not	Guembelina striata (Ehrenberg)	Voorwijk. p.194, pl.1, fig.9-10
1941	Guembelina globulosa var. striatula Marie.	p.182f, pl.28, figs. 273a,b,c, 274a,b, 275a,b
1944 Not	Guembelina striata (Ehrenberg)	Cushman. p.91, pl.14, fig.4
1946 Not	Guembelina striata (Ehrenberg)	Cushman. p.7, pl.3, fig.24
1953 Not	Guembelina striata (Ehrenberg)	LeRoy. p.34, pl.5, figs.13,14 pl.6, figs.6-7

1953 Pseudoguembelina striata (Ehrenberg) Bronnimann and Brown. p.154, t.f.6
1956 Not Pseudoguembelina striata (Ehrenberg) Said and Kenawy. p.139, pl.3, fig.37
1957 Pseudoguembelina striata (Ehrenberg) Said and Barakat. p.77, pl.1, figs.17a-b
1958 Guembelina striata (Ehrenberg) Ansary and Fakhr . pp.122-123, pl.1, figs.24a-b
1959 Guembelina striata (Ehrenberg) Hofker. p.95, t.f.8
1959 Heterohelix striata (Ehrenberg) Olvera. p.71-72, pl.2, figs.4,8
1960 ? Pseudoguembelina striata (Ehrenberg) Belford. pp.60-61, pl.15, figs. 12,13
1960 Guembelina striata (Ehrenberg) Tollman. p.181, pl.18, figs.2,3
1961 Guembelina striata (Ehrenberg) Hofker. pp.570-571, t.f.58,59
1962 Guembelina striata (Ehrenberg) Haake. p.46, pl.4, fig.14
1962 Guembelina striata (Ehrenberg) Hofker. p.1063, t.f.8c, p.1067, t.f.12c
1962 Not Guembelina striata (Ehrenberg) Pessagno. p.358, pl.1, fig.5
1962 Heterohelix striata (Ehrenberg) Skinner. p.39, pl.5, fig.10
1962 Heterohelix navarroensis Leoblich. Pessagno. p.358, pl.1, fig.4
1964 Pseudoguembelina striata (Ehrenberg) Said and Sabry. p.394, pl.3, fig.21
1965 Heterohelix striata (Ehrenberg) Takayanagi. pp.198-199, pl.20, figs.4a-b (including additional synonymy in T. striata, Guembelina striata and H.striata)
1965 Heterohelix globulosa (Ehrenberg) Takayanagi. Ibid. figs.1a-b, (and synonymy)
1966 Heterohelix striata (Ehrenberg) Ansary and Tewfik. p.41, pl.3, figs. 3a-b
1967 Heterohelix striata (Ehrenberg) Pessagno. p.264, pl.78, figs.4-5, pl.88, figs.3-7
1969 Heterohelix striata (Ehrenberg) Douglas. pp.159-160, pl.11, figs.4,7-8
1969 Heterohelix striata (Ehrenberg) Funnell, Friend and Ramsay. p.21, pl.1, figs.3,4, t.f.2a-b
1969 Heterohelix striata (Ehrenberg) Stenestad. pp.653-654, pl.1, fig.4, pl.2, figs.1,1a,1b, t.f.1a-c
1967 Heterohelix globulosa (Ehrenberg) Douglas. pp.157-158, pl.11, figs.12a-b

Description. Test small to medium sized, one and a half times as long as broad, expanding moderately; maximum breadth at the last pair of chambers; median line straight to slightly bent; periphery moderately indented throughout; axial periphery broadly rounded; chambers in 6 pairs, early small, subglobular, later increasingly inflated; sutures deeply depressed, almost straight; wall calcareous, perforate; surface

ornamented by well developed, fine and curved striae; aperture a lunate opening on the inner margin of the last chamber.

Main variation

1. Test small to large, increasing slowly to rather rapidly in width, $1\frac{1}{4}$ - $2\frac{1}{4}$ times as long as wide.
2. Periphery either slightly or moderately lobate.
3. Median line straight or curved, slightly or moderately deepened.
4. Chambers in 6-9 pairs, either globular throughout or early subglobular and later globular. The ultimate pair of chambers is either well developed and constitutes $\frac{1}{4}$ - $\frac{1}{2}$ of the test size or reduced to equal to or smaller than the penultimate pairs.
5. Megalospheric forms have a large proloculus, small test and maximum of 4 chambers in the adult test.
6. Sutures either straight or slightly curved but always deeply depressed.
7. The striation of the surface either moderate, fine or very delicate and sometimes thickened giving to the test a Pseudoguembelina costulata - like appearance. Ornamentation confined to the early part of the test or throughout and sometimes the ultimate pair of chambers is exceptionally smooth.

Remarks. Heterohelix striata was first described by Ehrenberg (1840) as Textularia striata. His type specimens came from four different geographical locations in the Northern hemisphere;

1. Puszkary Grodno gegenuber, am ufer der Memel, in Poland (Figures 1 alpha, 1 alpha prime).

2. Jutland in Denmark (Fig.2 alpha)

3. Insel Rugen in Pommern, Germany (Fig.3 alpha)

4. Gebirgsmasse Van Hamam Farun, in Sinaitischen, Arabia, (Fig.9 alpha)

Neither the type locality nor the type specimen were designated. Pessagno (1967) selected Fig.2 alpha and the corresponding specimen as lectotype figure, and lectotype specimen of Textularia striata Ehrenberg respectively, and figs.1alpha, 1alpha prime, 3alpha and their corresponding specimens as paralectotypes. Thus Jutland, Denmark automatically becomes the type locality.

Pessagno (op.cit.) regarded the specimens figured by Berggren (1962, figures 1a-5b) from the Kjolby Gaard marl, Jutland, Denmark as topotypes of H. striata (Ehrenberg). Thus the Kjolby Gaard is the type lithic unit.

Ehrenberg (1854 1856) and his followers Tutkovskiy (1887, 1925) and Yakovlev (1891), despite his own description of the genera Heterohelix (1843) and Spiroplecta (1844) continued placing this species in Textularia d'Orbigny.

Ehrenberg's T. striata is much closer to H. americana than to any other species. Both show similar chambers and sutural characters, and parallel striation perpendicular to the septa. The only noticeable difference is the lack of early coiling in T. striata. However, the early coiling is itself not sufficient for specific descrimination. Moreover, even amongst individuals of the same species, specimens both with early coiling and lacking it are present.

The form figured by Yakovlev (1891) as T. striata belongs in H. striata.

Egger (1899(1900)) described Gumbelina as a new genus to include T. striata Ehrenberg, but later M. Gallitelli (1957) affirmed the synonymity of Gumbelina with Heterohelix. As Heterohelix has periority over Guembelina she retained the former (in opposition to Hofker (1957), who considered Heterohelix the junior synonym). In fact, the name Guembelina Egger was itself found a junior homonym of Guembelina Kuntz (1895) and thus doubly invalidated. (Loeblich and Tappan (1961).)

Forms figured by Egger (Ibid) as G. striata have widely spread, thickened and less massive striae and are probably transitional from Pseudoguembelina costulata (Cushman) to Ps. excolata (Cushman). They are here questionably assigned to H. striata (Ehrenberg).

Ehrenberg (1840) described as Textularia globulosa, five other specimens similar to H. striata, again neither the type locality nor the type specimen was designated. His specimens came from five different geographical locations; Denmark, Poland, England, France and Egypt. Judging from the description and figures (pl.4, figs.2B, 4B, 5B, 7B, 8B) the only noticeable difference between H. striata and this species is in the lack of surface ornamentation of the latter.

The presence of ornament in H. globulosa was later announced by McGugan (1964) who found some of the H. globulosa specimens to have traces of longitudinally arranged costae or lineation.

Takayanagi (1960, 1965) found the same features on the wall of specimens of H. globulosa from Hokkaido and California. Berggren (1962) reported specimens of H. striata from Jutland, Denmark with moderately developed striae as well as specimens with no apparent striae. Pessagno (1967) confirmed the presence of striae on the early part of the test of H. globulosa from Arkansas, Texas and Mexico.

However, none of those authors attempted to demonstrate the synonymity of the two species.

Noel K. Brown (1967) stated, "Any ornamentation, fine or coarse, exhibited on the Heterohelicid test is herein referred to as striae". This means that any specimen of Heterohelix of H. globulosa - type with either fine or coarse striate ornamentation is H. striata. Moreover, specimens showing different strengths of striation were illustrated under H. striata in the "Catalogue of Index Smaller Foraminifera, Part 1, Ellis, Messina .. et.al (1969)".

Stenestad (1967) in "The Genus Heterohelix Ehrenberg (1843)" found very few Danish specimens of Heterohelix completely smooth. He stated, "The Danish specimens called H. globulosa are actually faintly and indistinctly striate specimens of H. striata ...." He (Ibid) also examined a few hypotypes of H. globulosa from the Kemp clay, Texas and found that they all are slightly striate.

However, the morphological similarity and the stratigraphic ranges of these two species throughout the stratigraphic sequences of southern Iraq strongly suggest their synonymity. If entirely smooth forms are actually present in sequences younger than the early Coniacian they most probably represent the primitive stages in the lineage leading to H. striata.

One the other hand this writer, so far favours the view put forward by Noel K. Brown (op.cit) "intensification of stria on the whole is an evolutionary trend in the Heterohelicidae family", but finds in practice that variations in environment during life and secondary changes on fossilisation (i.e. dolomitization, etc.) so modify surface ornament that it loses much of its taxonomic and stratigraphic importance.

Cushman (1936, 1944), Voorwijk (1937) and LeRoy (1953) described as Guembelina striata Ehrenberg forms which are actually Pseudotextularia elegans (Rzehak). Germeraad (1946) and Pessagno (1962) figured as G. striata forms which probably belong in H. punctulata (Cushman). The form figured by Said and Kenawy (1956) as Pseudoguembelina striata (Ehrenberg) belongs in a different species.

Nakkady (1949, 1950) recorded the occurrence of G. striata (Ehrenberg), G. striata var. compressa n.var. Nakkady and G. globulosa (Ehrenberg) from the Maestrichtian - Danian succession of six widely separated sections in Egypt. The examination of these specimens in the British Museum of Natural History, London, showed that;;

1. The slide labeled G. striata (Ehrenberg) contains 15 specimens of Heterohelicidae belonging in 4 different species; H. striata (Ehrenberg), H. ultimatumida (White), Ps. excolata (Cushman) and Ps. palpebra Bronnimann and Brown.

2. The slide labeled G. striata var. compressa n.var. contains 16 specimens belonging in 6 different species; H. striata (Ehrenberg), H. ultimatumida (White), Ps. excolata (Cushman), Ps. costulata (Cushman), Ps. palpebra Bronnimann and Brown and Pt. elegans (Rzehak).

3. The slide labeled G. globulosa (Ehrenberg) contains 20 specimens belonging in 2 different species; H. striata (Ehrenberg), with faint surface striation and H. reussi (Cushman) with pronounced triangular openings between the adult chambers.

Occurrence. Abundant in the Khasib and Tanuma formations and the lower half of the Sadi formation. Rare in the Hartha, Qurna and Tayarat formations, and the upper half of the Sadi formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri

zone.

Previous records of Occurrence: According to the above references, H. striata ranges from Campanian to Maestrichtian in various parts of Europe, North America, the Caribbean region, the West Indies, Australia, Asia, North Africa; from Santonian to Maestrichtian in the U.S.S.R., Denmark, Iran; from Coniacian to Maestrichtian in the Gulf Coast and the Western interior region, the U.S.A., Egypt; from Turonian to Maestrichtian in California; and from the Cenomanian of Egypt and the (Tertiary?) of Moravea of Czechoslovakia.

Genus Gublerina Kikoine 1948

Type species Gublerina cuvillieri Kikoine 1948

Gublerina cuvillieri Kikoine

pl.6, fig.8; pl.27, fig.9

1948 Gublerina cuvillieri Kikoine, p.26, pl.2, figs. 10a-c
1953 Gublerina cuvillieri Kikoine. deKlasz. p.246, pl.8, figs.1a-b
1953 Gublerina aff. cuvillieri Kikoine. deKlasz. Ibid. p.248, footnote 1, pl.8, figs.2a-b
1955 Gublerina cuvillieri Kikoine. Bettenstaedt and Whicher. p.502, pl.2, fig.15
1957 Gublerina ornatissima (Cushman and Church) Gallitelli. p.140, pl.32, fig.6 (not figs.1-5)
1963 Gublerina ornatissima (Cushman and Church) Bronnimann and Rigassi. p.17, fig.4
1966 Gublerina cuvillieri Kikoine. Wille-Janoschek. p.117, t.f.8, fig.11

Remarks Gublerina cuvillieri was first described by Kikoine (1948) from the Maestrichtian of the French Pyrenees.

Kikoine's figured holotype, analysis of all other figured and described hypotypes and the samples here studied show the main diagnostic characters of this species to be;

1. Chamber divergence starting in the early portion of the test.
2. Proliferation of chambers (if present) occurring between divergent

chambers and sometimes extending up to the top pair (not starting from the top pair).

3. Reniform shape of biserial chambers.

4. The non-septate median portion compressed below the level of the lateral surfaces of the biserial chambers.

Occurrence. Rare in the Qurna formation. Globotruncana gansseri zone.

Previous records of Occurrence. Maestrichtian of Austria, Bavaria, northwestern Germany, France and Cuba.

Gublerina glaessneri Bronnimann and Brown

pl.6, fig.6

1953 Gublerina glaessneri n.sp. Bronnimann and Brown. pp.155-156 t.f. 13-14

1957 Gublerina glaessneri Bronnimann and Brown. M.Gallitelli. p.141 pl.32, fig.7

1967 Gublerina glaessneri Bronnimann and Brown. Pessagno. p.265 (no figure)

Remarks. A single specimen showing compressed, early closely appressed and later diverging chambers is assigned to Gb. glaessneri Bronnimann and Brown. The outline is sharply lobate, and six pairs of subrectangular, reniform, angled, biserial chambers enclose chambers which are compressed below the level of those outside. The sutures are thick and limbate; the aperture is not seen. The uniserially arranged median chambers are different from those of the holotype but simila to that of the figured paratype. A similar Gublerina was also figured by M. Gallitelli (1957).

Gb. glaessneri was first described by Bronnimann and Brown (1953) from the Maestrichtian of Cuba, together with Gb. hedbergi n.sp. They later (1954) suggested that the latter species is a junior synonymy of Gb. acuta rubosta deKlasz (1953).

Occurrence. Lower part of the Sadi formation. Globotruncana concavata subzone.

Previous record of Occurrence. Originally described from the Maestrichtian of Cuba. Elsewhere, this epcies has only been found in the Gulf Coast area at the type locality of the Mendez shale (Maestrichtian).

Gublerina ? reniformis (Marie)

pl.6, fig.7

1941 Ventilabrella reniformis Marie. p.185, fig.277a-b

Remarks. A single specimen referable to this species is characterized by its small, rapid expanding and triangular test; early entire and later very slightly lobate sides; rapidly increasing chambers which become reniform and diverge into two series with a simple proliferation tendency in the adult stages. The test as a whole is laterally compressed but chambers individually retain their inflation. Two apertures were seen in top view, one on each side of the median extra chamber.

The present species differs from Marie's holotype in not having early diverging chambers.

Occurrence. In the lower part of the Tanuma formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

The species was originally described by Marie (1941) from the Senonian of the Paris Basin as Ventilabrella reniformis.

Gublerina sp.A

pl.6, fig.9; pl.7, fig.2.

Remarks. A single specimen of a species with a regularly tapering and laterally compressed test, lobulate periphery and biserially arranged,

slightly divergent and inflated chambers was found. One single chamber occupied the whole central space between the last two pairs of chambers and protrudes strongly on both sides of the test. The sutures are slightly curved, strongly oblique and depressed. The wall is calcareous and perforate. The peripheral margins are heavily striated, the lateral surfaces less strongly so and the last adult chambers are almost smooth.

The species differs from the similarly compressed Ventilabrella compressa Van der Slus (1950) from the Maestrichtian of eastern Seran, Indonesia, mainly in the lack of limbate sutures, in having the aberrant chamber not compressed below the level of the test and in possessing surface markings (striation). It differs from Gublerina ornatissima Takayanagi (1965) (not Cushman and Church 1929) from the Upper Coniacian - Campanian of the Puta Greek subsurface section, in the same characters. From Ventilabrella ornatissima Cushman and Church (1929, pl.39, fig.5 and paratypes) it differs in exhibiting inner protruded chambers and the absence of proliferation of chambers at the top of the test.

Occurrence. The species was found in the upper part of the Tanuma formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Genus Pseudoguembelina Bronnimann and Brown 1953

Type species Guembelina excolata Cushman 1926

Pseudoguembelina costulata (Cushman)

pl.7, fig.1; pl.8, figs.4-5

1938 Guembelina costulata Cushman. p.16, pl.3, figs.7-9
1937 Guembelina excolata Cushman. Voorwijk. p.194, pl.1, figs.7-8
1953 Guembelina costulata Cushman. Hamilton. p.234, pl.30, fig.12
1953 Pseudoguembelina costulata (Cushman) Bronnimann and Brown pp.153-154, tex.fig.5
1958 Pseudoguembelina excolata (Cushman) Ansary and Fakher. p.119, pl.1, fig.23
1959 Pseudoguembelina costulata (Cushman) Haque. pp.10-11 (no figure)

1964	Pseudoguembelina costulata (Cushman)	Said and Sabry. p.392, pl.3, fig.19
1965	Pseudoguembelina costulata (Cushman)	Perlmutter and Todd. p.114, pl.2, fig.14
1966	Pseudoguembelina costulata (Cushman)	Ansary and Tewfik. p.42, pl.3, figs.9a-b
1967	Pseudoguembelina costulata (Cushman)	Pessagno. p.266, pl.79, fig.1, pl.88, figs.8-9, pl.90, fig.3 and synonym
1967	Pseudoguembelina excolata costulata (Cushman)	Bandy. p.24, t.f.12(11)
1969	Pseudoguembelina costulata (Cushman)	Douglas. p.160, pl.11, fig.6
1969 ?	Pseudoguembelina costulata (Cushman)	Funnell, Friend and Ramsay. pl.1, figs.11-12, t.f.1 (not t.f.6)

Remarks. Pseudoguembelina costulata was first described by Cushman (1938) as Guembelina costulata. He redescribed this species in 1946 without further comment. Bronnimann and Brown (1953) described Pseudoguembelina as a new genas and distinguished it from the genus Guembelina Egger (see under H. striata) by its distinctive, supplementary apertures along the median line in the lobate stage, and to lesser extent, by the nature of its costae. They included in this genus four already described species of Guembelina, including G. costulata Cushman and the newly described Ps. palpebra Bronnimann and Brown.

In southern Iraq, Ps. costulata at its first appearance is distinguished from Ps. excolata (Cushman) in having a compressed test, both fine and massive costae and an early entire and later strongly lobated periphery. It differs from Ps. palpebra Bronnimann and Brown in having less inflated, slightly lobated or entire chambers in lateral view.

Pessagno (1967) distinguished Ps. costulata from Ps. excolata by its narrow outline and the possession of fine rather than coarse costae.

However, forms with coarse costae and a narrow or small, rapid

tapering, wide test and fine costae were found in this study.

The forms described by White (1929) and LeRoy (1953) as Guembelina excolata Cushman, and by Said and Kenawy (1956) as Ps. excolata (Cushman) are good examples.

The specimens described by Said and Sabry (1964) as Ps. excolata showing a compressed test, fine and massive costae are identical with Ps. costulata.

Occurrence. Abundant in the lower part of the Sadi, uppermost part of Hartha and the lower part of Qurna formations. Rare in the upper part of the Sadi, lower part of the Hartha and throughout the Tayarat formations. Globotruncana concavata subzone - Globotruncana gansseri zone.

Previous record of Occurrence. In the United States it is known from the Campanian of Texas, Mississippi, Alabama, Tennessee and the Campanian-Maestrichtian of southwestern Arkansas and California. In the Caribbean, it occurs in the Maestrichtian of Cuba and Campanian - Maestrichtian of Peurto Rico and Mexico. In Europe it is known from the Campanian - Maestrichtian of western Spain. Ps. costulata is also found in the Campanian - Maestrichtian of west Pakistan and the U.A.R.

Pseudoguembelina excolata (Cushman)

pl.8, figs.1

1926	Guembelina excolata Cushman.	p.20, pl.2, fig.9
1926	Textularia costata Carsey.	p.26, pl.1, fig.4
1931	Guembelina excolata Cushman.	Plummer. pp.176-177, pl.8, fig.10
1937 Not	Guembelina excolata Cushman.	Voorwijk. p.194, pl.1, figs.7-8
1938 ?	Guembelina excolata Cushman.	Cole. pl.3, fig.4
1938	Guembelina excolata Cushman.	Cushman. p.17, pl.3, fig.2
1941	Guembelina excolata Cushman.	Cushman and Hedberg. p.92, pl.46, fig.14
1947	Guembelina excolata Cushman.	Cushman and Renz. p.44, pl.11, figs.11-13

1953		Guembelina excolata Cushman.	LeRoy. p.34, pl.7, figs.24-25
1954		Guembelina excolata Cushman.	Frizzell. p.108, pl.15, fig.20
1956		Pseudoguembelina excolata (Cushman)	Said and Kenawy. p.139, pl.3, fig.36
1957	Not	Pseudoguembelina excolata (Cushman)	Gallitelli. pp.139-140, pl.31, fig.23
1958	Not	Pseudoguembelina excolata (Cushman)	Ansary and Fakher. pp.124-125. pl.1, figs.28a-b
1959	?	Pseudoguembelina excolata (Cushman)	Olvera. pp.75-76, pl.2, figs.2-3
1959		Pseudoguembelina excolata (Cushman)	Haque. pp.10-11 (no figure)
1960	Not	Pseudoguembelina excolata (Cushman)	Olsson. p.28, pl.4, fig.11
1964	Not	Pseudoguembelina excolata (Cushman)	Loeblich and Tappan. p.656C, fig.525,5,6
1966		Pseudoguembelina excolata (Cushman)	Ansary and Tewfik. p.42, pl.3, figs.10a-b
1967		Pseudoguembelina excolata excolata (Cushman)	Bandy. t.f.12 (10,not 11)
1967		Pseudoguembelina excolata (Cushman)	Pessagno. pp.266-267, pl.68, figs.4-5 (not pl.90, fig.5) and synonym.
1969		Pseudoguembelina excolata (Cushman)	Funnell, Friend and Ramsay, pl.2, figs.1,2, t.f.7

Remarks. Pseudoguembelina excolata was first described by Cushman (1926) as Guembelina excolata from the Upper Cretaceous of San Luis Potosi, Mexico. Bronnimann and Brown (1953) in their observations on some planktonic Heterohelicidae from the Upper Cretaceous of Habana, Cuba, found that certain species of the striate Heterohelicidae possess minute supplementary apertures developed at the base of each chamber on both sides, and covered by tiny valves or flaps. They also noted that these apertures do not appear until the lobate stage. On this basis they established the genus Pseudoguembelina. The present study confirms Bronnimann and Brown's observations. M. Gallitelli's statement that the supplementary apertures are developed from the very first stage is in error. The form which has fine costae, more inflated chambers (especially the last pair) and is nearly as wide as high, figured by the latter author (1957) as Ps. excolata (Cushman) is assignable to Ps. palpebra Bronnimann and Brown. Casey (1926) figured as Textularia

costata a specimen which belongs in Ps. excolata (Cushman). Specimens possessing fine, massive costae and compressed tests, described by Voorwijk (1937) as Guembelina excolata and by Ansary and Fakher (1958) as Ps. excolata are related to Ps. costulata (Cushman).

The specimen figured by Olsson (1960) as Ps. excolata also should be assigned to Ps. costulata. That depicted by Leoblich and Tappan in the Treatise of Invertebrate Palaeontology (1964) as representative of the genus Pseudoguembelina (Ps. palpebra) shows the same characters as the one figured by M. Gallitelli (op.cit.).

Ps. excolata (Cushman) is distinguished from species of Heterohelix by the possession of elongate, tube-like, apertural flaps. It differs from Ps. palpebra Bronnimann and Brown in its less inflated chambers (although some Ps. palpebra specimens exhibit compressed chambers in the last stage (see under Ps. palpebra)), slightly coarser but less massive costae and, as mentioned by Pessagno (1967), but the flat or gently arched flaps covering the supplementary sutural apertures.

In this study Ps. costulata was found to exhibit some characters of Ps. excolata in late Santonian time. Some forms have a small test but coarse costae, others a large test and fine to medium costae or coarse costae and a narrow outline. Nevertheless, there still remain the striking characters of Ps. excolata, namely the few, widely spaced coarse, adult costae and smooth, slightly costate early portion.

Further investigations may demonstrate the synonymy of these two morphologically similar species.

Occurrence. Abundant in the Qurna formation. Rare in the Tayarat formation. Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of Texas, Arkansas, Colombia, Mexico, Trinidad, Habana, Farfara Oasis of U.A.R., west Spain; the Maestrichtian - Danian of north Sinai, the U.A.R; and the Campanian to Maestrichtian of west Pakistan, the Gulf of Suez, U.A.R.

Pseudoguembelina palpebra Bronnimann and Brown

pl.6, figs.10-12; pl.8, figs.11-13

1953		Pseudoguembelina palpebra	Bronnimann and Brown. p.155, t.f.9a-b 10a-b
1959	?	Pseudoguembelina cornuta	Seiglie, pp.60-61, pl.4, figs.1a-b 2a-b 3a-b 4a-b 5a-b 6, 7
1967		Pseudoguembelina palpebra	Bronnimann and Brown. Pessagno. p.267, pl.78, figs.1-3 (not pl.89, figs.3,4,5) and additional synonymy

Remarks. Ps. palpebra Bronnimann and Brown is distinguished by its as long as broad, compressed test; its large, as high as wide penultimate adult chambers which increase in height towards the last pair and by the usual compression of the final one or two chambers.

Although Bronnimann and Brown (1953) stated "In many specimens, the ultimate pair of chambers display strong lateral compression", their test figure 10b shows only one chamber of the final pair displaying this character.

In the present study both variations were observed and these are not considered to have any taxonomic importance.

A few specimens having fine surface striation, very slowly tapering adult stage and a small and compressed ultimate chamber were found. These are identical with the form described by Seiglie (1959) as Ps. cornuta n.sp. No striking differences were found between this species and Ps. palpebra, and, following the study of Pessagno (1967 p.267) Ps. cornuta Seiglie is included in the synonymy of Ps. palpebra Bronnimann and Brown.

Ps. palpebra morphologically is closely related to both Ps. costulata (Cushman) and Ps. excolata (Cushman). It differs in having an inflated test as long as broad, as high as wide chambers in the adult stages and costae intermediate in character between those of Ps. excolata and Ps. costulata.

Pessagno (Ibid) suggested that "the arched, tube like apertural flaps covering the supplementary apertures" serve as another criterion distinguishing Ps. palpebra from Ps. excolata or from the other related forms. Such a feature seems unsatisfactory and is not used for specific differentiation in this study. Moreover, none of Pessagno's figures shows such a distinctive feature.

It is believed that both Ps. palpebra and Ps. costulata have evolved from the Heterohelix reussi stock through H. planata by increase in the coarseness of the surface ornamentation and the development of apertural flaps which cover the supplementary apertures. The morphologic similarity between these two species is probably due to the parallel development.

The specimens figured by Pessagno (1967 pl.8 figs.3,4) as Ps. palpebra and (pl.89, figs.5,12-14) as Ps. aff. palpebra are referable to H. robusta Stenestad. They have robust, coarsely striated surface ornamentation and lack the Pseudoguembelina-type supplementary apertures (see under H. robusta).

Occurrence. Abundant in the Qurna formation. Rare in the Tayarat formation. Globotruncana gansseri zone.

Previous records of occurrence. It was originally described by Bronnimann and Brown (1953) from the Upper Maestrichtian of Cuba, and from the Middle Maestrichtian to Upper Maestrichtian of Mexico, Texas and Arkansas.

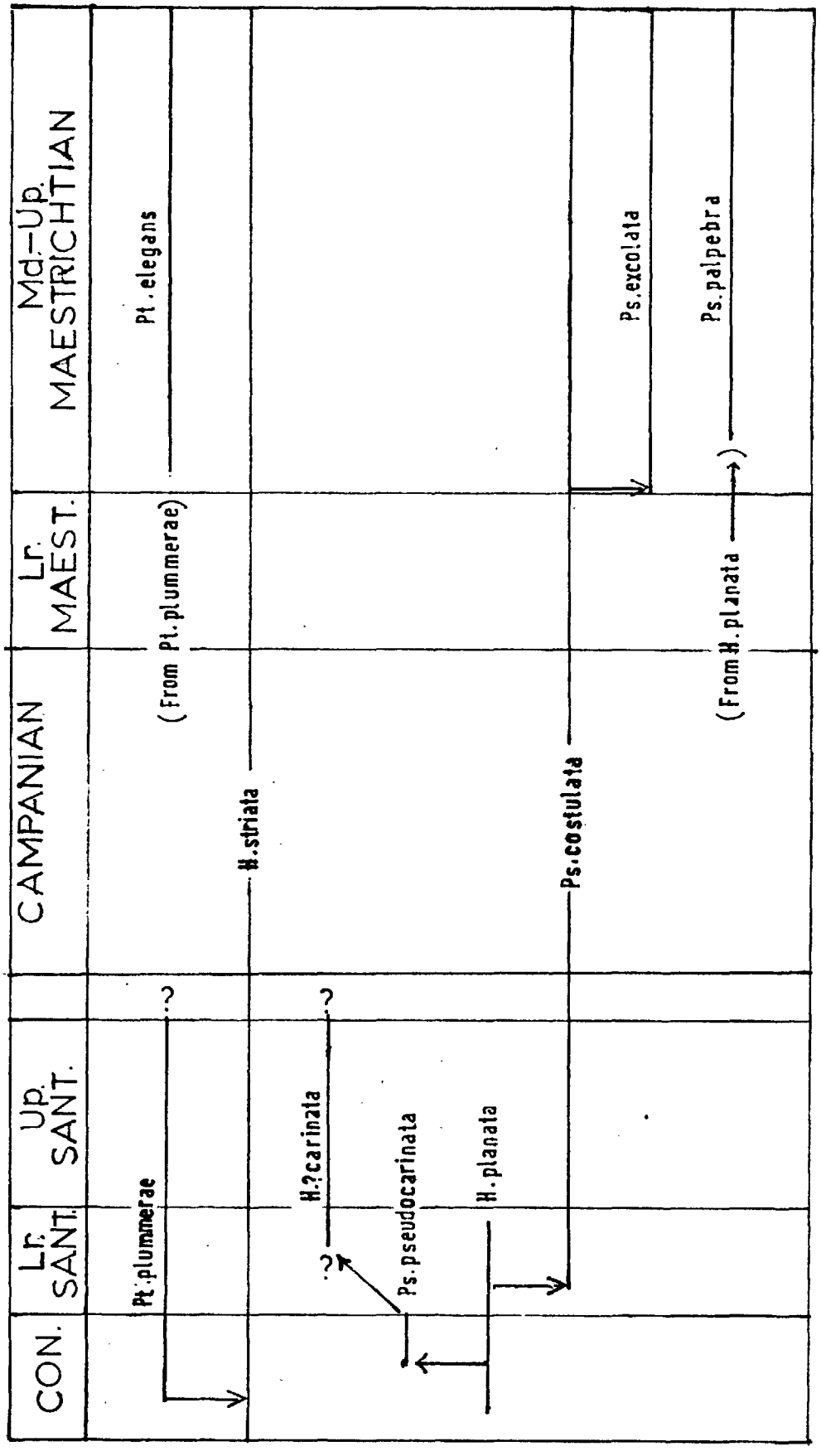


Fig.11 — Suggested phylogeny of some species of Pseudoguembelina and Pseudotextularia in S. Iraq.

Pseudoguembelina zubairensis sp.nov.

pl.8, figs.8-10

Description. Test medium sized, compressed, twice as long as broad moderately to strongly tapering; median line deep and wide in its adult stage; periphery in early stage entire, later slightly lobate; axial periphery rounded; initial chambers small, compressed, 5-9 pairs, followed by large, inflated and overlapping chambers, slightly wider than high and increasing in height towards the apertural end; the ultimate pair are inflated and much higher than wide; the biseriality of the test is terminated by the appearance of single, elongated chamber between the last pair with two accessory chambers, one on its each side, giving to the test Ventilabrella-like appearance; sutures deeply depressed, strongly curved, especially in the adult stages; wall calcareous, perforate; surface ornamented by well developed striae; a tiny primary aperture was seen at the inner margin of the last central chamber bordered by a narrow lip; the flaps extending along to the previous chambers and some paratypes show more than one aperture; sutural supplementary apertures along the median line of the adult stages covered by arched and elongated flaps.

Remarks. Pseudoguembelina zubairensis sp.nov. is distinguished by its overlapping and inflated chambers, elongated and much higher than wide last pair of chambers, the presence of a single central and two small marginal aberrant chambers, the presence of multiple primary apertures and the supplementary sutural apertures which are covered by elongated and arched flaps.

These characters differentiate Ps. zubairensis from the morphologically related Ps. palpebra Bronnimann and Brown, and from other members

of this genus. It differs from Ventilabrella carseyae Plummer in having compressed test, in the shape and arrangement of the adult chambers, in the surface ornamentation and in possessing sutural supplementary apertures and apertural flaps.

Occurrence. Abundant in the lower part of the Sadi formation. Globotruncana concavata subzone.

Pseudoguembelina pseudocarinata sp.nov.

pl.9, figs.1-3

Description. Test small, biserial, laterally compressed, almost as long as wide, rapidly tapering; maximum breadth at the last pair of chambers; periphery in very early stages entire, later slightly indented with keel-like thickening of chambers margins; axial periphery subtruncated; chambers initially planispiral, minute and not inflated, followed by 5 pairs of rapidly increasing chambers; last 4-5 chambers large, slightly wider than high, subrectangular and inflated, in cross section perpendicular to the axis of growth chambers narrow, rhomboid, margins acute and thickened; lateral sides slightly curved; sutures initially flush, later deeply depressed and straight; wall calcareous, finely perforate; surface ornamented by faint striae equally distributed over the test surface; primary aperture a moderate sized opening at the base of the final chamber; supplementary apertures in the adult stages along the median line sometimes covered by elongated thin apertural flaps.

Main variation:

1. Test small to medium sized, moderately to strongly compressed. 1 - $1\frac{1}{2}$ times as long as wide, increasing moderately or rapidly in width.

2. Pseudo keel either partially developed or covering the whole margin of the test.
3. Chambers in 5-6 pairs, either slightly wider than high, or equal in width and height, biserial throughout or with the initial portion planispiral.
4. Early chambers and/or last chambers either symmetrical or twisted.
5. Primary aperture high, either wide or narrow and sometimes of Chilloguembelina-type due to twisting.
6. Supplementary apertures either closed by elongated, thin, apertural flaps or remaining open (this later condition possibly more apparent than real and probably due to poor preservation).

Remarks. Pseudoguembelina pseudocarinata sp.nov. is distinguished by its moderately to strongly compressed test; keel-like marginal thickening and entire early part; subtruncate axial periphery; chambers sub-rectangular in lateral view and rhomboid in sectioned top view.

It is morphologically similar to each of the following Heterohelix species, all of which appear at a stratigraphically younger level except the first which is older ; H. planata (Cushman), H? carinata(Cushman), H. pachymarginata Stenestad, H. globocarinata (Cushman) and H. glabrans (Cushman).

Compressed specimens of Ps. pseudocarinata sp.nov. resemble H.? carinata (Cushman), but differ in having striae covering the whole surface of the test, keel-like marginal thickening rather than a true keel and supplementary apertures between the adult chambers. However, since Cushman (1938) description of H? carinata no one has made a detailed study of the type specimen. If the holotype is examined and found to

have a wholly striated test surface, thickened peripheral margins and supplementary apertures, then it might be possible to include the present new form in its synonymy.

Both H. planata (Cushman) and H. globocarinata (Cushman) are morphologically related to Ps. pseudocarinata; they differ in having less compressed and larger tests, rounded rather than rhomboid chambers in apertural view. The keel if present, restricted to the early portion.

However, H. globocarinata has a strongly inflated and enlarged last pair of chambers, a larger primary aperture and has longer stratigraphic range.

H. pachymarginata Stenestad shows limbate, raised sutures at least in its early stages; a marginal, keel-like, thickening restricted to the initial portion, formed by the extension of its raised limbate sutures along this part of the test. Furthermore, H. pachymarginate lacks the characteristic supplementary apertures and the subtruncated axial periphery.

Ps. pseudocarinata sp.nov. is more closely related to H. glabrans (Cushman). The species agree in the apertural characteristics and to a lesser extent, in those of the supplementary apertures. However, they have a different surface ornamentation and keel character. In addition, H. glabrans has a smaller width to length ratio and a less compressed test.

The writer has the feeling that H. glabrans (Cushman) and Ps. pseudocarinata are from the same ancestral stock. This is suggested by their close morphological characters and stratigraphic distribution (see Cushman 1938). On the other hand, by smoothening the test surface, developing the marginal thickening into a true keel and development

of supplementary apertures, Ps. pseudocarinata might possibly have evolved into H.? carinata. However, contrary to Pessagno's statement (1967), there is little or no relationship between this species and either H. pulchra (Brotzen) or H. glabrans. The reniform chambers in H. pulchra, especially the last one or two pairs, are unique among the known species of Heterohelix. For the same reason, one cannot place H. planata in the synonymy of H. pulchra (see Douglas 1969).

Occurrence. Abundant in the Tanuma formation.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Genus Pseudotextularia Rzehak 1891

Type species Cuneolina elegans Rzehak 1891

Pseudotexularia elegans Rzehak

pl.27, fig.11

1891 Cuneolina elegans Rzehak. p.2, m
1895 Pseudotextularia varians Rzehak. p.217, pl.7, fig.1a-b (not figs.2,3)
1929 Guembelina elegans (Rzehak) White. pp.34,35, pl.4, fig.8
1938 Guembelina plummerae Loetterle. Cushman. pp.15-16, pl.3, figs. 3a-b,4,5a-b
1943 Guembelina plummerae Loetterle. Wessem. p.145, pl.1, figs.37-38
1952 Guembelina plummerae Loetterle. Civrieux. p.270, pl.6, fig.11a-b (not 12)
1956 Guembelina plummerae Loetterle. Said and Kenawy. p.139, pl.3, fig.33a-b
1956 Bronnimannella plummerae (Loetterle) Gallitelli. p.35, pl.7, figs.1,2
1957 Pseudotextularia elegans (Rzehak) Gallitelli. p.138, pl.33, figs.6a-c
1959 Guembelina plummerae Loetterle. Nagappa. pl.7, figs.5,6a-b
1966 Pseudotextularia elegans (Rzehak) Salaj and Samuel. p.232, tab.37, fig.11
1967 Pseudotextularia elegans elegans (Rzehak) Bandy. p.24, t.f.12(12)
1967 Pseudotextularia elegans (Rzehak) Pessagno. pp.268-269, pl.75, figs.12-17, pl.85, figs.10-11, pl.88, figs.14-16 (not pl.89, figs.10-11 = Pt. plummerae) And additional synonymy, except Pt. elongata Seiglie

Also see under H. striata (Ehrenberg).

Remarks. Pseudotextularia elegans (Rzehak) was originally described as Cuneolina elegans Rzehak. White (1929) designated the specimen figured by Rzehak (1895, pl.7, fig.1a-b) as Pt. varians Rzehak the lectotype of Pt. elegans Rzehak.

The species is very closely related to Pt. plummerae (Loetterle); its separation from the latter depends on the intensity of the surface striation and the length/breadth ratio of the test.

Many authors, including Cushman, confused this species with H. striata (Ehrenberg). (See under H. striata Ehrenberg)

Pessagno (1967) examined the two paratype slides of H. globocarinata (Cushman) in the Cushman's collection, United States (National Museum), and found that the slides contain specimens which not only belong in H. globocarinata but also Pt. elegans (Rzehak).

From the above study it can be concluded that;

1. Both H. globocarinata (Cushman) and Pt. elegans (Rzehak) probably occur together in the same sample worked by Cushman (1938).

2. Cushman has included in the synonymy of H. globocarinata all specimens having a greatly enlarged and inflated last pair of chambers regardless of the surface ornamentation. This is confirmed by the occurrence of H. globulosa (Ehrenberg) (= H. striata in this study.) in the same paratype slides.

Ps. elegans (Rzehak) is distinguished from H. globocarinata (Cushman) by having chambers strongly compressed in the direction perpendicular to the axis of growth (periphery), a heavily and coarsely striated surface, reniform chambers which are much wider than high in the peripheral view and in the lack of early peripheral keel or entire margin.

Cushman (1936, 1944), Voorwijk (1937) and LeRoy (1953) described as Guembelina striata (Ehrenberg) forms which are actually Pt. elegans (Rzehak).

It is believed that Pt. elegans has evolved from H. striata stock through Pt. plummerae by further increase in the intensity of the surface striation and renification of the chambers in peripheral view.

Occurrence. Occurs rarely in the Qurna and Tayarat formations. Globotruncana gansseri zone.

Previous record of Occurrence. The Campanian and Maestrichtian of Texas, Arkansas, Mexico, Peurto Rico, Cuba, Venezuela and west Carpathians.

From its stratigraphic occurrence Pt. elegans seems to be a good Campanian - Maestrichtian index fossil in the Tythyan regions although there are records from the Boreal regions also.

Pseudotextularia plummerae (Loetterle)

pl.9, figs.5-6

1937 Guembelina plummerae Loetterle. p.33, pl.5, figs.1,2
1967 Pseudotextularia elegans (Rzehak) Pessagno. pp.268-269, pl.89, figs.10-11 (not pl.75, figs.12-17, pl.85, figs.10-11, pl.88, figs.14-16)
1969 Pseudotextularia plummerae (Loetterle) Noel K. Brown. pp.56,57 pl.4, figs.6,7

Remarks. The specimens here described as Pt. plummerae (Loetterle) are similar to the holotype described as Guembelina plummerae from the Niobrara formation of south Dakota. They differ from Pt. elegans (Rzehak), (the lectotype of Pt. elegans (Rzehak) was designated by White 1929, J. pal. v.3. no.1, p.34,35) in having faint surface striation and a low length/breadth ratio of the test.

Occurrence. Abundant in the Tanuma and lowerhalf part of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana fornicata subzone.

Previous record of Occurrence. According to Noel and Brown (1969) this species ranges from Coniacian to Santonian.

Genus Sigalia Reiss 1957

Type species Guembelina (Guembelina Ventilabrella) deflaensis Sigal 1952 p.36, fig.41 (top figure)

Diagnosis. Test slightly to moderately laterally compressed, periphery moderately to strongly lobate or serrate; axial periphery subrounded or truncate, The last two or more chambers with depressed band which often extends along both sides of the test, joining the sutural extension and giving the test a marginally serrate appearance; chambers biserially arranged almost to the top of the test. Mature individuals show more than two chambers added in a single plane on the last pair, or an abundant proliferation of rounded, compressed chambers. The latter form frequently has larger test size but shorter biserial chamber arrangement (five pairs maximum as opposed to nine in the non-proliferated form). The early Guembelina-type chambers are followed by rectangular to subrectangular or reniform, flat or slightly inflated chambers; sutures slightly curved distinct, slightly depressed or flush in the early portions, raised, slightly curved, moderately to strongly thickened, limbate or covered by prominent granulated beads in the last stages; wall calcareous, perforate, except for the imperforate granulated parts and truncated margins; surface coarsely ornamented, nodose or faintly to moderately striate in the early part, less rough to nearly smooth in the adult stage; aperture a low opening, single in biserial forms, two or more in

proliferated ones.

Discussion. Sigalia deflaensis was originally described by Sigal (1952) from the Coniacian of northern Algeria as Guembelina (Gumberlina Ventilabrella) deflaensis. He depicted two forms in figure 41 without designating the holotype. Later (1955) he accepted that these two forms belong in the two different genera, Guembelina and Ventilabrella.

Bettenstaedt and Wicher (1955) considered this species, together with S. decoratissima (de Klasz) and S. alpina (de Klasz) to belong in Ventilabrella Cushman. They also figured as V. deflaensis (Sigal) two other forms which are probably synonymous with Sigalia carpatica Salaj and Samuel. The same authors (1957) described and refigured Sigalia carpatica and a second form which also probably belongs in it.

Reiss (1957) examined Sigals topotype material from the Santonian (Coniacian, Sigal 1952) of north Africa, assemblages containing G. (G.V.) deflaensis Sigal from the Globotruncana concavata zone of Palestine and from various deposits of the eastern Tethys region including Europe. He concluded that G. (G.V.) deflaensis shows certain characters different from those of all the other genera of Heterohelicidae and is distinctive enough to be placed in a new genus for which he proposed the name Sigalia in honour of J. Sigal.

Although Reiss was quite justified in erecting Sigalia, unfortunately he did not state which of Sigal's two figures represents the type species. However, Salaj and Samuel (1962) selected one of the specimens figured by Sigal (1952) (fig.41 (top figure) p.36) as lectotype of S. deflaensis; this automatically becomes the type species of Genus Sigalia.

Sigalia Reiss is distinguished from Ventilabrella Cushman by the shape of the chambers, the surface ornament and the sutural and peripheral

characters (see under diagnosis).

It is differentiated from Gublerina Kikoine by the absence of divergence of the chambers, the presence of proliferated chambers at the top of the test and the raised, limbate and granular sutures.

The status of Gublerina acuta deKlasz is doubtful, its chambers show no divergence with growth and it possibly belongs in the Heterohelix pulchra group.

S. deflaensis (Sigal) possibly evolved from H. striata through an as yet unknown species of Heterohelix during early Coniacian time, by the development of compressed chambers, slightly limbate, thickened sutures and a slight development of early striate ornamentation. The serrated lateral periphery and truncated apertural margins were not well developed at this stage. On the other hand S. deflaensis is believed to have evolved into Sigalia carpatica during very late Coniacian time by the development of more regularly flattened, subrectangular chambers, strongly raised, limbate, granular sutures, serrated margins and coarse ornamentation in the early part. S. carpatica evolved into S. decoratissima through S. carpatica var.1 var.nov. during early Santonian time by the development of 1 - longitudinal, more strongly granulated ornamentation covering the early and mid part of the test, 2 - the characteristic early biserial chambers of S. deflaensis, 3 - a series of semi-circular, subrounded and compressed chambers following the additional chambers on the top of some specimens of S. carpatica var.1 which are thought to be transitional with proliferated chambers.

It is not certain if S. decoratissima is the ancestor S. alpina the latter species is missing from southern Iraq.

Sigalia carpatica Salaj and Samuel

pl.9, figs.10-11; pl.10, figs.1,4;
pl.11, figs.2,4; pl.27, fig.12

1955 Ventilabrella deflaensis (Sigal) Bettenstaedt and Wicher. p.11, pl.1, fig.2

1957 Ventilabrella deflaensis (Sigal) Wicher and Bettenstaedt. p.30, t.f.3a-c

1957 Sigalia deflaensis (Sigal) Reiss. pp.242-244

1966 Sigalia carpatica Salaj and Samuel. tab.37, fig.2 (two figures)

1966 Sigalia deflaensis (Sigal) Wille-Janoschek. pp.123-125, t.f.8, figs.5 (not fig.6)

1969 Gublerina deflaensis (Sigal) Scheibnerova. pp.55-56, pl.6, figs.6a-b (not fig.5)

Description. Test medium-sized, compressed, flattened; sides tapering towards the initial end; apical portion sharply pointed, followed by rapid expansion in breadth giving a fairly broad triangular outline; peripheral outline in early stage entire, later serrated; axial periphery truncated; chambers in 7 pairs, biserially arranged, increasing rapidly but showing no divergence, occasionally with a third chamber on the top of last pair; first 3 pairs rather appressed, followed by subangular, subrectangular chambers; sutures flush to slightly raised in early portion, becoming more strongly raised, limbate and granular in later development with prominent beads; wall calcareous, perforate, except on the granulated parts and truncated margins; surface in early stage coarsely ornamented; aperture, a low opening on the inner margin of the last chamber.

Remarks. Sigalia carpatica morphologically resembles both S. deflaensis (Sigal) and Sigalia carpatica var.1 var.nov. It is distinguished from the first by its much more compressed test, flat, subrectangular chambers (as against the moderately inflated chambers of S. deflaensis), serrated margins, truncated axial periphery, heavier ornamentation in the early portion and strongly raised beaded sutures. It differs from the second in lacking the third chamber between last pair, in its much more triangular

test shape and rapid increase in chamber breadth, in its less coarse early costate ornamentation and less thickened and curved sutures.

Sigalia carpatica has possibly evolved from S. deflaensis. This is suggested by their stratigraphical distribution and by the occurrence of several transitional forms.

Occurrence. Abundant in the Tanuma formation and in the lower partof of the Sadi formation. Globotruncana renzi/Heterohelix pseudoguembelini-formis zone - Globotruncana fornicata subzone.

Previous records of Occurrence. The Coniacian - Santonian of Tethyan Austria, Bavaria, France and Morocco. The Santonian of Palestine, north Africa, and west Carpathian.

Sigalia carpatica var.1 var.nov

pl.10, figs.2-3

Remarks. Variety differing from the typical in having 3 chambers in the last growth stage; much more oblique, strongly raised, beaded sutures and much more strongly serrated margins.

It differs from Ventilabrella tricamerata sp.nov. in having raised, limbate, beaded sutures, serrated periphery and flat, subrectangular chambers.

Occurrence. Abundant in the upper part of Tanuma and lowermost part of Sadi formations. Globotruncana renzi/Heterohelix pseudoguembelini-formis zone - Globotruncana concavata subzone.

Sigalia sp.A

pl.10, fig.6

Occurrence. Rare in the uppermost part of Tanuma and lowermost part of Sadi formations. Globotruncana renzi/Heterhhelix pseudoguembelini-formis zone - Globotruncana concavata subzone.

Sigalia decoratissima (de Klasz)

pl.10, figs.7-9,11; pl.11, fig.3

1953 Ventilabrella decoratissima deKlasz. p.228, pl.4, figs.5a-b
1955 Ventilabrella decoratissima deKlasz. Bettenstaedt and Wicher. pl.1, fig.3
1957 ? Gublerina decoratissima (deKlasz) Gallitelli. pp.140-141, pl.32, fig.8
1957 ? Ventilabrella decoratissima deKlasz. Reiss. pp.242-245, (no figure)
1967 ? Gublerina decoratissima (deKlasz) Bandy. p.25, t.f.11(4)
1967 ? Gublerina decoratissima (deKlasz) Pessagno. p.265 (no figure)
1969 Gublerina decoratissima (deKlasz) Esker. p.212, pl.1, figs.7,8
1969 ? Planoglobulina glabrata (Cushman) Ibid. pl.2, fig.10
1969 Gublerina deflaensis (Sigal) Schneibnerova. pp.55-56, pl.6, figs.5a-b (not fig.6)

Main variation. The truncated axial periphery shows either a slightly, moderately, or strongly depressed band. The ornamentation either in the early part or throughout the whole of the biserial stage, can be slightly to heavily costated.

Remarks. Sigalia decoratissima was first described by Klasz (1953) as Ventilabrella decoratissima. He noted its close relation to S. deflaensis (Sigal) and stated that S. decoratissima differs from the latter in having knobs arranged longitudinally on the sutures of the biserial stage and in lacking stripes on the chambers. However, according to Esker (1969), who had opportunity to examine topotypes of S. decoratissima, specimens of this species have rather large nodes (knobs) or costae, while S. deflaensis shows finer costae or striae.

The present work suggests that the final chamber proliferation, raised, strongly thickened or beaded, well developed sutures, serrated lateral margins, and truncated axial and equatorial peripheries supply further criteria for distinguishing this species from S. deflaensis and other similar forms. The proliferation of chambers begins early in

S. decoratissima whereas in S. deflaensis there is biserial chamber arrangement but not proliferation. The "rare proliferated forms (1-2 additional chambers in last pair)" mentioned by Esker (op.cit.) either are transitional to S. decoratissima or to a yet undescribed form.

Bettenstaedt and Wicher (1955) considered S. decoratissima together with S. alpina as synonymus with S. deflaensis (although their figured forms carried the name Ventilabrella decoratissima deKlasz). They stated "In 1953, deKlasz designated two species from the same stratigraphic range in Bavaria as V. decoratissima and V. alpina ....., in reality the correct name of these species is V. deflaensis".

To date all described and figured Bavarian and Austrian specimens of S. deflaensis are synonymus with S. carpatica Salaj and Samuel (see under genetic description).

Gallitelli (1957) placed this species in the genus Gublerina. Her figured paratype, from the Santonian of Bavaria is actually different from deKlasz's original figures (holotype, pl.4, figs.5a-b), and thus is assigned to S. decoratissima with some doubt; it shows no perfect and complete proliferation of chambers or any other diagnostic character. The test is thick rather than compressed and its final growth stage does not seem in a single plane. This form is transitional between S. carpatica and either a S. decoratissima-shaped, undescribed variety or to another form. Gallitelli (op.cit.) herself remarked on the difference in the character of the chambers and surface ornamentation of this paratype.

The form figured by Bandy (1967) as Gublerina decoratissima is the same as the paratype figured by Gallitelli (1957). Those figured by Sigal (1952, fig.41, lower) Bettenstaedt and Whicher (1957, fig.10) and by Loeblich and Tappan (1964, pl.525, fig.3) are probably transitional

from S. carpatica to S. decoratissima. Forms of this type have been found in the present work.

The specimen figured by Esker (1969) as Planoglobulina glabrata with raised, limbate sutures, subrectangular chambers and serrated edges should be placed in Sigalia. The smooth early portion and proliferated stage place it in a transitional position with an as yet unknown, smooth "S. decoratissima"-type form already alluded to.

Occurrence. Abundant in the lower half of the Sadi formation, decreasing gradually in numbers upwards and becoming rare. Globotruncana concavata subzone - Globotruncana fornicata subzone.

Previous record of Occurrence. S. decoratissima originally was described by deKlasz (1953) from the lowermost part of the Santonian Bucheck beds of southereastern Germany. Bettensteadt and Wicher recorded it from the Bavarian and Austrian Santonian. It also has been recorded from Palestine by Riess (1957), Mexico by Pessagno (1967) and from the late Coniacian to early Santonian of Jamaica by Esker (1969) (see synonymy).

Sigalia deflaensis (Sigal)

pl.9, figs.7-8; pl.11, fig.1

1952	Guembelina (Guembelina, Ventilabrella) deflaensis Sigal.	pp.36,37, t.f. 41 top, (not below)
1955	Ventilabrella deflaensis (Sigal)	Bettensteadt and Wicher. p.11, pl.1, fig.1 (only first and second figures)
1957 Not	Ventilabrella deflaensis (Sigal)	Wicher and Bettensteadt. p.30, t.f. 3a-c
1964 Not	Gublerina deflaensis (Sigal)	Loeblich and Tappan
1966 Not	Sigalia deflaensis (Sigal)	Wille-Janoschek. pp.123-124, tab.8, figs.5,?6
1966	Sigalia deflaensis (Sigal)	Salaj and Samuel. p.227, tab.37, fig.1
1969	Gublerina deflaensis (Sigal)	Esker. p.213, pl.2, figs.4-5
1969 Not	Gublerina deflaensis (Sigal)	Scheibnerova. pp.55-56, pl.6, figs.5a-b, 6a-b

Description. Test small, compressed, biserial; equatorial periphery lobate, slightly serrate; axial periphery subrounded, or subacute; sutures curved, flush to slightly raised, limbate; chambers in about 7 pairs, increasing rather rapidly in size, wider than high, roughly rectangular, last pair more compressed than the early pairs; wall calcareous, finely perforate; surface in early stages striated, later smooth; aperture on the inner side of the last chamber.

Remarks. The distinguishing characteristic of S. deflaensis as given by Riess (1957) actually refer to S.carpatica Salaj and Samuel. The rare specimens which are said to have more than one chamber per row in mature forms mentioned by the same author most probably belong to transitional forms.

Specimens figured as V. deflaensis (Sigal) by Wicher and Bettenstaedt (1957) and a Gublerina deflaensis (Sigal) by Loeblich and Tappan (1964) belong in S. carpatica Salaj and Samuel, and to the transitional form respectively. However, as noted by Esker (1969), S. deflaensis is distinguished by the presence of fine ornamentation on the early part of the test, small size, limbate and flush to slightly raised sutures, and the Guembelina type early portion of the test and aperture.

Occurrence. Abundant in the Khasib, Tanuma and lower part of Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. The Coniacian of Algeria. The Coniacian - Santonian of Austria, Bavaria, France, Morocco, West Carpathian and Jamaica. All other ranges given by different authors refer to S. carpatica or to transitional forms with it.

Genus Ventilabrella Cushman 1928

Type species Ventilabrella eggeri Cushman 1928

Ventilabrella cf. eggeri Cushman

pl.12, fig.9

1928 cf. Ventilabrella eggeri Cushman. p.2, pl.1, figs.10-12

Remarks. The specimens here described as Ventilabrella cf. eggeri differ from the holotype in having strongly appressed chambers in the proliferation stage and in lacking surface ornamentation. Cushman's holotype shows globular chambers in the proliferation stage and a faintly striated surface.

V. cf. eggeri differs from V. carseyae Plummer in having a smooth test and only small apertural openings, as against well defined striae and large, lunate apertural openings (in Plummer's holotype).

The forms of V. cf. eggeri from southern Iraq probably represent juviniles of V. carseyae or are transitional with it.

Occurrence. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Ventilabrella glabrata Cushman

pl.12, figs.5,7-8

1938	Ventilabrella eggeri Cushman var. glabrata	Cushman. p.26, pl.4, figs.15-17
1946	Ventilabrella eggeri Cushman var. glabrata	Cushman Cushman. p.111, pl.47, figs. 20-22
1954	Ventilabrella aggeri Cushman var. glabrata	Cushman. Frizzell p.111, pl.16, figs. 11-12
1957	Planoglobulina glabrata (Cushman)	Gallitelli. p.142, pl.32, figs.10-12? 11
1960	Planoglobulina acervulinoides (Egger)	Olsson. pp.28,29, pl.4 fig.11
1966	Ventilabrella glabrata Cushman.	Salaj and Samuel. p.231, tab.37, fig.7

1967 Planoglobulina acervulinoides glabrata (Cushman) Bandy. p.25, t.f.12(7)

1969 Not Planoglobulina glabrata (Cushman) Esker. p.213, pl.2, fig.10

Remarks. Ventilabrella glabrata was first described by Cushman (1938) from the upper part of Taylor marl, Texas, as a variety of V. eggeri Cushman. He stated that this variety differs from V. eggeri in having only slightly costate early growth stages and is smooth in the adult. He added that the perforations sometimes appear in lines whereas V. eggeri has longitudinal costae which are heavier on the biserial portion. In southern Iraq, forms of V. glabrata either with faint or strong costae on either the early chambers or over the whole surface of the test were found.

The specimen figured by Olsson (1960) as Planoglobulina acervulinoides (Egger) belongs in V. glabrata. It possesses large numbers of small chambers and a fan-shaped, compressed test.

Occurrence. Abundant in the upper part of the Tanuma and lower part of Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. The Coniacian - Campanian of Texas, Arkansas. The Santonian of Jamaica. The Santonian-Campanian of Puerto Rico, The Campanian of the west Carpathians and the Coniacian-Maestrichtian of west Pakistan.

Ventilabrella ornatissima Cushman and Church

pl.12, figs.1-4

1929 Ventilabrella ornatissima Cushman and Church. p.512, figs.12-14 (not 15)

1938 Ventilabrella ornatissima Cushman and Church. Cushman. p.27, pl.4, figs.11a-b

1948 Not Ventilabrella ornatissima Cushman and Church. Kikoine. pp.25-26 pl.2, figs.8a-c

1957 Gublerina ornatissima (Cushman and Church) Gallitelli. p.140, pl.32, fig.6(not figs.1-5)

1962 Gublerina ornatissima (Cushman and Church) Graham. p.105, pl.19, figs.16a-c
1963 Gublerina ornatissima (Cushman and Church) Graham and Church. p.61, pl.7, figs.10a-b
1963 Not Gublerina ornatissima (Cushman and Church) Bronnimann and Rigassi p.17, fig.4
1964 Gublerina ornatissima (Cushman and Church) Martin. p.86, pl.11, figs.3a-c
1965 Not Gublerina ornatissima (Cushman and Church) Takayanagi. p.200, pl.20, figs.6-8
1967 Not Gublerina ornatissima (Cushman and Church) Bandy. p.25, t.f.11(3)
1969 Planoglobulina ornatissima (Cushman and Church) Douglas. p.160, pl.2, figs.1-2

Description. Test medium-sized, compressed, early biserial stage followed by rapid expanded, rhomboid adult proliferated stage; early periphery entire, later moderately lobulate; axial periphery rounded; chambers added in a single plane, initial 3 pairs of chambers small, appressed, followed by distinct, inflated, subglobular chambers, increasing gradually in size as added, proliferating on top of the last pair, alternating in position, globular to subglobular; early sutures flush, later very deeply depressed, limbate, in rare cases flush throughout; wall calcareous, perforate; surface striate, ornament heaviest on the two margins and fading out towards the last chambers.

Remarks. V. ornatissima was first described by Cushman and Church (1929) from the Upper Cretaceous of Fresno county, California. Kikoine (1948) described the new genus Gublerina from the Maestrichtian of the French Pyrenees, with Gublerina cuvillieri as type species. He distinguished the latter by the broad, nor-septate area between the diverging rows of chambers. "..... s'etageant des deux cotés du tout a la peripherie et laissant vide l'espace inter calaire de prime ....". Kikoine (op.cit) in the same publication figured as Ventilabrella ornatissima a form which possibly belongs elsewhere.

Gallitelli (1957) considered V. ornatissima Cushman and Church as a junior synonym of G. cuvillieri Kikoine. Douglas (1969) in a revision of V. ornatissima from northern California Upper Cretaceous state "In complete adult specimens of V. ornatissima (the holotype and paratypes are broken) the fan-shaped portion of the test is composed of numerous small, globular chambers. The test frequently broke at a line of weakness just above the biserial portion, the damage producing a form which superficially resembles G. cuvillieri. The species is, however, completely multichambered ..... exhibits a rapid increase in width following the early biserial portion which gives the test a distinct flare".

The present study substantiates Douglas' observations in part. The V-shaped V. ornatissima forms showing a slow increase in width was found, although rarely, in the area studied. However, G. cuvillieri showing a rapid increase in width was illustrated by Gallitelli (1957, pl.32, fig.4). Nevertheless, the present work suggests that the proliferation of chambers at the top of the test and not the divergence between the two rows of initial chambers is the best criterion in distinguishing this species from G. cuvillieri Kikoine.

V. ornatissima differs from V. glabrata Cushman and other similar forms in its comparatively long, biserial stage, globular to subglobular, moderately inflated, similarly-sized chambers and deeply depressed, limbate sutures in the proliferation stage. Forms described and figured by Graham and Church (1963) and Martin (1964) as Gublerina ornatissima belong in the genus Ventilabrella Cushman. The chambers in these specimens show no divergence with growth. Forms described by Bronnimann and Rigassi (1963) and by Bandy (1967) as Gublerina ornatissima show diverging chambers and belong in G. cuvillieri Kikoine. Those figured

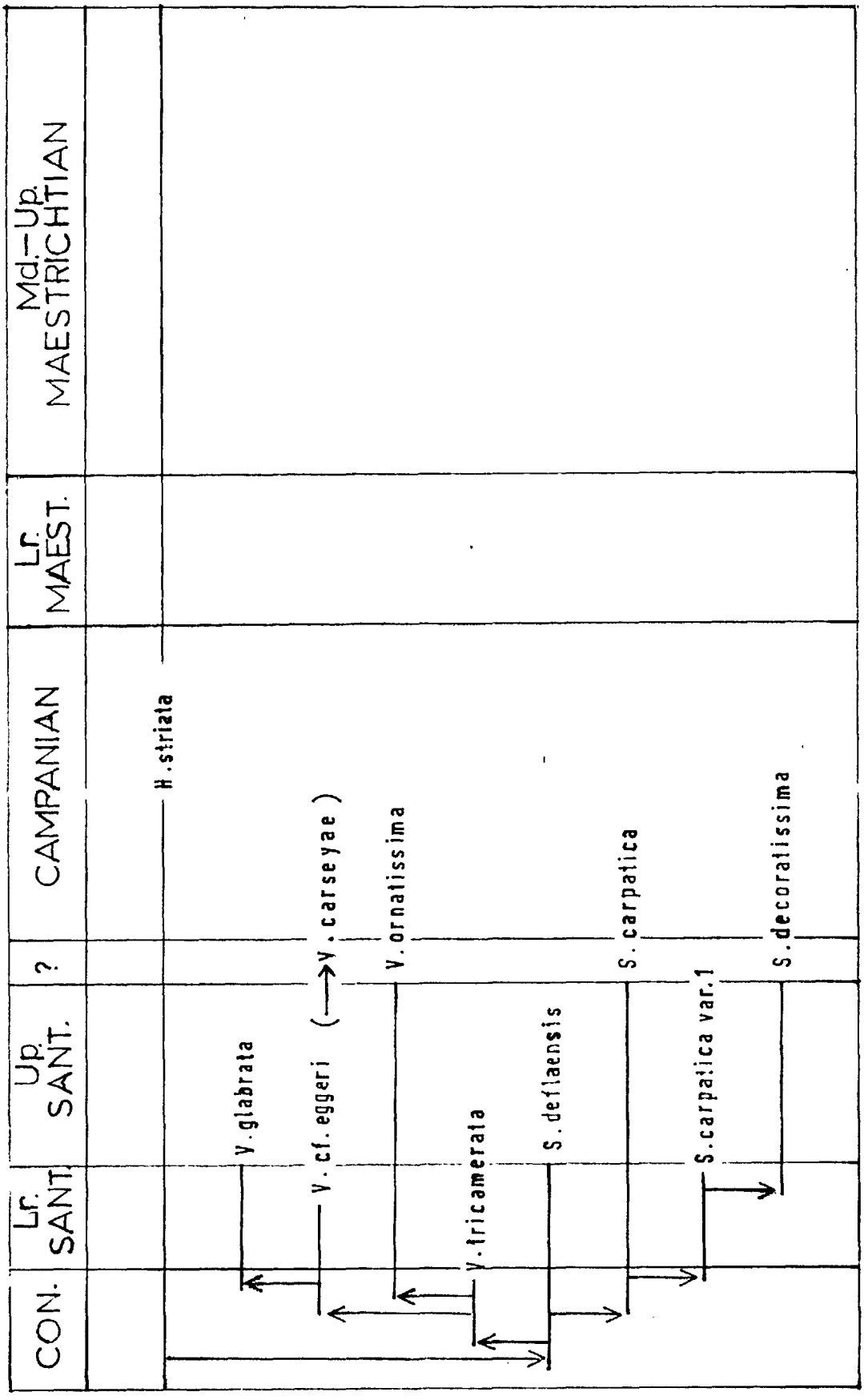


Fig. 12 – Suggested phylogeny of the species of Sigalia & Ventilabrella in S. Iraq.

and described by Takayanagi (1965) are quite different from the species in question.

Occurrence. Abundant in the Tanuma and lower part of the Sadi formations. Rare in the middle part of the Sadi formation. Globotruncana renzi/ Heterohelix pseudoguembeliniformis zone - Globotruncana fornicata subzone.

Previous record of Occurrence. The Santonian - Maestrichtian of California.

All other ranges given by different authors refer to G. cuvillieri.

Ventilabrella tricamerata sp.nov

pl.12, fig.6

Description. Test small, compressed, triangular; early stages of Guembelina type, biseral, adult chambers tending to become triserial in adding an extra, third chamber between the last pair; periphery slightly lobate; axial periphery narrowly rounded; median line straight, slightly depressed; chambers 13 in number, moderately inflated, arranged in biserially, last pair with a third chamber which is rounded, compressed level with the other two in lateral as well as apertural views; individual chambers moderately inflated, slightly wider than high; sutures nearly straight, depressed, slightly oblique to median line except the last pair which seems more curved and less oblique; wall calcareous, perforate; surface coarsely striate except in last three chambers, much more strongly so on peripheral margins, the striation fading out gradually towards apertural end; aperture multiple.

Remarks. V. tricamerata sp.nov. differs from V. glabrata Cushman in having three compressed chambers in the last portion instead of a proliferation of inflated chambers and a blunt, longer rather than short apical end.

It differs from V. cf. eggeri Cushman in having a more compressed test, and a striate rather than a merely roughened surface (although Cushman (1928) mentioned the presence of costae, his figured forms show only a roughened surface).

V. tricamerata is distinguished from the morphologically similar V. ornatissima Cushman (paratype, fig.15) in having a more compressed test, three chambers in the adult stage and coarser surface ornament.

Douglas (1969) stated "..... however, the species is multicamerate and cannot be assigned to Gublerina". If this statement is true (there are no further records of V. ornatissima from the type locality) the only significant difference remaining between V. glabrata and V. ornatissima is the degree of proliferation of the chambers in the adult stages. Hence, both the above mentioned species are placed under the same genetic name. On the other hand, V. tricamerata might include in its synonymy Cushman's paratype specimen (Fig.15).

V. tricamerata differs from Gublerina compressa (Van der Slus) in lacking diverging chambers of Gublerina-type, in having the surface covered with medium to coarse striae, especially on the peripheral edges (Van der Slus did not mention the surface character of his specimens but his figured form shows it smooth). Furthermore, G. compressa has an aberrent chamber independently occupying the central, non-septate area, while the third chamber in V. tricamerata is a normal unit in a triserial stage.

Forms of V. tricamerata with limbate sutures were found in younger beds while those with non-limbate sutures occur at lower levels.

As suggested by its morphologic features, V. tricamerata sp.nov. possibly evolved from S. deflaensis (Sigal), later passing into V. ornatissima on one side and V. cf. eggeri on the other

Occurrence. Rare specimens were found in the upper part of the Khasib formation and abundant in the lower part of the Tamuma formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Family PLANOMALINIDAE Bolli, Loeblich & Tappan 1957

Genus Planomalina Loeblich and Tappan 1946

Type species Planomalina apsidostroba Loeblich and Tappan 1946

Planomalina sp.A sp.nov.

pl.13, figs.7-9

Description. Test small, biumbilicate, planispirally coiled, partially evolute, laterally compressed; equatorial periphery subcircular, lobate, with a faint, keel-like, marginal thickening on the last few chambers; axial periphery sharply angled; chambers 13, increasing slowly in size as added; the early whorls composed of 6 small, subglobular to globular, inflated chambers which can be made clearly visible by wetting the specimen; the last whorl is composed of 7 comparatively large chambers, early ones slightly compressed, subovoidal and slightly inflated, while the last few are strongly compressed and distorted; sutures gently curved, depressed in the early part, straight and radial in the later part; umbilicus small, shallow; wall calcareous, finely perforate; surface finely hisped; aperture a low interiomarginal, equatorial, opening, extending into both unbilical areas; the apertures of previous chambers remain open in the umbilical region as relict supplementary apertures.

Main variation. The main variation observed is in the degree of

development of marginal keel, and degree of compression of chambers.

Remarks. Planomalina sp.A sp.nov. is distinguished from the similarly compressed Globigerinelloides messinae subcarinata (Bronnimann) by the possession of a marginal keel, small, low aperture and in its greater number of chambers which increase slowly in size.

The writer has examined the holotype of G. ehrenbergi (Barr) at the British Museum of Natural History, London, and has found this species to be morphologically different from Planomalina sp.A. G. ehrenbergi (Barr) has a more tightly coiled, thicker test; rounded axial periphery and non-keeled peripheral margin.

Planomalina sp.A morphologically is very close to G. ultramica (Subbotina) described from the Cenomanian - Turonian rocks of the Caucasus, U.S.S.R; they have the same type of equatorial periphery and coiling, and similar sized tests. They differ in the character of the axial periphery and marginal keel.

Occurrence. Abundant, in the upper part of the Tamuma formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Genus Biglobigerinella Lalicker 1948

Type species Globigerinella multispina Lalicker 1948

Biglobigerinella algeriana Ten Dam and Sigal

pl.15, figs.9-10

1949 Biglobigerinella algeriana Ten Dam and Sigal. p.234, t.f.1a-d, 2,3.

Remarks. This writer believes that this form which appears in association with other species of Biglobigerinella is a direct derivative of Globigerinelloides cushmani (Tappan). It is distinguished from this latter in having a lesser number of chambers; a less tightly coiled

test and by the development Biglobigerinella-type adult chambers and apertures. This supposition is supported by the occurrence in the material of several transitional specimens.

Occurrence. It was originally described from the Upper Senonian of Algeria. In southern Iraq B. algeriana occurs rarely in the lower part of the Sadi formation.

Biglobigerinella multispina Lalicker

pl.15, fig.6

1948 Biglobigerinella multispina Lalicker. p.624, pl.92, figs.1a-c, 2a-c, 3a-c

1957 Biglobigerinella multispina Lalicker. Bolli. p.25, pl.1, figs.11,12a-b

1962 Biglobigerinella multispina Lalicker. Herm. p.53, pl.3, fig.8 (3 figures)

1962 ? Planomalina multispina (Lalicker) Barr. pp.563-564, pl.69, figs.5a-b

1964 Biglobigerinella multispina Lalicker. Subbotina. pp.253-254, pl.54, figs.11a-c, 14a-c (not figs.10a-c, 15a-d), pl.55, figs.1a-c? 2a-c? 3a-c, 4a-c, 5a-c? 6a-e, 7a-c, 8a-d

1964 Biglobigerinella multispina Lalicker. Loeblich and Tappan. p.c656, fig.526,?4, 5a-b

1967 Globigerinelloides multispina (Lalicker) Pessagno. pp.276-277, pl.70, figs.1,2, pl.82, figs.10-11? (not pl.91, figs.1-2 = G. biforaminita (Hofker))

1969 Not Globigerinelloides multispina (Lalicker) Douglas. pp.161-162, pl.9, figs.6a-c

Description. Test medium-sized, biumbilicate, planispirally coiled, involute to partially evolute; equatorial periphery roughly quadrate, lobate; chambers 4-6 in the last whorl, of which the early ones are small, globular, while the last few are broad and compressed perpendicular in direction to the equatorial periphery; the final chamber (in rare cases also the penultimate one) is divided into two, subglobular, smaller

chambers; sutures straight, radial or gently curved, depressed; umbilicus small and similar to that of G. pinguis (Herm); wall calcareous, perforate, surface very finely hisped to smooth; aperture double, each in a low extraumbilical opening at the base of the bipartite chamber, and in well preserved specimens each aperture extending along the umbilical margin; only few specimens show relict apertures.

Main variations

1. The final chamber (rarely the penultimate) shows either a trace of constriction on its peripheral margin, partial division or complete division into two separate chambers.
2. The bipartite pair of chambers are either globular, subspherical or compressed.
3. The apertural face varies as in G. pinguis (Herm).
4. The surface is either finely hisped, finely pitted or smooth.

Remarks. The genus Biglobigerinella was first described by Lalicker (1948) with B. multispina as a type species. Banner and Blow (1959) considered this genus to be a junior synonym of the genus Globigerinelloides Cushman and Ten Dam, and later a subgenus of Planomalina Loeblich and Tappan. Berggren (1962) accepted the taxon subgenus and the synonymy given by Banner and Blow (op.cit.). He regarded taxon "Biglobigerinella" as artificial since in a single fossil population various stages of development leading to a Biglobigerinella stage occur. He stated, "the holotype (cc 51898), figured paratypes (cc 5189, 51900) and numerous unfigured paratypes (cc 51897) of Biglobigerinella multispina Lalicker, represent the subjectively chosen adult stages of a species belonging to the Planomalina (Globigerinelloides) group".

He added "P.(G) multispina ..... is probably the ancestor of P.(G) messinae.

On the other hand, Berggren (Ibid) contradicted his own statement by describing G. messinae as having globular chambers, a tendency to develop biserial chambers and bipartite, primary apertures.

The present writer considers Globigerinelloides ? biforaminata (Hofker) represents the final stage of development of G. asperum (Ehrenberg) through G. messinae messinae (Bronnimann). On the other hand B. multispina is believed to have evolved from Globigerinelloides sp.A sp.nov. through G. pinguis (Herm).

The writer has examined specimens of G. multispina Lalicker from the Isle of Wight described by Barr (1962) and deposited at the British Museum of Natural History, London. These represent the final mature stage of this species. The latter is chiefly characterized by possessing the final three chambers of complete Biglobigerinella-stage shape.

Occurrence. Abundant in the lower part of the Sadi formation.

Globotruncana concavata subzone.

Previous record of Occurrence. The Campanian of England. The Campanian - Middle Maestrichtian of Texas, Arkansas, Mexico. The Upper Maestrichtian of the Austrian - German border and the Maestrichtian of West Siberia U.S.S.R.

Biglobigerinella sp.1 sp.nov.

pl.16, figs.1-3

Description. Test small, thick, biumbilicate, planispirally coiled and tightly involute; equatorial periphery nearly circular, lobate; axial periphery broadly rounded; chambers 6 in the last whorl, strongly

appressed, early ones slightly later strongly compressed in a direction perpendicular to the equatorial periphery and increasing moderately in size as added; in apertural view the chambers are ovoid, 2-3 times as wide as high; sutures straight, radial and depressed; umbilical very small, shallow; wall calcareous, perforate; surface finely hisped; aperture interiomarginal and equatorial with slight constriction in the middle.

Remarks. The holotype is not a mature specimen and was chosen chiefly to show the immature Biglobigerinella-stage of the ultimate chamber and primary aperture. The paratype, on the other hand, show the different stages of development. They are distinguished from the holotype in having bipartite ultimate chambers, double apertures and 6-7 chambers in the final whorl.

Biglobigerinella sp.1 sp.nov. is distinguished from Globigerinelloides sp.A sp.nov. in its much more tightly involute test; its strongly appressed and peripherally compressed chambers; and its double, extra-umbilical, primary aperture. It differs from B. multispina Lalicker in its nearly circular peripheral outline; its small, globular to sub-globular and narrowly spaced ultimate pair of chambers; its smaller number of chambers which are strongly appressed and in its tightly involute test.

Biglobigerinella sp.1 is believed to have evolved from G. cushmani (Tappan) through Globigerinelloides sp.A by the decrease in the number of chambers, the development of final biserial chambers and double apertures.

Occurrence. Restricted to the lower part of the Sadi formation. Globotruncana concavata subzone.

Biglobigerinella sp.

pl.12, figs.10-11

Remarks and Occurrence. A few specimens similar to G. messinae voluta (White) but with Biglobigerinella-type final chambers are here described as Biglobigerinella sp. Although it is clearly different from the known species of Biglobigerinella, it is not ascribed to a new species because of its rarity.

The species may have evolved from G. messinae voluta (White). It occurs as a rare form in the lower part of the Sadi formation. The lower part of the Globotruncana fornicata subzone.

Genus Globigerinelloides Cushman and Ten Dam 1948

Type species Globigerinelloides algerianas Cushman and Ten Dam 1948

Globigerinelloides asperum (Ehrenberg)

pl.13, figs.2-3

1854 Phanerostomum asperum Ehrenberg. p.23, pl.30, figs.26a-b (not pl.32,(group 1) fig.24, pl.32,(group 2) fig.42)
1929 ? Globigerinella aspera (Ehrenberg) Carmen. p.315, pl.34, fig.6
1932 Globigerinella voluta (White) Sandidge. p.284, pl.44, figs.1,2
1936 Globigerinella aspera (Ehrenberg) Brotzen. p.170, pl.13, figs.2a-c, t.f.62
1937 Globigerinella aspera (Ehrenberg) Loetterle. p.45, pl.7, figs.4 a-c
1951 Globigerinella aspera (Ehrenberg) Band. p.508, pl.75, figs.3a-c
1951 Globigerinella aspera (Ehrenberg) Visser. p.285, pl.8, figs.15 a-b
1953 Globigerinella aspera (Ehrenberg) Hamilton. p.266, pl.30, fig.5
1960 Globigerinella aspera (Ehrenberg) Belford. p.91, pl.25, figs.4-6
1961 Globigerinella aspera (Ehrenberg) Graham and Clark. p.113, pl.5, figs.6a-c
1962 Planomalina aspera (Ehrenberg) Barr. pp.361,362, pl.69, figs.4 a-b
1963 ? Globigerinella aspera (Ehrenberg) Graham and Church. p.64, pl.7, figs.17a-c
1963 Planomalina (Globigerinelloides) aspera aspera (Ehrenberg) Van Hinte p.97, pl.12, figs.2,3 5, t.f.15(a-b)

1964
1964 Globigerinella (?) sp. cf. G. aspera (Ehrenberg) Kavary and Frizzell, p.48, pl.9, figs. 7a-c
1965 Globigerina (Biglobigerinella) biforaminata Hofker. Perlmutter and Todd. p.118, pl.5, figs.2a-b (not fig.3)
1965 Globigerinelloides aspera (Ehrenberg) Takayanagi, p.201, pl.20, figs.9a-c
1965 Planomalina (Globigerinelloides) aspera aspera (Ehrenberg) Van Hinte p.85, pl.1, fig.2
1967 Globigerinelloides aspera aspera (Ehrenberg) Bandy. p.12, t.f.5(8)
1967 Globigerinelloides asperus (Ehrenberg) Pessagno. pp.274-275 pl.60, figs.4,5

Remarks. Globigerinelloides asperum was first described by Ehrenberg (1854) as Phanerostomum asperum, but he failed to designate both a definite type locality and a type depository. His specimens of Gl. asperum came from three different geographic localities;

1. Insel, Rugen, Pommern, Germany (Figs.26a-b)
2. Missouri - Gebiet, North America (Fig.24)

and 3. Mississippi - Gebiet, North America (Fig.42).

Pessagno (1967) selected the syntipic specimen (pl.30, figs.26a-b) as lectotype. This clearly shows an equatorial aperture.

Ehrenberg (1854) described as Rotalia aspera another form which all later workers considered a senior synonym of Ph. asperum Ehrenberg.

None of the specimens of R. aspera figured by Ehrenberg (1854, pl.23,27,28 and 31) showed more than one side, and his description was not clear enough for generic determination.

This writer considers Rotalia aspera Ehrenberg to be an uncertain form and should be rejected in favour of the name "asperum" (not "asperus" as mentioned by Pessagno 1967).

According to Cushman (1927) who selected and examined the type species and its unpublished original drawing in Berlin, Phanerostomum Ehrenberg 1841(1843) included.Ph. integerrimum Ehrenberg (the selected

type species) and Ph. ocellatum Ehrenberg. Both of these are assignable to genus Discorbis. Thus Phanerostomum Ehrenberg becomes a junior synonym of Discorbis Lamarck 1804. Globigerinelloides was established by Cushman and Ten Dam (1948) with G. algeriana Cushman and Ten Dam as type species. This genus was amended by Loeblich and Tappan (1961, 1964) to include forms having planispiral, biumbilicate and involute to partially evolute tests; perforate, non-carinate peripherys and interiomarginal, equatorial aperture. This places Ph. asperum in the synonym of this genus. G. asperum (Ehrenberg) is distinguished from Gl. messinae messinae Bronnimann and Brown in having a thicker test, a circular to subcircular peripheral outline, a greater number of chambers and in the character of the aperture which is comparatively lower.

Gl. asperum is morphologically closely related to Gl. messinae voluta (White), but differs in its rougher surface ornament and in having a higher apertural opening. Gl. messinae voluta was originally described as having a smooth surface and low apertural opening. G. prairiehillensis was said by Pessagno to have a large test-size, a low apertural opening, deep umbilicus, and chambers increasing rapidly in size as added and compressed in a direction perpendicular to the periphery.

Occurrence. Appears in the lower part of the Khasib formation. It gradually increases in numbers upwards in the Tanuma and lower half of the Sadi formations. Rare in the upper half of the Sadi formation and dying out completely in the Tayarat formation. Globotruncana renzi/ Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri zone.

Previous record of Occurrence. All reliable records from Mississippi Texas, Missouri, Wyoming, Kansas, California, Alabama, New York, Mexico, Australia, Mid-Pacific, Germany, Switzerland, Sweden, England (Isle of

Wight) and Iran show that Gl. asperum has no restricted range in Upper Cretaceous stratigraphy.

Globigerinelloides bentonensis (Morrow)

pl.13, fig.1

1934 Anomalina bentonensis Morrow. p.201, pl.30, figs.4a-b
1961 Globigerinelloides bentonensis (Morrow) Loeblich and Tappan. p.267, pl.2, figs.8-10
1964 Globigerinelloides bentonensis (Morrow) Low. p.123, pl.3
1967 Globigerinelloides bentonensis (Morrow) Bandy. p.12, t.f.5(7)
1967 ? Globigerinelloides bentonensis (Morrow) Pessagno. p.275, pl.76, figs.10-11

Remarks. Globigerinelloides bentonensis was first described by Morrow (1934) from the Greenhorn Limestone formation of Kansas as Anomalina bentonensis. The planktonic nature of this species was first recognized by Loeblich and Tappan (1961) who re-examined the holotype and other topotypic materials and recorded its possession of all the generic characters of Globigerinelloides. They figured three different specimens of Gl. bentonensis (Morrow) clearly showing the wide range of variation of this species. The variation especially concerns the number, size, appression and rate of increase of the chambers and the development of supplementary relict apertures.

In the present study, Gl. bentonensis usually shows 6 chambers in the last whorl and which increase rather rapidly in size as added. The increase in Loeblich and Tappan's specimens is more gradual, but the features shown by the specimens from Iraq coincide well. (See Loeblich and Tappan 1961, pl.2, figs.8a-b.)

Low (1964) stated that the degree of involution, number of chambers and umbilical character are sufficient criteria to distinguish Gl. bentonensis from Gl. caseyi (Bolli, Loeblich and Tappan). On the other hand Esker (1965) failed to separate them.

This writer agrees with Esker (Op.cit) and Douglas (1969) regarding the close morphological resemblance and similar stratigraphic distribution of Gl. bentonensis and Gl. caseyi and difficulty of separating the two species. Both "species" would be expected to occur in the material under discussion.

According to Bolli Loeblich and Tappan (1957), Loeblich and Tappan (1961), Low 1964, Douglas (1969) and the writer's study of material from Iraq, Gl. bentonensis is distinguished from G. caseyi from the Upper Gault (L. Cretaceous) of England in having a thicker and larger test, less evolute, less exposed early chambers, few chambers in the last whorl, a distinctly hisped surface in the early part of the test and a less hisped to smooth last few chambers.

Gl. bentonensis differs from Gl. asperum (Ehrenberg) in its larger test size, its greater number of chambers in the last whorl and its lower apertural opening.

The writer had no opportunity to examine the type of Anomalina eaglefordensis Moreman, but according to Low (Op.cit.) it is a benthonic species. This statement was recently reaffirmed by Pessagno (1967) who added "..there is no question about A. eaglefordensis Moreman being a benthonic species. The assignment of Gl. caseyi (Bolli, Loeblich and Tappan) to this species by Loeblich and Tappan (1961) (1964) and by Ayala (1962) is incorrect".

Occurrence. Abundant, in the lower part of the Khasib formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. The Late Cenomanian of Kansas and Bahama Island. The Cenomanian of Texas and Mexico.

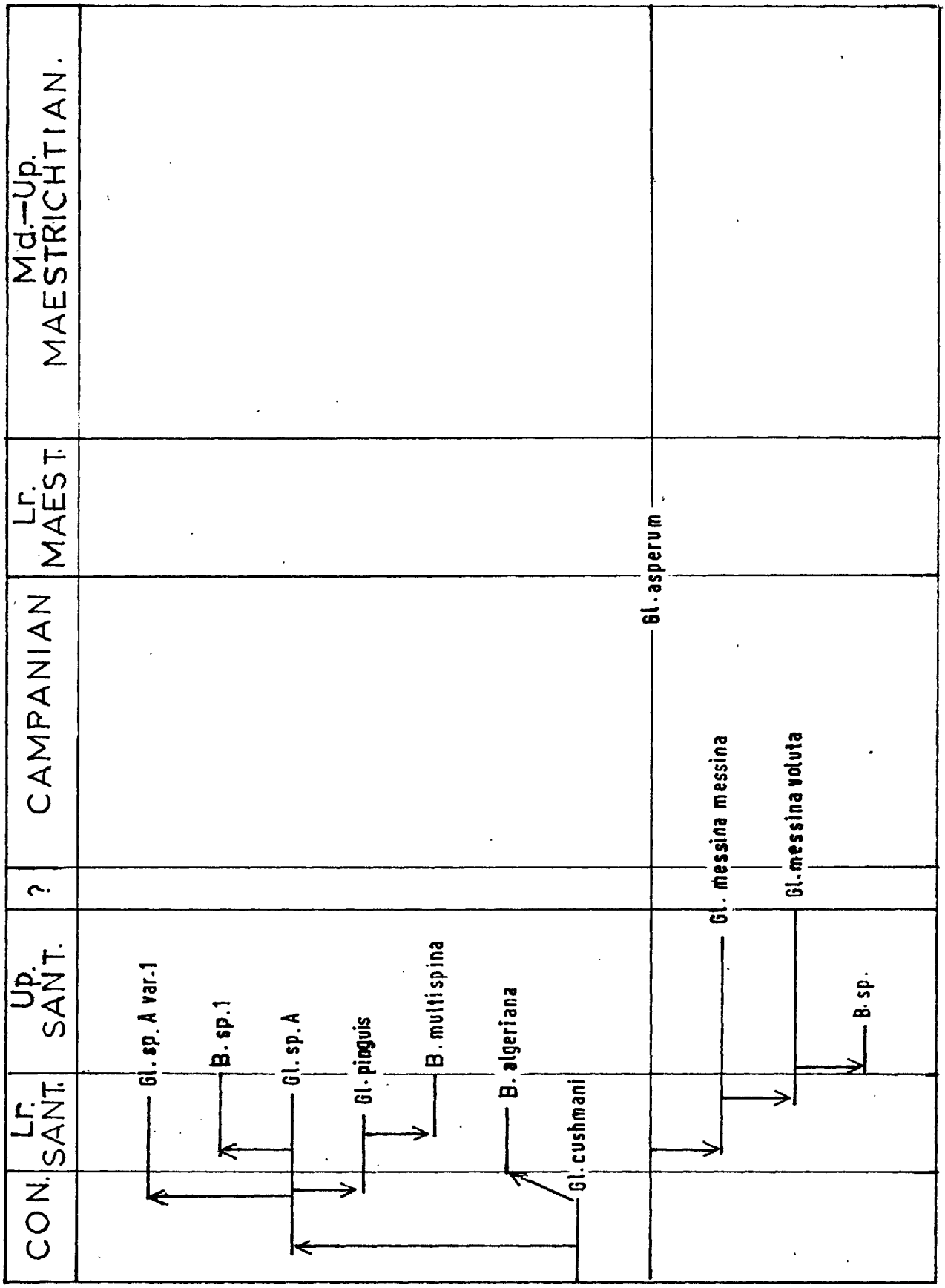


Fig 13 — Suggested phylogeny of some species of Globigerinelloides in S. Iraq.

Globigerinelloides cushmani (Tappan)

pl.14, fig.2

1943 Globigerinella cushmani Tappan. p.513, pl.83, figs.5a-b

Remarks. The hypotype is chosen chiefly to show the early immature stage of the last chamber and the aperture which tend to become bipartite. This writer considers Gl. cushmani (Tappan) to be transitional to Biglobigerinella algeriana Ten Dam and Sigal. The morphological characters and stratigraphic distribution of the two species strongly favour this supposition.

Occurrence. In the Khasib and lower part of the Tanuma formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone. It was originally described from the Lower Cretaceous of the Washita group, Oklahoma.

Globigerinelloides sp. aff. Gl. japanica (Takayanagi)

pl.14, fig.1

1960 cf. Globigerinella japanica Takayanagi. p.131, pl.9, figs.12a-b, t.f.22a-e

1965 cf. Globigerinelloides japanica (Takayanagi) p.202

Remarks. A few specimens from the Late Coniacian of southern Iraq are tentatively described here as Gl. sp. aff. Gl. japanica Takayanagi. The specimens from Iraq have a much larger test size than the holotype of Gl. japanica Takayanagi. They also have spherical to subspherical chambers, and less exposed early chambers in the umbilical region. Gl. Japanica was first described from the Santonian to Upper Campanian of Hokkaido, Japan.

Globigerinelloides messinae messinae (Bronnimann)

pl.14, fig.12

1952 Globigerinella messinae messinae Bronnimann. pp.42-44, pl.1, figs.6,7, t.f.20a-q

1959 ? Planomalina messinae messinae (Bronnimann) Bolli. p.261

1962 Globigerinella messinae messinae Bronnimann. Herm. p.51, pl.3, fig.5

1962 Planomalina (Globigerinelloides) messinae (Bronnimann) Berggren. pp.44-49, t.f.6, figs.1a-b, 3a-b, 4a-b, 6a-b, t.f.7, figs.1a-b, ?2a-b, ?3a-b, 5a-b (not pl. 8, figs.4-8, t.f.6, figs.2a-b, 5a-b, t.f.7, figs.4a-b, 6a-b, 7a-b, 8a-b)

1962 ? Planomalina messinae messinae (Bronnimann) Pessagno. p.358.

1963 Planomalina (Globigerinelloides) messinae messinae (Bronnimann) Van Hinte pp.100-101, pl.12, fig.6

1964 Not Globigerinelloides messinae (Bronnimann) Olsson. pp.174-176, pl.7, figs.6-8

1966 Not Globigerinelloides messinae (Bronnimann) Ansary and Tewfik. p.45, pl.4, figs.7a-b

1967 ? Globigerinelloides volutus (White) Pessagno. pp.278-279, pl.62, figs.10-11 (not fig.9)

1969 Globigerinelloides multispinata (Lalicker) Douglas. pp.161-162, pl.9, figs.6a-c

Remarks. Gl. messinae messinae (Bronnimann) is characterized by its small, laterally compressed test; its $4\frac{1}{2}$-5 chambers in the last whorl; hisped surface; small umbilicus and high apertural opening.

It is morphologically similar to both Gl. asperum (Ehrenberg) and Gl. messinae voluta (White). It is distinguished from the former by its smaller and laterally compressed test, lesser number of chambers in the last whorl and ovoid peripheral outline. It differs from Gl. messinae voluta in the compressed nature of its test, hisped surface and higher apertural opening. The morphologically similar Gl. messinae subcarinata (Bronnimann) was originally described to have a strongly compressed test, angled periphery and rougher surface ornament.

Forms described by Berggren (1962) (see synonymy) from the Maestrichtian of Denmark as Planomalina (Gl.) messinae show the combined characters of Gl. messinae messinae and Gl. messinae voluta. They probably represent transitional specimens.

Forms described by Olsson (1964, pl.7, figs.6-8) from the Late Campanian and Early Maestrichtian of Delaware and New Jersey as Gl. messinae belong in two different species; Biglobigerinella multispina Lalicker and Gl. biforaminata (Hofker). That described by Douglas (1969, pl.9, figs.6a-c) as Gl. multispinata (Lalicker) is referrable to Gl. messinae messinae; it shows a compressed test, hisped surface ornament and a high apertural opening.

Pessagno (1967) considered Gl. messinae messinae to be a junior synonym of Gl. messinae voluta (White) originally described as Globigerina voluta. He (Op.cit.) stated "Although White's drawings of Gl. volutus are not accurate, it seems obvious from a comparison of the topotypic material with the holotype and paratypes of G. messinae s.s (Bronnimann) (U.S.N.M.) that G. voluta (White) is a senior synonym of G. messinae s.s (Bronnimann)". Unfortunately this statement cannot be checked, since (according to Dr. John Imbrie of Colombia University) White's types are missing from the Colombia University Paleontology Collection (see Pessagno 1967, p.278). However, as can be seen from the original description and figures of Bronnimann (1952) and that of White (1928) and from the samples here studied, the two forms should be separated.

Occurrence. Rare, in the lower and middle part of the Sadi formation. Sigalia carpatica zone, Globotruncana concavata subzone to Globotruncana fornicata subzone.

Previous record of Occurrence. The Maestrichtian of Trinidad, Denmark the Austro-German border and Switzerland. The Campanian - Maestrichtian of Texas? Arkansas? Mexico? and California.

Globigerinelloides messinae voluta (White)

pl.14, figs.10-11

1928 Globigerina voluta White pp.197-198, pl.28, figs.5a-b
1967 Not Globigerinelloides volutus (White) Pessagno. pp.278-279, pl.62, figs.9-11, pl.100, fig.9

Remarks. As stated under Gl. messinae messinae (Bronnimann) the types of this species are missing from the Colombia University Paleontology Collection. Thus a neotype will have to be erected from the Mendez station material.

Specimens figured by Pessagno (1967) as Gl. volutus (White) which show compressed tests, indistinct (hisped?) surface ornament and high, apertural openings belong in Gl. messinae messinae.

The writer suggests that all specimens of Globigerinelloides exhibiting; 1 - more than 5, globular or rather globular, inflated chambers which increase rather rapidly in size; hisped or papillate surface ornamentation and rather high apertural openings are referrable to Gl. asperum (Ehrenberg). 2.- $4\frac{1}{2}$ - 6 globular or rather globular inflated chambers increasing rapidly in size; a smooth or very finely ornamented surface;and low apertural openings are referrable to Gl. messinae voluta (White). 3 - small ovoid, moderately compressed tests; with $4\frac{1}{2}$ - 5 compressed, slightly inflated chambers which are elongated and elliptical in apertural view; a hisped surface and high apertural openings are referrable to Gl. messinae messinae (Bronnimann). 4 - similarity with (3) but with much more strongly compressed tests and with distinctly acutely angled axial peripheries are referrable to

Gl. messinae subcarinata (Bronnimann)

Occurrence. Abundant in the lower part of the Sadi formation. The upper part of the Globotruncana concavata subzone to Globotruncana fornicata subzone.

Previous record of Occurrence. It was originally described from the Mendez shale and base of the Velasco of Mexico.

Globigerinelloides pinguis (Herm)

pl.14, figs.7-9

1962 Globigerinella voluta (White) sub.sp. pinguis Herm. p.52, pl.1, fig.4 (three figures)

Description. Test small, biumbilicate, planispirally coiled, compressed in a direction perpendicular to the equatorial periphery; equatorial periphery subcircular to ovoid, slightly to moderately lobate; axial periphery rounded; chambers 5-7 in the last whorl, the early ones of which are comparatively very small, globular or subglobular, while the last two or three are large, ovoid, elongated in the direction perpendicular to that of coiling, $1\frac{1}{2}$ - 2 times as wide as high in apertural view, increasing rapidly in size; sutures straight, radial to gently curved and depressed on both sides; umbilicus very small compared with those of other species of Globigerinelloides owing to strong marginal compression, shallow and irregular in shape; wall calcareous, finely perforate; surface finely to moderately hisped, the hispidity gradually decreasing towards the last chamber; primary aperture interiomarginal, equatorial, a medium to rather low arch. The majority of specimens show no lip or lip-like projection but often relict supplementary apertures are present.

Main variations

1. The equatorial periphery is either subcircular, ovoid or subrectangular.
2. The test can be moderately to strongly compressed in a direction perpendicular to the equatorial periphery, and sometimes so strongly that it looks much thinner laterally than peripherally.
3. The apertural face is either flat, concave or slightly inflated. Its upper margin is either angled or narrowly rounded.
4. The aperture in very strongly compressed specimens is rather highly arched, but niether bipartite chambers nor a biapertural stage has been observed.

Remarks. Gl. pinguis was first described by Herm (1962) from the Lower Maestrichtian of the Austro - German border as Globigerinella voluta (White) sub.sp. pinguis. However, it is thought here that Globigerinella should be included in Hestigerina Thomson 1876 as a junior synonym. (See the amended definition of Loeblich and Tappan (1961, p.267).)

Gl. pinguis is morphologically rather close to each of the following species of Globigerinelloides, all of which, except Gl. asperum, appear in stratigraphically younger strata;

1. Gl. messinae messinae (Bronnimann)
2. Gl. messinae voluta (White)
3. Gl. asperum (Ehrenberg)

However, it differs in the shape of its test; the character of the axial periphery; the character of the last two or three chambers; the size and shape of the umbilicus; the apertural face and the character of its

upper margin.

Occurrence. Abundant in the upper part of the Tanuma and lowermost part of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone to Globotruncana concavata subzone.

Previous record of Occurrence. The Lower Maestrichtian of the Austro-German border.

Globigerinelloides prairiehillensis Pessagno

pl.14, fig.3

1967 Globigerinelloides prairiehillensis Pessagno. pl.60, figs.2-3, pl.83,?fig.1, pl.90, figs.1-2, ?,4.

Remarks and Occurrence. The writer has examined toptypic and hypotypic materials of Gl. yaucoensis (Pessagno) from the Rio Yauco formation of Puerto Rico and the Taylor formation of Texas respectively. He has also examined topotypic materials of Gl. prairiehillensis Pessagno from the Taylor formation of Texas and has found that there is little significant difference between them.

Gl. prairiehillensis is distinguished by its large and rapidly increasing chambers; its wider than high chambers, ovate in apertural view finely hisped surface ornamentation, straight and deep sutures and low apertural opening.

Occurrence. Rare in the uppermost part of the Khasib formation, the Tanuma formation and the lower half of the Sadi formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone to Globotruncana fornicata subzone.

Previous record of Occurrence. Campanian-Maestrichtian of Texas, southwestern Arkansas, Mexico and Puerto Rico (Pessagno (Op.cit.)).

Globigerinelloides tururensis (Bronnimann)

pl.13, figs.4-6

1952 Globigerinella tururensis Bronnimann. pp.51-52, pl.1, figs.4-5 t.f.27, figs.a-b,c-d,e-f, g-h,i-k,l-m

1959 Planomalina tururensis (Bronnimann) Bolli. pp.262-263 (no figure)

Description. Test small, thin, biumbilicate, planispirally coiled, partially evolute and laterally compressed; equatorial periphery ovoid, weakly lobate; axial periphery narrowly rounded; chambers 6-8 in the last whorl, compressed, early nearly ovoid and obliquely arranged, later laterally compressed, slightly ellipsoidal in peripheral view and trapizoidal in lateral view; as a general rule, chambers increase moderately in size as added; sutures straight, oblique in the early part, straight and more strongly depressed in the later part; umbilici medium, shallow; wall calcareous, perforate; surface smooth or very finely ornamented; aperture interiomarginal equatorial, a low arch. In well preserved specimens, the apertures of previous chambers remaining open in the umbilical region as relict supplementary apertures.

Main variation: The main variation observed in Gl. tururensis is in the degree of test compression (especially in the last portion) and in the degree of exposure of the early chambers in the umbilicus.

Remarks. All the characters given for Gl. escheri (Kaufmann) by Bronnimann (1952) coincide with those given for Gl. tururensis (Bronnimann) by the same author (Op.cit.). Both species show nearly the same test size, partially evolute coils, early inflated and later less inflated and laterally compressed chambers which increase gradually in size as added, elongate, ellipsoid last chambers in peripheral view, shallow umbilici, smooth surface and low apertural openings. Thus

Gl. escheri (Kaufmann) of Bronnimann (1952) (not Kaufmann 1885) is a synonym of Gl. tururensis (Bronnimann).

When Kaufmann (1865) figures N. escheri he failed to designate either a definite type locality or a type specimen. In 1952, Bronnimann selected the specimen represented by Kaufmann's figure 110 a (1865) as the lectotype. However, the selected lectotype is unfortunate choice as neither the surface ornamentation nor the apertural character is identifiable. For this reason Gl. tururensis is considered separately.

Occurrence. Abundant in the uppermost part of the Tanuma and the lowermost portion of the Sadi formation. ?Globotruncana renzi/Heterohelix pseudoguembeliniformis zone to Globotruncana concavata subzone.

Previous record of Occurrence. The Cenomanian - Lower Turonian of Trinidad.

Globigerinelloides sp.B sp.nov.

pl.15, figs.4-5

Description. Test small, biumbilicate, planispirally coiled and partially evolute; equatorial periphery circular, slightly lobate; axial periphery rounded; chambers 8 in the last whorl, small and globular even in the very mature forms, increasing so slowly that they all appear to be equal in size; sutures distinct, straight, radial and depressed on both sides; umbilici rather large, circular; wall calcareous, finely perforate; surface hisped; primary aperture an interiomarginal, equatorial, low arch with a bordering lip extending as a circular rim into both umbilical areas; the apertures of previous chambers remain open in the umbilical region as relict supplementary apertures.

Main variation: The main variation observed is in the size of the last chamber which sometimes is smaller than the penultimate one.

Remarks. Globigerinelloides sp.B. sp.nov. differs from Gl. escheri (Kaufmann) (the lectotype selected by Bronnimann 1952) in its greater number of chambers which are small, globular and increase very slowly in size as added; its fine but well defined, hisped surface, and the distinct, interumbilical, circular projection of the apertural lip. Judging from its figured lectotype, Gl. escheri (Kaufmann) is characterized by the 6 (rarely 5 or 7) rapidly increasing chambers, the early ones of which are subglobular, while the last are laterally compressed with an ellipsoid outline in apertural view and smooth surface. In addition, no interumbilical lip projection or other similar features are seen. The description given by Bronnimann (1952) for Kaufmann's species needs correction as neither definite apertural characters nor surface ornamentation can be seen. Its chambers are polygonal and increase rather rapidly in size as they are added; they are not globular and slowly increasing in size as stated by Bronnimann.

Globigerinelloides sp.B is morphologically similar to Gl. bentonensis (Morrow) originally described from the late Cenomanian rocks of the Greenhorn limestone of Kansas, but differ from it in its smaller test and chambers size; straight, radial sutures and partially exposed early whorls. In addition Gl. bentonensis possess's early spinose, closely appressed and later smooth chambers which increase rather rapidly in size as added. It differs from Gl. caseyi Loeblich and Tappan, originally described from the Gault clay of Arlesey, England, in its smaller test size, small to minute chambers which increase very slowly in size as added and its hisped surface.

Gl. bollii Pessagno was defined as having 6-7 spherical to ovoid chambers, smooth surface and high apertural opening.

Bolli (1959) followed by Bandy (1967) described as Planomalina escheri (Kaufmann) and Gl. escheri (Kaufmann) respectively, specimens which probably belong in Globigerinelloides sp.B sp.nov.

The writer has examined the holotype and paratypes of Planomalina rowi Barr at the B.M.(N.H.) and has found it to be a junior synonym of Gl. escheri clavata (Bronnimann).

Occurrence. Rare in the Khasib and Tanuma formations, abundant in the lowermost part of the Sadi formation immediately above which it dies out completely. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Globigerinelloides sp.A sp.nov.

pl.14, figs.4-6

Description. Test small, thick, biumbilicate, planispirally coiled; equatorial periphery ovoid, moderately lobate; axial periphery broadly rounded; chambers 7 in the last whorl, the early ones of which are small globular, slightly appressed, while the last two are ovoid, strongly appressed, strongly compressed in a direction perpendicular to the apertural face, increasing regularly in size as added; sutures straight, radial and depressed, umbilici small and shallow; wall calcareous, perforate; surface finely hisped, the hispidity gradually decreasing towards the last chamber; aperture interiomarginal, equatorial, a rather low opening; relict apertures hardly seen in the holotype, but in some well preserved specimens they remain open in the umbilical region as supplementary apertures.

Main variation: The last two or three chambers usually are so strongly compressed that they fuse and give the appearance of a single chamber.

Remarks. Globigerinelloides sp.A sp.nov. is distinguished from Gl. asperum (Ehrenberg) by the character of its last two or three chambers; the slow increase in chamber size and the low arched apertural opening.

The writer has examined the holotype of Gl. ehrenbergi (Barr) at the B.M.(N.H.) and has found that it differs from Globigerinelloides sp.A in having a partially evolute test; a greater number of chambers in the last whorl; a nearly circular outline and curved sutures. In addition its last two chambers are neither ovoidal nor appressed and compressed.

Globigerinelloides sp.A is similar to Gl. aissana (Sigal) originally described from the Cenomanian of north Algeria as Globigerinella aissana. However, as the type description contains no information about the surface ornamentation and chambers character and as its sutures seem distinctly curved, this writer considers the two species to be distinct.

Occurrence. Rare in the upper part of the Khasib formation, rare to abundant in the Tanuma and lower part of the Sadi formations.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Globigerinelloides sp.A var.1 var.nov.

pl.15, figs.1-3

Remarks. Globigerinelloides sp.A var.1 is distinguished from the typical form of the species by its smaller and thinner test; its very small, minute, distinctly globular early chambers in the last whorl which increase comparatively rapidly in size as added; its larger and deeper umbilici and its ultimate chamber which is sometimes smaller than the penultimate one.

The form is considered as a variety of Globigerinelloides sp.A sp.nov. because of similarity in shape of the test, the character of the last two or three chambers and in the hisped surface ornament. The two forms have different stratigraphic ranges.

Occurrence. Abundant, in the Tanuma and the lower part of the Sadi formations. ?Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Family	ROTALIPORIDAE	Sigal 1958
Subfamily	HEDBERGELLINAE	Loeblich and Tappan 1961
Genus	Clavihedbergella	Banner and Blow 1959

Type species Hastigerinella subcretacea Tappan 1943

Clavihedbergella cf. simplex (Morrow)

pl.16, fig.6

1934	Hastigerinella simplex Morrow.	p.198, pl.30, fig.6
1961	Clavihedbergella simplex (Morrow)	Loeblich and Tappan. pp.279-280 pl.3, figs.11a-c (not figs. 12-14a-b)
1962	Clavihedbergella simplex (Morrow)	Ayala. pp.25-26, pl.4, figs.2a-c,3a-c (not fig.1) pl.5, figs.1a-c
1964	Clavihedbergella simplex (Morrow)	Todd and Low. pp.403-404, pl.1, figs.1a-c
1969	Clavihedbergella simplex (Morrow)	Douglas. p.163, pl.5, figs. 5a-c (not fig.4)

Remarks. A few specimens here described as Clavihedbergella cf. simplex (Morrow) probably belong in different species. They differ from the holotype in having a less strongly lobate equatorial periphery.

According to the latest records, the stratigraphic range of Clavihedbergella simplex (Morrow) is Cenomanian to Coniacian. (Loeblich and Tappan (1961), Pessagno (1967) and Douglas (1969).)

In southern Iraq it occurs as a rare form in the Coniacian of the Khasib formation.

Genus Hedbergella Bronnimann and Brown 1958

Type species Anomalina lorneiana d'Orbigny
var. trocoidea Gandolfi 1942.

Hedbergella amabilis Loeblich and Tappan

pl.16, fig.6

1961 Hedbergella amabilis Loeblich and Tappan p.274, pl.3, figs.1-10
1967 Hedbergella amabilis Loeblich and Tappan. Pessagno. pp.281-282, pl.52, figs.6-8

Remarks. Hd. amabilis is distinguished by its compressed, flattened and low trochospiral test; strongly lobate equatorial periphery; subclavate chambers and deeply constricted sutures which are radial to gently curved. Hd. planispira (Tappan) has more chambers per whorl, less constricted sutures and less radially elongated chambers.

Loeblich and Tappan (1961) illustrated the range of variation of this species and its close relation to Clavihedbergella simplex (Morrow). However, the later species has perfect clavate chambers.

In general, Hd. amabilis Loeblich and Tappan differs from other species of Hedbergella in the subclavate nature of its chambers.

Occurrence. Only a few specimens were found in the Khasib formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. The Cenomanian of Georgia, U.S.A., Puerto Rico and Trinidad, The Cenomanian - Coniacian of Texas and Mexico (see Pessagno 1967, p.282)

Hedbergella brittonensis Loeblich and Tappan

pl.16, figs.4-5

1961 Hedbergella brittonensis Loeblich and Tappan. pp.274-275, pl.4, figs.1-8
1962 Hedbergella brittonensis Loeblich and Tappan. Ayala. pp.23-24, pl.3, figs.1a-c, pl.8, figs.3a-b

1966 Hedbergella delrioensis (Carsey) Butt. pp.173-174, pl.2, figs.8a-c (not figs.1-7)
1967 Hedbergella brittonensis Loeblich and Tappan. Pessagno. p.282, pl.52, figs.9-12

Remarks. Bandy (1967) considered Hd. brittonensis Loeblich and Tappan to be a junior synonym of Globigerina portsdownensis Williams - Mitchell (1948) because of the similar apertural characters, surface ornament and stratigraphic range (Cenomanian). However, this is to be doubted since Hd. brittonensis in this study was found at stratigraphically younger levels. In addition, Hd. portsdownensis was originally described to have a cancellate surface ornament, a lesser number of chambers and strongly constricted sutures. According to M. Hart (personal communication) the types show two weak peripheral keels and the species does not belong in Hedbergella.

Butt (1966) described from the type Turonian as Hd. delrioensis (Carsey) a form which probably belong in Hd. brittonensis (see synonomy).

Occurrence. Rare, in the Khasib and Tanuma formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. The Cenomanian of Kansas and Georgia. The Turonian of the Paris basin. The Cenomanian - Turonian of Mexico and the Cenomanian - Coniacian of Texas.

Hedbergella crassa (Bolli)

pl.18, figs.5-6

1959 Praeglobotruncana crassa Bolli. p.265, pl.21, figs.1,2
1962 ? Praeglobotruncana crassa Bolli. Pessagno. p.358, pl.6, figs. 5-6
1965 Hedbergella crassa (Bolli). Takayanagi. p.203, pl.21, figs.2a-3c
1969 Hedbergella crassa (Bolli). Douglas. p.165, pl.5, fig.2

Remarks. The main variation observed in Hd. crassa is in the degree of flattening of the spiral side, which in some specimens may even become

concave.

Hd. crassa was first described by Bolli (1959) as Praeglobotruncana crassa n.sp. He (Ibid) remarked that the species differs from Hd. gautierensis (Bronnimann) in the possession of only 5 chambers in the last whorl, less compressed chambers and a smaller, deeper umbilicus.

Because the lack of imperforate peripheral margin or keel, Hd. crassa (Bolli) is here assigned in genus Hedbergella.

Hd. prachalvetica (Trujilla) described from the middle Turonian of California differs from Hd. crassa in having the chambers in the last whorl increasing rapidly in size, a large umbilicus and slightly sharpened periphery.

Occurrence. Abundant in the Khasib, Tanuma and the lowermost part of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembelini-formis zone - Globotruncana concavata subzone.

Previous record of Occurrence. The Turonian - Maestrichtian of California The Turonian - Lower Santonian of Naparima Hill formation, Trinidad. The Turonian - Lower Campanian of Puerto Rico.

Hedbergella delrioensis (Carsey)

pl.17, figs.8-10

1926 Globigerina cretacea d'Orbigny. var. delrioensis Carsey. p.43 (no figure)

1943 Globigerina cretacea d'Orbigny. Tappan. p.512, pl.82, figs.16, 17.

1954 Globigerina delrioensis Carsey. Frizzell. p.127, pl.20, fig.1

1959 Praeglobotruncana (Hedbergella) delrioensis (Carsey) Banner and Blow. p.8

1960(a) Globigerina cretacea d'Orbigny. Takayanagi. p.137, pl.10, figs.8a-c

1960(b) Globigerina cf. delrioensis Carsey. Takayanagi. p.138, pl.10, figs.9a-c

1961 Hedbergella delrioensis (Carsey) Loeblich and Tappan. p.275, pl.2, figs.11-13

1962 Hedbergella delrioensis (Carsey) Takayanagi and Iwamoto. p.190, pl.28, figs.10a-12c

1963	Hedbergella delrioensis (Carsey)	Renz Luterbacher and Schneider p.1083, pl.9, figs.5a-c
1964	Hedbergella trocoidea (Gandolfi)	Taylor. p.593-594, pl.84, figs.4,5(not fig.6), ?7
1965	Hedbergella delrioensis (Carsey)	Takayanagi. p.204-205, pl.21, figs.4a-c
1966(a)	Hedbergella delrioensis (Carsey)	Salaj and Samuel. p.167, pl.8, figs.5a-c
1966(b)	Hedbergella infracretacea (Glaessner)	Salaj and Samuel. Ibid. p.163, pl.8, figs.10a-c
1966	Hedbergella delrioensis (Carsey)	Butt. pp.173-174, pl.2, figs.3, 4,6,7 (not figs.1,2,5,8)
1967	Hedbergella delrioensis (Carsey)	Pessagno. p.282-283, pl.48, figs.3-5 (not figs.1,2)

Remarks. Hd. delrioensis (Carsey) is distinguished by its $4\frac{1}{2}$ - 5, rarely 6, rather rapidly increasing chambers, the nature of last chamber which usually bends towards the umbilicus, flush to slightly raised initial chambers, hisped, papillose surface and straight to gently curved sutures. The writer suggests that all Hedbergella exhibiting;

1. Low trochospiral to nearly planispiral test, chambers slowly to rather rapidly increasing in size and gently curved sutures at least in the early portions of the last volution, should refer to Hd. planispira (Tappan).

2. As in (1) but with a rapid increase in the size of the chambers, and a lesser number of chambers, should refer to Hd. monmouthensis Olsson.

3. As in (2) with compressed, ovate and elongated chambers, should refer to Hd. holmdelensis Olsson.

Hd. delrioensis was originally described by Carsey (1926) as a variety of Globigerina cretacea d'Orbigny, but he failed to figure it and designate the depository of the type specimens. According to Pessagno (1967) the location of the type specimens which are assumed to be deposited in the Carsey collection at the University of Texas is doubtful. Frizzell (1954) elevated Globigerina cretacea var. delrioensis Carsey to specific rank.

Banner and Blow (1959) placed it in the subgenus Praeglobotruncana (Hedbergella) and Loeblich and Tappan (1961) in the genus Hedbergella. Owing to its apertural character and the perforate peripheral margins, the species is here placed in Hedbergella.

Occurrence. Appears in the lower part of the Khasib formation. It increases gradually upwards in the section and dies out completely in the middle part of the Sadi formation.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana fornicata subzone.

Previous record of Occurrence. The Cenomanian of Trinidad. The Cenomanian to Coniacian of California and Europe. The Aptian - Campanian of Texas, Mexico, West Carpathian and Hokaido (Japan).

Hedbergella gautierensis (Bronnimann)

pl.16, figs.7-8

1952	Globigerina gautierensis Bronnimann.	pp.11-14, pl.1, figs.1-3, t.f. 2a-m
1940	Globigerina cretacea d'Orbigny. Tappan.	pp.121-122, pl.11, figs.11a-c
1959 Not	Praeglobotruncana gautierensis (Bronnimann) Bolli.	pl.21, figs.3-6 = Hd. trocoidea, p.265. (Gandolfi)
1960	Praeglobotruncana gautierensis (Bronnimann) Jones.	p.102, pl.15, figs.1a-c,2a-c,3-6, (not figs.7-9)
1960	Praeglobotruncana gautierensis (Bronnimann) Pessagno.	p.98 (no figure)
1962 ?	Praeglobotruncana gautierensis (Bronnimann) Pessagno.	p.358, pl.6, fig.4
1962	Praeglobotruncana gautierensis (Bronnimann) Petri.	pl.17, figs.1a-c,2a-c

Remarks. Hd. gautierensis was first described by Bronnimann (1952) from the Cenomanian - Turonian of the Gautier formation of Trinidad as Globigerina gautierensis. Inspite of its unkeeled, perforate peripheral margins and apertural character, no one has yet placed this species in

Hedbergella.

Loeblich and Tappan (1961), followed by Takayanagi (1965) and Pessagno (1967), considered Hd. gautierensis (Bronnimann) to be a junior synonym of Hd. delrioensis (Carsey). However, as can be seen from the original description, the figured holotype and paratypes and from the samples here studied, the morphological features of the two species strongly warrent their separation in spite of their apparent similarity.

Hd. gautierensis is distinguished by its loosely coiled test, depressed early chambers, compressed last chamber, small umbilicus and by the nature of its aperture which extends also to the spiral side.

Forms described by Bolli (1959) as Praeglobotruncana gautierensis lack the above-mentioned characters and have 2-3 coils which are highly trochospiral. They possibly belong in Hd. trocoidea (Gandolfi).

Occurrence. Abundant in the lowermost part of the Khasib formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. The Cenomanian of Trinidad. The Cenomanian - Middle Campanian of Texas. The Cenomanian - Maestrichtian of Brazil. The Coniacian - Campanian of South-Central Puerto Rico.

Hedbergella hessi (Pessagno)

pl.17, fig.11

1962 Praeglobotruncana hessi Pessagno. pp.358-360, pl.5, figs.8-12
1966 ? Hedbergella hessi (Pessagno) El-Naggar. p.151 (no figure)
1966 Hedbergella hessi hessi (Pessagno) Ansary and Tewfik. p.47, pl.4, figs.8a-c
1967 Loeblichella hessi (Pessagno) Pessagno. p.288, pl.48, figs.17-19 (not pl.61, figs.6-11)

Remarks. In southern Iraq several specimens were observed similar to Hd. hessi (Pessagno). The holotype was described by Pessagno (1962) from the Rio Yauco formation of Puerto Rico, and was said to have a

flattened to gently convex spiral side, 5-6 chambers in the last whorl which increase rapidly in size as added, radial to slightly curved and depressed sutures on both spiral and umbilical sides, an early spinose and later smooth surface, a broad umbilicus and an interiomarginal, extraumbilical-umbilical aperture.

In the redescription of Hd. hessi, Pessagno (1967) added "spiral side flattened, last whorl with 5-6 subtrapizoidal to trapizoidal chambers, chambers coarsely rugose". He (1962) remarked that the holotype differs from Pr. hessi compressiformis Pessagno (= Pr. coarctata Bolli) in its less compressed chambers and lack of a keel, and, in 1967, only in the absence of an angled periphery.

In spite of this confusion, Pessagno was trying to insist mainly on three characters; 1 - the elongate, subtrapizoidal to trapizoidal chambers of the last whorl, 2 - the low trochospiral to nearly flat spiral side, and 3 - the random surface ornamentation. However, these characters, in fact are the main diagnostic features of Pr. coarctata, originally described by Bolli (1957).

The writer has examined topotype specimens of Hd. hessi (Pessagno) Pr. hessi compressiformis Pessagno and Pr. coaretata Bolli Kidely presented by Dr. E. Pessagno.

Occurrence. Abundant in the Tanuma formation, rare in the Sadi, Hartha, Qurna and Tayarat formations. The upper part of the Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of Puerto Rico, the Upper Cenomanian to Santonian of Mexico, the Upper Cenomanian to Maestrichtian of Texas, the Campanian of Arkansas and the Campanian to

flattened to gently convex spiral side, 5-6 chambers in the last whorl which increase rapidly in size as added, radial to slightly curved and depressed sutures on both spiral and umbilical sides, an early spinose and later smooth surface, a broad umbilicus and an interiomarginal, extraumbilical-umbilical aperture.

In the redescription of Hd. hessi, Pessagno (1967) added "spiral side flattened, last whorl with 5-6 subtrapizoidal to trapizoidal chambers, chambers coarsely rugose". He (1962) remarked that the holotype differs from Pr. hessi compressiformis Pessagno (= Pr. coarctata Bolli) in its less compressed chambers and lack of a keel, and, in 1967, only in the absence of an angled periphery.

In spite of this confusion, Pessagno was trying to insist mainly on three characters; 1 - the elongate, subtrapizoidal to trapizoidal chambers of the last whorl, 2 - the low trochospiral to nearly flat spiral side, and 3 - the random surface ornamentation. However, these characters, in fact are the main diagnostic features of Pr. coarctata, originally described by Bolli (1957).

The writer has examined topotype specimens of Hd. hessi (Pessagno) Pr. hessi compressiformis Pessagno and Pr. coaretata Bolli Kidely presented by Dr. E. Pessagno.

Occurrence. Abundant in the Tamuma formation, rare in the Sadi, Hartha, Qurna and Tayarat formations. The upper part of the Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of Puerto Rico, the Upper Cenomanian to Santonian of Mexico, the Upper Cenomanian to Maestrichtian of Texas, the Campanian of Arkansas and the Campanian to

Maestrichtian of Egypt, U.A.R.

Hedbergella holmdelensis Olsson

Hedbergella holmdelensis Olsson

1964 Hedbergella holmdelensis Olsson. pp.160-161, pl.1, figs.1-2

Remarks. In southern Iraq all specimens of Hd. holmdelensis were poorly preserved.

Hd. holmdelensis is very close to Hd. planispira (Tappan) and further investigations may prove their synonymity. However, in this study Hd. holmdelensis was found to differ from Hd. planispira in having compressed, subspherical chambers and a large and shallower umbilicus.

Occurrence. Rare in the lower part of the Tayarat formation.

Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of the Navesink formation, New Jersey.

Hedbergella aff. paradubia (Sigal)

pl.17, figs.1-3

1952 Globigerina paradubia Sigal. p.28, fig.28 (three figures)
1962 Praeglobotruncana ? paradubia (Sigal) Lehmann. p.40,154, pl.2, fig.3
1966 Praeglobotruncana ? paradubia (Sigal) Caron. pl.3, figs.5a-c
1966 Hedbergella delrioensis (Carsey) Butt. pp.173-174, figs.1a-c 5a-c (not figs.2,3,4,6 7,8)

Remarks. Hd. paradubia was originally described by Sigal (1952) from the Cenomanian rocks of the northern Algeria, but he failed to designate the exact type locality. Moreover, neither the apertural character nor the surface ornamentation were illustrated and his type description was so brief and vague that most later authors assigned similar forms to different species.

However, judging from figure 28, it shows an interiomarginal extra-

umbilical - umbilical aperture, a medium sized umbilicus, 2½ rather highly coiled whorls, subspherical, moderately inflated chambers and a narrowly rounded axial periphery.

Comparison with a similar form from norther Algeria in Mr. Carter's personal collection, shows that the Iraqi materials have a rugose and hisped surface ornament, as opposed to a smooth test and less strongly compressed chambers in the last whorl.

The writer has found that there is little significant difference between the holotype of Rugoglobigerina kingi Trujillo and the figured type of Globigerina paradubia Sigal. The former should be regarded as a junior synonym of the latter.

Three of the specimens (pl.3, figs.5a-c, pl.4, figs.7,8) figured by Subbotina (1953) as Rotundata ordinaria are referrable to Hd. paradubia. Likewise, the specimens figured as Hd. delrioensis (Carsey) by Butt (1966) (see synonymy) from the type Turonian are referrable to Hd. paradubia (Sigal).

Occurrence. Rare in the Khasib and Tanuma formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. The Cenomanian of Algeria, Turonian of Switzerland, France and Morocco. It was also recorded as Rugoglobigerina kingi Trujillo from the Cenomanian - Coniacian of California (Trujillo 1960, Takayanagi 1965 and Douglas 1969).

Hedbergella planispira (Tappan)

pl.16, figs.10-12; pl.17, figs.4-7

1940 Globigerina planispira Tappan. p.12, pl.19, fig.12
1952 Globigerina planispira Tappan. Colom. p.269, pl.1, figs.1-12
1953 Globigerina planispira Tappan. Crespin. p.35, pl.6, fig.16
1959 Praeglobotruncana modesta Bolli. p.267, pl.22, figs.2a-c

1960	Praeglobotruncana hansbollii	Trujillo.	p.339, pl.49, figs.7a-c
1962	Praeglobotruncana planispira (Tappan)	Petri.	pp.121-122, pl.16, figs.8a-c (not figs.7a-c)
1963	Hedbergella planispira (Tappan)	Rasheed.	pp.238-239, pl.4, figs.8-10
1964	Hedbergella planispira (Tappan)	Olsson.	pp.161-162, pl.1, figs.5a-c,(not figs.4a-c)
1965	Hedbergella planispira (Tappan)	Escher.	p.905, pl.106, figs. 1a-c
1965	Hedbergella planispira (Tappan)	Takayanagi.	pp.205-206, pl.21, figs.6a-c,7a-c, pl.22, figs.1a-c (including additional synonymy up to 1961)
1966	Hedbergella planispira (Tappan)	Marianos and Zingula.	p.335, pl.37, figs.6a-c
1967	Hedbergella planispira (Tappan)	Bandy.	p.10-11, t.f.4(3) (lower)
1967	Hedbergella planispira (Tappan)	Pessagno.	p.283, pl.51, fig.1 pl.53, figs.1,2,3,4
1969	Hedbergella planispira (Tappan)	Douglas.	p.168, pl.5, fig.1

Remarks. Hd. planispira (Tappan) was originally described as Globigerina planispira; later Loeblich and Tappan (1961) placed it in the genus Hedbergella. Tappan (Op.cit.) compared her species with Globigerina cretacea d'Orbigny. In fact, Hd. planispira (Tappan) is much more closely related to Hd. trocoidea (Gandolfi) than to Globigerina cretacea. It differs in having chambers arranged in two whorls as opposed to 3-4 in Hd. trocoidea and in its low trochospiral to nearly planispiral test.

Bolli (1959) described from the Albian and Cenomanian rocks of Trinidad as Praeglobotruncana modesta, a form which only differs from Hd. planispira in having 7-8 chambers in its last whorl as opposed to 5-6. The writer has found that there is little if any significant difference between the two holotypes. Hence Pr. modesta Bolli is regarded as a junior synonym of Hd. planispira (Tappan).

Trujillo (1960) described from the Coniacian of California as Praeglobotruncana hansbollii a form which is not significantly morphologically different from Hd. planispira, both species are characterized by

having small, low trochospiral test, straight radial to gently curved sutures and a wide umbilicus.

Regarding Pr. hansbollii Trujillo stated "they are considerably flatter and do not have such a depressed umbilical area as does Hd. planispira" and "it appears that the aperture of Pr. planispira does not extend as a low slit on to the peripheral margin".

In southern Iraq, both the above characters fall within the range of variation of Hd. planispira; moreover, this latter exhibits either a slow or a rather rapid increase in the chambers size. Hence Pr. hansbollii Trujillo is also regarded as a junior synonym of Hd. planispira (Tappan).

The forms described by Olsson (1964) in pl.1, fig.4 as Hd. planispira (Tappan) and in pl.1, fig.3 as Hd. monmouthensis should be referred in Hd. holmdelensis Olsson.

Occurrence. Abundant in the Khasib and Tanuma formations.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. Texas, Cenomanian - Coniacian. California, Albian - Campanian. New Jersey, Upper Campanian. Trinidad, Aptian - Campanian. Mexico, Albian - Coniacian. Brazil, Aptian - Lower Cenomanian. West Australia, Cenomanian - Campanian. Spain, Cenomanian - Turonian. Rumania, Albian. Germany, Cenomanian. England, Aptian. U.S.S.R., Aptian - Cenomanian and Egypt, Coniacian - Santonian.

Hedbergella praehelvetica (Trujillo)

pl.17, fig.12

1960 Rugoglobigerina praehelvetica Trujillo. p.340, pl.49, figs.6a-b
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

Remarks. Hd. praehelvetica is rare to rather abundant in the Coniacian rocks of the Khasib formation and the lower part of the Tanuma formation.

The writer has examined a topotype specimen of Praeglobotruncana helvetica (Bolli), kindly presented by Dr. Bolli and found a close link between this species and Hd. praehelvetica.

Occurrence. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. Known only from the Turonian of California.

Genus Praeglobotruncana Bermudez 1952

Type species Globorotalia delrioensis Plummer 1931

Praeglobotruncana coarctata Bolli

pl.19, figs.1-2

1957 Praeglobotruncana coarctata Bolli. p.55, pl.12, figs.2a-c, 3a-c

1960 ? Praeglobotruncana mattsoni Pessagno. pp.98-99, pl.2, figs.1-3 6-8

1962 Praeglobotruncana hessi compressiformis Pessagno. p.360, pl.5, figs.1-7

1967 Loeblichella coarctata (Bolli) Pessagno. pp.288-289, pl.48, figs.14,16,20, pl.61, figs.4,5, pl.62, figs.1-3,6-8, pl.76, figs.7-9

1967 Loeblichella hessi (Pessagno) Pessagno. Ibid. p.288, pl.61, figs.6-8,9-11, pl.100, figs.1-2? (not pl.48, figs.17-19)

Remarks. Pr. coarctata Bolli is distinguished by its compressed, thin test, with 5-6 (rarely $4\frac{1}{2}$) ovate to subtrapizoidal chambers in the last whorl, its carinate equatorial periphery and angled axial one.

Pessagno (1962) described Pr. hessi compressiformis as a new subspecies and remarked that it differs from Pr. coarctata Bolli in its more elongate chambers in the last whorls and in the coarsely spinose

nature of all but last two chambers. He later (1967) considered it to be a junior synonym of the latter.

On comparing the type description, the figured holotype and paratypes of Pr. hessi compressiformis with those of Pr. coarctata and examining topotypic material kindly sent by Dr. Pessagno, it was found that the morphological features of the two species strongly favour their synonymity. Both species are characterized in having compressed, thin tests, low trochospiral, slightly convex to nearly flat spiral sides, carinate last two chambers, angled axial peripheries and elongate to ovoid or subtrapizoidal chambers in the last whorls.

The writer also has examined topotypic material of Pr. mattsoni Pessagno. This species is regarded as a junior synonym of Pr. coarctata Bolli.

Occurrence. Abundant in the upper part of Khasib formation, the Tanuma formation and the lower part of the Sadi formation. Rare in the upper part of the Sadi formation, the Hartha formation, the Qurna formation and the lowermost part of the Tayarat formation. Upper part of the Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. The Lower Campanian of the Naparima Hill formation of Trinidad, the Campanian of Arkansas, the Cenomanian - Turonian, Campanian and Maestrichtian of Texas, the Turonian of Mexico and the Lower Maestrichtian of Puerto Rico. There are also unconfirmed records from north Africa.

Praeglobotruncana inornata (Bolli)

pl.18, figs.1-4

1957	Globotruncana inornata Bolli.	pp.57-58, pl.13, figs.5-6
1962	Globotruncana (Globotruncana) inornata Bolli. Pessagno.	p.362, pl.6, figs.7-9
1967 ?	Whiteinella inornata (Bolli) Pessagno.	p.299, pl.71, figs.3-5
1967	Whiteinella archaeocretacea Pessagno.	pp.298-299, pl.51, figs.2-4 (not figs.19-21, 22-24, 25)
1969	Hedbergella archaeocretacea (Pessagno) Douglas.	p.165, pl.1 figs.5a-c (not pl.6, figs.7a-c)

Remarks. Pr. inornata was first described by Bolli (1957) from the Turonian Lower Campanian rocks of Trinidad. It is distinguished from other similar species by its slightly compressed test, with 4-5 large, ovate chambers in the last whorl, the early ones of which are subspherical in peripheral view and the last two laterally compressed, a narrowly rounded or carinate or only sharpened periphery and a wide umbilicus.

Pr. inornata is morphologically similar to Pr. wilsoni (Bolli) but differs from it in having the early chambers of the last whorl rounded on the periphery rather than with a double keel (see also Bolli 1957, p.58).

Pessagno (1967) in the type description remarked that Whiteinella archaeocretacea n.sp. differs from W. inornata (Bolli) in having a rounded rather than an angled periphery, but he did not mention which part is rounded and whether it is narrowly or broadly rounded. He also stated that he has noted no true carinae on Bolli's type specimens or on the specimens encountered during the courseoof his study and that the sectioned specimens of W. inornata (Bolli) show a completely perforate peripheral band. However, his figured specimens of W. inornata (pl.7, figs.3-5) show distinctly thickened carinae all round the periphery. The examination of topotypic materials belonging to both species revealed

the presence of a close relationship in their peripheral character, chambers shape, surface ornamentation and the umbilicus.

Inspite of this fact, this writer hesitates to postulate their complete synonymity, mainly because Pessagno's type description does not coincide with the figured holotype.

Specimens described by Douglas (1969, pl.5, figs.5a-c) as Hd. archaeocretacea (Pessagno) are actually of Pr. inornata (Bolli), one of his forms (pl.6, figs.7a-c) probably belongs in Hd. amabilis Loeblich and Tappan.

Occurrence. Abundant in the Khasib, Tanuma and the lower half of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana fornicata subzone.

Previous record of Occurrence. The Turonian - lower Campanian of the Naparima Hill formation of Trinidad. It was also recorded from the Turonian to Lower Santonian of Texas and Mexico and the Turonian - Coniacian of California.

Praeglobotruncana wilsoni (Bolli)

pl.18, figs.7-9

1957 Globotruncana wilsoni Bolli. pp.58-59, pl.14, figs.4a-c
1967 Praeglobotruncana wilsoni (Bolli) Bandy. p.17, t.f.8(5)

Remarks. Pr. wilsoni was first described by Bolli (1957) from the Lower Santonian of the Naparima Hill formation of Trinidad as Globotruncana wilsoni. He remarked that this species differs from G. lapparenti bulloides Vogler in having an ovate test, two more closely spaced keels which often reduce to one and in having only 4 chambers in the last whorl.

Pessagno (1967), who examined the types of G. wilsoni Bolli (= Pr. wilsoni (Bolli)) at the U.S. Natural Museum, noted that the

holotype is closely related to Marginotruncana marginata (Reuss) (= G. marginata (Reuss)), but shows depressed sutures both spirally and umbilically. He added that the paratypes from the Maestrichtian portion of Guayare formation show rugosities aligned in a meridional pattern and are clearly referrable to Rugotruncana subcircumnodifer (Gandolfi) (= G. subcircumnodifer (Gandolfi)).

However, as can be judged from the figured holotype, the figured paratypes, the type description of Pr. wilsoni (Bolli) and from the specimens here studied, Pr. wilsoni is distinguished from G. subcircumnodifer by its quadrelobate periphery; its poorly developed, faint keels; its lesser number of chambers in the last whorl (4 chambers as opposed to 5 plus) and less rough to nearly smooth surface. In addition, Pr. wilsoni appears in stratigraphically older strata than G. subcircumnodifer.

It differs from G. marginata (Reuss) in its poorly developed, faint keels; its lesser number of chambers in the last whorl and in having depressed sutures on both sides of the test.

Occurrence. Abundant, restricted to the lower part of the Sadi formation. Globotruncana concavata subzone.

Previous record of Occurrence. The holotype was described from the lower Santonian of the Naparima Hill formation; the paratypes were from the Maestrichtian of the Guayaguayare formation, Trinidad.

Family	GLOBOTRUNCANIDAE	Brotzen 1942
Genus	Globotruncana	Cushman 1927
Type species	Pulvinulina arca	Cushman 1926

Globotruncana aegyptiaca aegyptiaca Nakkady

pl.19, figs.7-9

1950 Globotruncana aegyptiaca Nakkady. p.690, pl.90, figs.20-22
1954 ? Globotruncana aegyptiaca Nakkady. Nakkady and Osman. pp.75-76, pl.20, fig.20
1956 Not Globotruncana aegyptiaca Nakkady. Said and Kenawy. p.150, pl.5, figs.19a-c
1963 Not Globotruncana aegyptiaca Nakkady. Kavary and Frizzell. p.51, pl.9, figs.26-28
1963 Not Globotruncana (Globotruncana) aegyptiaca Nakkady. Van Hinte pp.87-89, pl.8, figs.1a-2c
1966 ? Globotruncana aegyptiaca Nakkady. Ansary and Tewfik. p.49, pl.6 figs.8a-c
1966 Globotruncana aegyptiaca aegyptiaca Nakkady. El-Naggar. pp.76-80, pl.3, figs.4a-d, pl.4, fig.1
1967 Globotruncana aegyptiaca Nakkady. Pessagno. pp.319-321, pl.83, figs.8-10 (not pl.79, figs. 2-4; pl.94, fig.6; pl.95, fig.8-9)
1967 Globotruncana duwi Nakkady. Pessagno. Ibid. pp.333-336, pl.83, figs.2-4, (not pl.83, figs.5-7)

Remarks. G. aegyptiaca aegyptiaca was originally described by Nakkady (1950) from the Maestrichtian rocks of western Sinai. Berggren (1962), followed by Van Hinte(1963) and Pessagno (1967) considered G. gagnebini Tilev to be a junior synonym of G. aegyptiaca Nakkady, while Bandy (1967) included it in the synonymy of G. aegyptiaca duwi Nakkady.

G. gagnebini Tilev differs from G. aegyptiaca aegyptiaca in its moderately lobate, ovate test and its greater number of chambers in the last whorl which are elongated and increase rapidly in size as added.

Bronnimann and Brown (1956) described as Rugotruncana skewesae a form which Van Hinte(1963) and El-Naggar (1966) included in the synonymy of G. aegyptiaca aegyptiaca Nakkady, Olsson (1964) in that of

G. gagnebini Tilev and Pessagno (1967) with G. aegyptiaca duwi Nakkady. As can be seen from the original description and figures of Rugotruncana skewesae and from sample here studied it is more closely related to G. gagnebini than to any other species. It has neither the triangular peripheral outline of G. aegyptiaca duwi nor the quadrilobate one of G. aegyptiaca aegyptiaca. In addition, its last whorl is composed of a greater number of chambers which differ from those of the above two species and increase moderately in size as added.

El-Naggar (1966 pp.78-79) stated "forms of G. aegyptiaca aegyptiaca with a distinctly spinose periphery and spinose early chambers on the ventral side mentioned by Nakkady (1950), were observed amongst his paratypes (B.M.N.H., no.P41774)."

Inspite of this statement, Nakkady (195C) did not mention the presence of such spine-like features in his specimens. This writer has examined the holotype and the paratypes of the species in question at the British Museum (Natural History) and has found they also lack the spinose ventral chambers and spinose periphery.

When the morphological similarity between the G. bulloides austinensis Pessagno (not Gandolfi) and G. aegyptiaca groups, their vertical stratigraphic distribution and the general evolutionary tendencies of species of Globotruncana are considered, G. bulloides austinensis appears to represent the ancestral stock of Nakkady's two species. By flattening of the spiral side, decreasing the number of the chambers in the last whorl and by development of equal sized, petaloid chambers, G. bulloides austinensis might possibly have evolved into G. aegyptiaca aegyptiaca Nakkady, probably through a yet unknown species (see under G. aegyptiaca duwi).

Occurrence. Abundant in the uppermost part of the Hartha formation, and the lower part of the Qurna formation. Rare in the upper part of the Qurna and throughout the Tayarat formation. The uppermost part of the Lower Maestrichtian - Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of Egypt, Mexico, Trinidad and south-western Arkansas.

Globotruncana aegyptiaca duwi Nakkady

pl.19, figs.10-12

1950 Globotruncana aegyptiaca Nakkady var. duwi Nakkady. p.690, pl.90, figs.17-19

1964 ? Globotruncana aegyptiaca var. duwi Nakkady. Said and Sabry. p.387, pl.3, figs.2a-c

1966 Globotruncana duwi Nakkady. Ansary and Tewfik. p.49, pl.6, figs.4a-b

1966 Globotruncana aegyptiaca duwi Nakkady. El-Naggar. p.80, pl.81, figs.5a-c

1967 Globotruncana duwi Nakkady. Pessagno. pp.333-336, pl.8, figs.5-7 (not figs.2-4)

Remarks. G. aegyptiaca duwi was originally described by Nakkady (1950) from the Upper Cretaceous chalk of Jebel Duwi of the U.A.R. Berggren (1962) and Van Hinte(1963), considered it as a junior synonym of G. aegyptiaca aegyptiaca Nakkady. However, an examination of the holotype and paratypes of Nakkady (1950) and the hypotypes of El-Naggar (1966) from the Esna - Idfu section of Egypt, at the British Museum (Natural History) and the samples here studied, suggests that the two species represent distinct morphologic types and should be considered as separate species. In addition, G. aegyptiaca duwi occurs in stratigraphically younger beds.

G. aegyptiaca duwi Nakkady is distinguished from G. aegyptiaca aegyptiaca Nakkady by its small test size, nearly triangular peripheral outline especially in the umbilical view, much less lobate equatorial

periphery, more protruded umbilical side and the rapidly increasing chamber size in the last whorl. It is morphologically close to G. fornicata cesarensis Gandolfi, described from the Campanian - Maestrichtian of Colombia. Both have a roughly similar test shape and an equal number of chambers with a similar rate of increase. However, G. fornicata cesarensis has its chambers distinctly inflated spirally and in some specimens, the last chamber shows a G. fornicata type appearance. Nevertheless, both species are considered to be valid as the latter appears in stratigraphically older strata. On the other hand, El-Naggar (Op.cit) mentioned the occurrence of G. fornicata cesarensis with a smooth test and non-inflated spiral side. The writer has examined the specimens of G. fornicata cesarensis Gandolfi in El-Naggar's collection at the B.M.N.H., and has found that there is no significant difference between G. fornicata cesarensis with a flat spiral side and G. aegyptiaca duwi. The form is considered a junior synonym of the latter.

Berggren (1962) and Pessagno (1967) suggested that G. aegyptiaca duwi has evolved from G. rosetta (Carsey). However, inspite of the fact that G. rosetta appears in stratigraphically older strata than G. aegyptiaca duwi (see also El-Naggar 1966. Bandy 1967), this writer does not agree with the above author's use of a reverse direction of development. The two species show the following contradictory evolutionary trends;

1. A tendency towards the partial or complete reduction of the lower (ventral) keel leading to G. rosetta, then the redevelopment of the reduced keel leading to G. aegyptiaca.

2. A tendency from petaloid chambers increasing slowly to moderately in size as added towards the development of crescentic, elongated and

rapidly increasing chambers leading to G. rosetta. This would be followed by the redevelopment of the petaloid, slowly increasing chambers leading to G. aegyptiaca aegyptiaca.

3. A tendency towards the repetition of the crescentic, elongated, rapidly increasing chambers in G. aegyptiaca duwi which is said to have evolved from G. rosetta.

El-Naggar (Op.cit) suggested the evolution of G. aegyptiaca aegyptiaca from G. ventricosa White through G. gagnebini Tilev and into G. aegyptiaca duwi, but he also stated that it is related to G. tricarinata colombiana Gandolfi which may possibly represent the ancestral stock.

Pessagno (Op.cit) also proposed the development of G. aegyptiaca aegyptiaca and G. aegyptiaca duwi from the G. stuarti group, while his phylogeny chart (t.f.35) shows their possible evolution from G. gansseri Bolli. However, this writer could see no direct relation between these forms and G. aegyptiaca group.

Two main evolutionary tendencies were suggested to occur in G. bulloides austinensis Pessagno (not Gandolfi);

1. G. bulloides austinensis - G.? - G. aegyptiaca aegyptiaca

Globotruncana ? possibly appeared in a short interval during late Campanian or early Maestrichtian times, and is characterized by having flattened spiral chambers showing a slow to moderate rate of increase, $4\frac{1}{2}$ - 5 chambers in the last whorl and a planoconvex test. Unfortunately planktonic Foraminifera of this age are very rare and poorly preserved in the southern Iraqi samples.

Nevertheless, by reduction in the number of chambers in the last whorl, the development of a strongly lobate periphery, a quadrilobate outline, Globotruncana ? might possibly have evolved into G. aegyptiaca

aegyptiaca.

2. G. bulloides austinensis - G. gagnebini - G. aegyptiaca duwi

By reduction in the size of the test, in the number of chambers in the last whorl, by development of chambers increasing very rapidly in size as added, with flattening of the spiral surface, development of a triagular peripheral outline, G. bulloides austinensis probably could have evolved into G. aegyptiaca duwi through G. gagnebini. The present writer believes that G. aegyptiaca duwi Nakkady and G. fornicata cesarensis Gandolfi are closely related.

Occurrence. G. aegyptiaca duwi appears in the basal part of the Qurna formation as an abundant form, increase upward in the formation. Rare in the upper part of the Qurna formation and dies out in the basal part of the Tayarat formation.

Globotruncana gansseri zone.

Previous record of Occurrence. The Campanian - Maestrichtian of the U.A.R. and the Middle to Late Maestrichtian of Texas, Arkansas, Mexico and Trinidad.

Globotruncana aegyptiaca var.1 Nakkady

pl.27, figs.4-6

1950 Globotruncana aegyptiaca var.1 Nakkady. p.690, pl.90, figs. 27-28

Remarks and Occurrence. The writer has examined the holotype and paratype of G. aegyptiaca var.1 Nakkady in the collections of the British Museum (Natural History) London, from the Upper Cretaceous of the Gebel Duwi chalk of the U.A.R. It is distinguished from G. aegyptiaca aegyptiaca by having a single keeled, equatorial periphery and an angled axial one and chambers rather rapidly increasing in size with growth.

The species is not closely related to G. aegyptiaca duwi Nakkady although they are found associated in the sections studied.

Globotruncana cf. angusticarenata Gandolfi

pl.20, figs.3,6

1942 cf.Globotruncana linnei angusticarenata Gandolfi. pp.126,150,153, t.f.46, figs.3a-c, pl.4, figs.17,30

1952 Globotruncana angusticarenata Gandolfi. Sigal. p.34, fig.37

Remarks. The two specimens described here as G. cf. angusticarenata Gandolfi are distinguished by having a highly convex spiral side, greater number of chambers (about 23) and $3\frac{1}{2}$ - 4 whorls. Compared with the original figures, the latter has a lesser convex spiral side and 14 chambers arranged in about $2\frac{1}{2}$ whorls.

G. cf. angusticarenata is morphologically close to G. tarfayensis Lehmann described from the Coniacian of Tarfaya, Morocco, but because of the absence of type material the writer did not include it in the above synonym.

G. angusticarenata (not G. angusticarinata, see Ellis and Messina Catalogue Foram. Supp.(1958)) was first described by Gandolfi (1942) as a variety of G. linnei (d'Orbigny) in syntypic series. Pessagno (1967) designated one of Gandolfi's specimens (1942, t.f.46, figs.3a-c) as the lectotype. Caron and Luterbacher (1969) stated that the holotype of G. angusticarenata Gandolfi has been lost, but they did not state which of the original specimens was the holotype.

Occurrence. In the lower part of the Sadi formation. Globotruncana concavata subzone.

Previous record of Occurrence. The Turonian of Switzerland and Texas. The Turonian - Coniacian of Algeria, the Turonian - Campanian of Italy

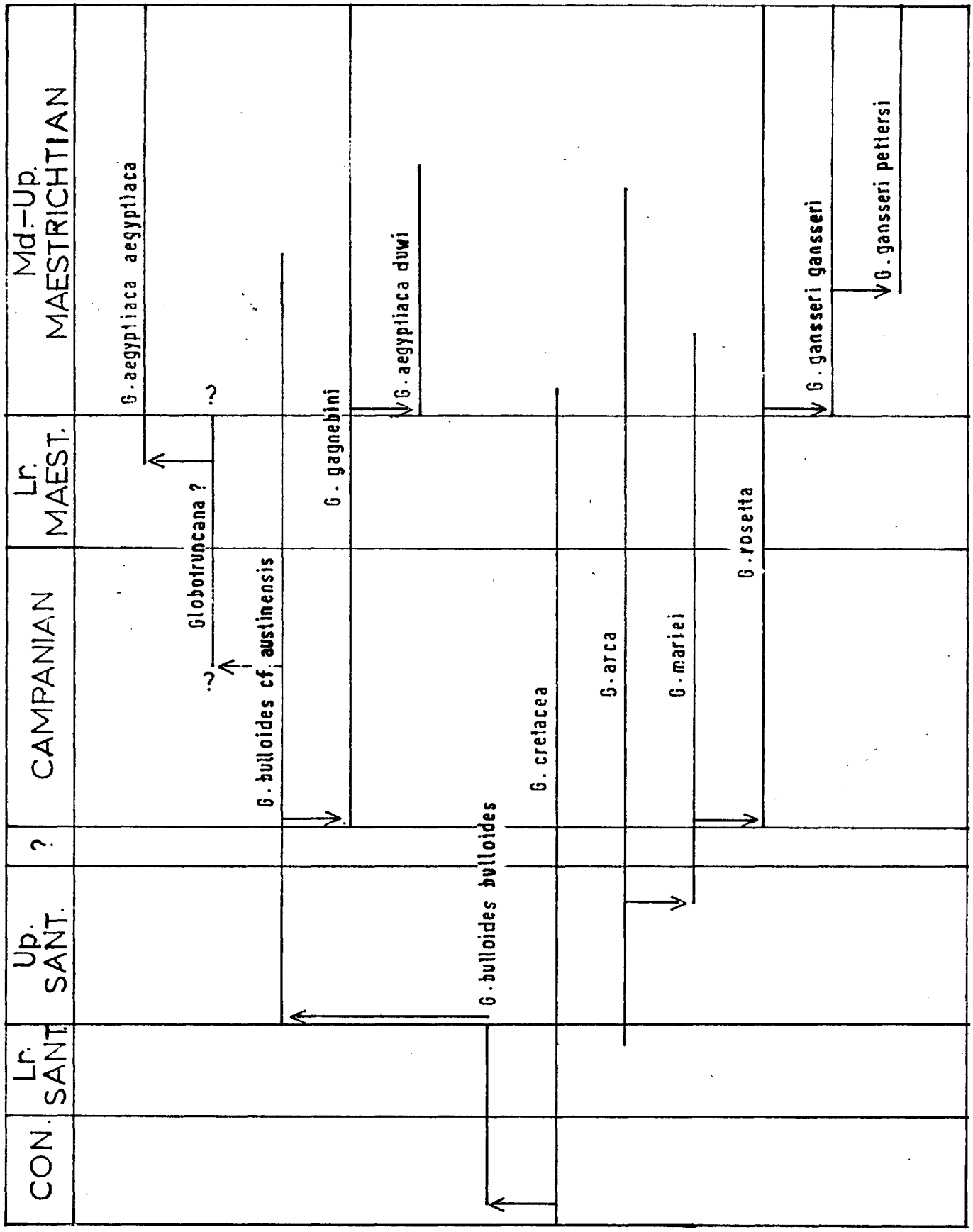


Fig.14a – Suggested phylogeny of some important species of Globotruncana in S. Iraq.

and Germany, the Senonian of France, the Coniacian - L. Santonian of Mexico and the Coniacian - Campanian of California.

Globotruncana arca (Cushman)

pl.20, figs.11-12

1926	Pulvinulina arca Cushman.	p.23, pl.3, figs.1a-c
1927	Globotruncana arca (Cushman) Cushman.	p.169, pl.28, figs.15a-c
1946	Globotruncana arca (Cushman) Cushman.	p.150, pl.62, figs.4a-c (not figs.5a-c)
1951	Globotruncana arca (Cushman) Nakkady.	p.56, pl.1, figs.4B-E (not 4A)
1951	Globotruncana arca (Cushman) Tilev.	p.57, t.f.18a-c, 19a-d
1955	Globotruncana arca arca (Cushman) Gandolfi.	pp.63-64, pl.5, figs.?2a-c, 3a-c, ?4a-c
1958	Globotruncana arca (Cushman) Bieda.	p.61, t.f.24a-c
1964	Globotruncana arca (Cushman) Martin.	p.79, pl.9, figs.4a-c
1964	Globotruncana arca (Cushman) Olsson.	pp.162-163, pl.4, figs.1a-3c.
1965	Globotruncana arca (Cushman) Takayanagi.	pp.207-211, pl.22, figs. ?6a-c, pl.23, figs.1a-2c (including additional synonymy upto 1963)
1965(a)	Globotruncana arca (Cushman) Van Hinte.	p.20, pl.3, figs.3a-c
1965(b)	Globotruncana arca (Cushman) Van Hinte. Ibid.	p.83, pl.1, figs.3a-c
1966	Globotruncana arca (Cushman) Christadoulou and Marangoudakis.	p.303, pl.1, figs.5,7
1966	Globotruncana arca (Cushman) El-Naggar.	pp.83-86, pl.1, figs.1a-c,2
1966	Globotruncana arca (Cushman) Lehmann.	p.313, pl.1, fig.5
1967	Globotruncana arca (Cushman) Pessagno.	pp.321-323, pl.79, figs.5-8, pl.90, figs.6-8 pl.96, figs.7,8,17
1968	Globotruncana arca (Cushman) Barr.	p.315, pl.39, figs.3a-c
1969	Globotruncana arca (Cushman) Funnell, Friend and Ramsay.	p.28, pl.2, figs.11-13, pl.8, figs.1-3, 11a-c
1969	Globotruncana arca (Cushman) Douglas.	p.176, pl.9, figs.1-3, pl.10, figs.4-7
1969	Globotruncana gaudkofi Martin. Douglas.	pp.179-180, pl.8, figs.3a-c

Remarks. G. arca was originally described by Cushman (1926) from the Papagallos shales (Mendez shale) of Mexico as Pulvinulina arca. He later (1927) designated it as the type species of Globotruncana Cushman. G. arca (Cushman) is characterized by its unequally biconvex, spirally

more convex test, its large number of chambers which are crescentic and increasing slowly in size; and its two, well developed, widely spaced keels of which the lower one is ventrally shifted.

Cushman (1931, pl.11, fig.6) described as G. arca a clearly different form, and later (1938) renamed it as G. cretacea new species.

Banner and Blow (1960) considered G. cretacea Cushman to be a junior homonym of G. cretacea (d'Orbigny) (see under G. mariei).

Bronnimann and Brown 1956(1955) described the specimens figured by Plummer (1931, figs.7,8) as belonging in G. cretacea Cushman and the specimens (figs. 9,11 Op.cit.) as belonging in G. rosetta (Carsey). An examination of Plummer's figures reveals that the first two specimens have planoconvex tests and two closely spaced keels which become more closely spaced on the last chamber; the second two specimens have planoconvex, umbilicoconvex tests and two closely spaced keels becoming single on the last chamber. Thus this writer substantiates the above authors observations (see also Banner and Blow 1956, pl.546, regarding characters of the keels).

Cushman (1932, 1946) described as G. arca distinctly planoconvex, umbilicoconvex, single-keeled specimens. Cita (1948) considered this form to belong in G. rosetta (Carsey). Bolli (1951) assigned it to the G. stuarti group, while Dalbiez (1955) followed by Berggren (1962) and Van Hinte (1963) placed it in G. elevata stuartiformis Dalbiez; and Pessagno (1967) considered it to be synonym of G. elevata (Brotzen). However, the figured specimens show a nearly planoconvex, only slightly spirally convex test, single keeled peripheral margins, nearly triangular chambers on the spiral side and strongly curved, roughly angled sutures on the umbilical side. These characters coincide with the description

and the figures of G. elevata stuartiformis given by Dalbiez (1955) and Van Hinte (1963).

The specimen figured as G. arca caribica n.sp. by Gandolfi (1955) is referrable to G. gagnebini Tilev. It shows a flattened, slightly raised, spiral side with 4 rapidly increasing chambers, a wide umbilicus which is surrounded by elongated chambers and two widely spaced, parallel, marginal keels. Pessagno (1967) suggested its relation to G. rosetta (Carsey). However, the form does not show chambers strongly protruding umbilically, or two closely spaced keels which reduced to a single one on the last chamber.

The specimens figured as G. arca by Said and Kerdany (1961) and Said and Sabry (1964) is quite different from the species in question.

G. arca is believed to have evolved from G. linneiana tricarinata (Quereau) by increasing the spiral convexity, the development of more pitalliform chambers and an umbilically shifted umbilical keel. On the other hand G. stephensoni Pessagno is believed to represent the direct descendent of G. arca as suggested by their close morphological relationship.

Two topotypic specimens belonging in G. arca Cushman were examined during the course of this study.

Occurrence. Rare in the Sadi and Hartha formations. Abundant in the lower half of the Qurna formation. Very rare in the upper half of the Qurna and the lowermost of the Tayarat formations. Globotruncana concavata subzone - Globotruncana gansseri zone.

Previous record of Occurrence. The Turonian - Maestrichtian of Algeria, the Turonian - Campanian of Alaska, the Turonian - Santonian of Switzerland, the Coniacian - Maestrichtian of Austria, the Santonian

Campanian of California, the Santonian - Maestrichtian of Poland and Iran, the Campanian of Germany, Isle of Wight (England), Arkansas, Colombia and Tanganyika; the Campanian - Maestrichtian of Italy, France, N. Ireland, the Caucasus (U.S.S.R.), Texas, Mexico, Trinidad, Haiti and W. Australia and the Maestrichtian of Denmark, New Jersey, Cuba, Turkey and Egypt.

Globotruncana bulloides cf. austinensis Pessagno

pl.19, figs.4-6

1967 Globotruncana austinensis Gandolfi. Pessagno. pp.323-324, pl.82, figs.12-15, pl.94, fig.9 (not G. marginata austinensis Gandolfi)

Remarks. Gandolfi (1955) described G. marginata austinensis from the Colon formation of Colombia. Pessagno (1967) raised it to specific rank, although his described specimens are different from the holotype of Gandolfi.

G. bulloides cf. austinensis is distinguished from Gandolfi's form by its planoconvex, distinctly umbilico-convex test and its two widely spaced, spirally shifted marginal keels. It differs from G. bulloides bulloides Vogler in its planoconvex test, spirally shifted keels which sometimes merge on the last chamber into one, curved, initially raised, later depressed sutures on the spiral and umbilical sides and the depression of its early whorls below the level of the last.

By the development of these features, G. bulloides cf. austinensis is believed to have evolved from G. bulloides bulloides.

Compared with Pessagno's (1967) figured specimens, those from Iraq have two rather narrow keels and the surface is less roughly ornamented. However, the other features coincide.

Occurrence. Rather abundant, in the lower part of the Sadi and Qurna formations, rare in the upper part of Sadi and Hartha formations, very rare in the upper part of the Qurna formation. Globotruncana fornicata subzone - Globotruncana gansseri zone.

Pessagno (1967) described this species from the Upper Santonian - Lower Maestrichtian of Mexico, Texas and Arkansas.

Globotruncana bulloides bulloides Vogler

pl.20, figs.4-5

1941	Globotruncana linnei (d'Orbigny) sub.sp. bulloides	Vogler pp.285-287, pl.3, figs.33,34, 36 (not figs.32,35,38,37,39)
1945	Globotruncana Lapparenti bulloides	Vogler. Bolli. pp.231-232, t.f.17,18, p.234, pl.7, fig.12
1951	Globotruncana lapparenti bulloides	Vogler. Bolli. pp.194,190, t.f.1
1954	Globotruncana lapparenti bulloides	Vogler. Hagn and Zeil. pp.45-46, pl.2, fig.5, pl.7 fig.4
1962	Globotruncana marginata (Reuss)	Barr. pp.574,575, pl.70, figs.3a-c, pl.72, figs.7,8a-c
1965	Globotruncana marginata (Reuss)	Van Hinte, pl.2, figs.2a-c
1966	Globotruncana marginata (Reuss)	Salaj and Samuel. p.210, pl.20, figs.3a-b-c, 5a-b-c
1967	Globotruncana bulloides Vogler.	Pessagno. pp.324-326, pl.67, figs.1-3, pl.73, figs.9,10, pl.75, figs.4-8, pl.97, figs.14,15 (not pl.64, figs.15-17). Including additional synonymy upto 1957

Remarks. G. bulloides bulloides Vogler was originally described from eight thin-section profiles as G. linnei bulloides. Neither the type locality, the type level nor the type specimen were designated. His type specimens came from 4 different localities in Indonisia;

1. East Indonisia, sample 65 (figs. 35-34)
2. Central Misol, sample 85a (figs.38-39) and sample 85 (fig.32)
3. Island Monjagana, sample 316 (fig.35-36)
4. Semoket Island, sample 327 (fig.27).

Owing to the inadequacy of Vogler's original description and figures, the morphological characters of G. bulloides bulloides were later much confused and the species lost its taxonomic status. To avoid further confusion and to put its taxonomy on a firm basis, Pessagno (1967) selected the specimen from sample 65, fig.33 (Vogler 1941) as the lectotype and the specimen from sample 65, fig.34 (Vogler 1941) as the paralectotype. Thus the area southeast of the village of Pawo, West-central part of the Island of Misol (Misoel), East Indonisia automatically becomes the type locality.

The specimen illustrated in fig.32 is referrable to G. cretacea (d'Orbigny), likewise the specimen shown in figs. 35,38 and 39 are referrable to G. linneiana linneiana (d'Orbigny). The specimen illustrated in fig.37 has a planoconvex test with two widely spaced keels reduced to a single keel on the last chamber and might possibly belong in an as yet undescribed species. The specimen shown in fig.36 is the only one similar to that shown in the paralectotype figure.

Edgell (1957), Barr (1962), Van Hinte (1956) and Salaj and Samuel (1966) considered G. bulloides bulloides to be a junior synonym of G. marginata (Reuss). However, although both have similar stratigraphic distributions, the present study showed clearly that the two forms are morphologically different and show different evolutionary trends.

G. bulloides bulloides is similar to G. cretacea (d'Orbigny) (lectotype) but differs in having a very compressed test, less inflated chambers which increase rapidly in size as added, raised, curved sutures on both sides and well developed marginal and periumbilical keels.

G. bulloides bulloides is believed to have evolved from G. cretacea by increasing its lateral compression, the development of raised, curved,

thickened sutures, spirally and umbilically and intensification of the two marginal keel and periumbilical ridges.

Occurrence. Abundant in the Khasib, Tanuma and the lower part of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. It was originally described from the Maestrichtian of Indonisia. Owing to the state of confusion it is difficult to ascertain the exact stratigraphic range of this species. However, according to the above-mentioned synonymy G. bulloides bulloides occurs in the Turonian to Maestrichtian of various parts of Europe, the Caribbean region, West Indies, Gulf Coast (U.S.A.) and the Santonian of West Australia.

Globotruncana coldreriensis Gandolfi

pl.20, figs.1-2

1942	Globotruncana renzi Gandolfi.	p.124, pl.3, figs.1a-c, pl.4, figs.16,28,29 (not pl.4, fig.15 not t.f.45a-c)
1942	Globotruncana renzi Thalmann.	p.8
1945	Globotruncana renzi Thalmann.	Thalmann.(type fig.of Renz 1936)
1957	Globotruncana coldreriensis Gandolfi.	new name. p.64, pl.9, figs.7a-c
1960	Globotruncana renzi Gandolfi. Trujillo.	p.343, pl.5, figs.3a-c (not fig.4)
1963	Globotruncana coldreriensis Gandolfi.	Lehmann. p.144, pl.3, figs.3,3j
1963	Globotruncana cf. sigali Reichel	Lehmann. Ibid. p.144, pl.3, figs.4a-c
1966 ?	Globotruncana coldreriensis Gandolfi.	Salaj and Samuel. pp.201-202, pl.18, figs.2a,b,c
1967	Globotruncana renzi Gandolfi. Bandy.	p.19, t.f.8(8)
1969	Marginotruncana renzi renzi (Gandolfi)	Esker. p.216, pl.1, figs.12-14
1969	Globotruncana renzi Gandolfi. Caron and Luterbacher.	pp.27-29, pl.9, figs.12a-c (not pl.9, figs.11,11a-c)

Remarks. G. coldreriensis was first described by Gandolfi (1957). The

erection of this species resulted from Gandolfi's belief that Thalmann's (1942) use of the name G. renzi had periority over his own (see under G. renzi). The holotype (pl.3, fig.1a-c, Gandolfi 1942) was chosen from the syntypic series of G. renzi Gandolfi. Thus the specimens (pl.4, figs.16,28,29 Op.cit) can be included in the synonym of G. coldreriensis Gandolfi. They show similar morphological characters and stratigraphic distribution.

G. coldreriensis differs from G. angusticarinata Gandolfi in its lesser number of chambers in the last whorl (4-5 chambers opposed to 6-8) and its less convex spiral side. It differs from G. renzi Gandolfi in having a biconvex test, chambers on the spiral side which are not petaloid and increase more slowly in size as added and a much less convex umbilical side.

G. sigali Reichel was described as having only a single keel throughout its periphery.

G. coldreriensis is believed to have evolved from G. sigali Reichel by the development a narrowly spaced double keel in the early portion of the last whorl. On the other hand, by a tendency to increase the size of the test, the number of chambers and the spiral convexity, G. coldreriensis might possibly have evolved into G. cf. angusticarinata. The morphological characters and stratigraphical distribution of the two species are in favour of this hypothesis.

Occurrence. Abundant in the Khasib and Tanuma formations, rare in the lower part of the Sadi formation. Globotruncana renzi/Heterohelix Pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. Turonian to Coniacian (Gandolfi 1957, Lehmann 1963, Salaj and Samuel 1966).

Globotruncana concavata carinata Dalbiez

pl.21, figs.7-8

1950 Globotruncana ventricosa White. Mornod. pp.590-591, t.f.12 (2a-c) (not 1a-c)

1955 Globotruncana (Globotruncana) ventricosa White. sub.sp. carinata Dalbiez. pp.161-171, t.f.8a-d

1962 ? Globotruncana concavata (Brotzen) carinata Dalbiez. Edgell. pp.41-50, pl.1, figs.1-5

1963 Globotruncana concavata (Brozen) var. carinata Lehmann. pp.147-148, pl.6, fig.4b (not figs. 2a-c, 3a-c) p.139, t.f. 2q-r (not 2n-p)

1965 Globotruncana concavata concavata (Brotzen) Loriga and Mantovani. p.114, fig.8

1969 Globotruncana carinata Dalbiez. Casati and Tomai. pp.25-340, pl.14, fig.1, pl.13, fig.4

Remarks. G. concavata carinata was first described by Dalbiez (1955) from the Upper Santonian rocks of northwestern Tunisia as a variety of G. ventricosa White. In his systematic description he adopted the subgeneric classification which had been introduced by Reichel (1950). Bolli (1957) followed by El-Naggar (1966) considered G. concavata carinata (Dalbiez to be a junior synonym of G. ventricosa White, while Pessagno (1967) included it in the synonymy of Marginotruncana concavata (Brotzen). Esker (1969) stated his doubt regarding the validity of this form.

G. concavata carinata can be distinguished from G. concavata concavata by its well developed, thickened periumbilical keel, the shape of chambers on the spiral side, their shape and geometrical position umbilically and by the character of the spiral side which is more strongly sloping towards the central area.

The morphological features and stratigraphical distribution of this group suggest that G. concavata carinata Dalbiez evolved from G. concavata concavata (Brotzen).

Occurrence. Abundant in the middle part of the Sadi formation. The uppermost part of the Globotruncana concavata subzone - Globotruncana fornicata subzone.

Previous record of Occurrence. The Upper Santonian of Tunisia, Morocco; the Santonian of northwestern Australia, Switzerland and the Upper Santonian - Campanian of Italy.

Globotruncana concavata concavata (Brotzen)

pl.21, figs.10-11

1934 Rotalia concavata Brotzen. p.66, pl.3, fig.6 (three figures)
1955 Globotruncana (Globotruncana) ventricosa ventricosa. White. Dalbiez. p.168, t.f.7a-d
1952 ? Globotruncana asymetrica Sigal. p.35, t.f.35 (three figures)
1952 Globotruncana ventricosa White. Carbonnier. pp.112,116,120, pl.6, figs.1a-c
1957 Globotruncana concavata (Brotzen) Bolli. p.57, pl.13, figs.3a-c
1962 Globotruncana concavata (Brotzen) Barr. p.569, pl.71, figs.4a-c
1963 Globotruncana concavata (Brotzen) Lehmann. pp.147-148, pl.6, figs.2a-3c (not fig.4b) p.139, t.f. 2n,o,p (not figs.2q and 2r)
1965 Not Globotruncana concavata (Brotzen) Takayanagi. p.211, pl.23, figs.3a-c
1966 Globotruncana ventricosa concavata (Brotzen) Salaj and Samuel pp.218-219, t.f.17a-b
1967 Marginotruncana concavata (Brotzen) Pessagno. pp.304-305, pl.58 figs.1-2,3-6 (not figs.7-9) pl.95, figs.6? 7
1969 ? Marginotruncana concavata (Brotzen) Esker. pp.213-214, pl.1, figs.4-6
1969 Globotruncana concavata (Brotzen) Casati and Tomai. pp.30-340, pl.13, fig.273

Remarks. G. concavata concavata was originally described by Brotzen (1934) as Rotalia concavata. Dalbiez (1955) included it in the synonymy of G. ventricosa White. He described G. (G.) ventricosa carinata and G. (G.) ventricosa primitiva as two new subspecies, thus changing the name G. ventricosa (White) to G. (G.) ventricosa ventricosa. His range chart clearly shows that these three new forms replace each other in

stratigraphic order; each have a short range restricted to the Upper Coniacian, Lower Santonian and Upper Santonian parts of the lower, middle and upper G. ventricosa faunal zone respectively. (See Dalbiez (1955), chart 2, p.167.)

In southern Iraq, the ranges of the three forms distinctly overlap. Bolli (1957) regarded G. (G.) ventricosa ventricosa as G. concavata, G. (G.) ventricosa carinata as probably G. ventricosa and G. (G.) ventricosa primitiva as G. renzi Gandolfi

El-Naggar (1966), who examined the types of the above three forms, confirmed Bolli's statement concerning the first two, but he considered G. (G.) ventricosa primitiva also as junior synonym of G. concavata (Brotzen). He (Op.cit) remarked that although the figures were published under the G. ventricosa ventricosa, the slide carried the name of G. ventricosa concavata (Brotzen).

However, the remarks made by the above author are not unexpected since Dalbiez (Ibid) himself stated that "if G. ventricosa as defined here is shown to be different from G. ventricosa White (1928) after revision of the type, the three subspecies proposed above will have to be called G. concavata (Brotzen) sub.sp. primitiva Dalbiez, G. concavata concavata (Brotzen) and G. concavata sub.sp. carinata Dalbiez, according to the rules of nomenclature".

Pessagno (1967) on the other hand, included G. (G.) ventricosa ventricosa and G. (G.) ventricosa carinata in the synonymy of Marginotruncana concavata (Brotzen), but made no comment on the third form.

As can be seen from the original description and figures of Dalbiez (1955) and from the samples here studied, the morphological features of the three forms and their vertical distribution strongly support the

acceptance of Dalbiez's subspecific separation.

As stated by Bolli (1957), G. concavata concavata (Brotzen) is distinguished from G. ventricosa White by its concavoconvex test; slightly curved, thinner and less raised sutures on the spiral side; narrower peripheral band and less thickened keels; larger size of chambers in the last whorl which are only slightly petaloid and increase rapidly in their size; greater umbilical convexity with chambers which are strongly protruding and stand nearly perpendicular and larger and deeper umbilicus. On the other hand G. concavata concavata is related to G. ventricosa in the general shape of the test and globigerine initial stage which extends to the early chambers of the last whorl.

Pessagno (1967) stated "whereas M. concavata shows a W. inornata nepionic stage, G. ventricosa shows a G. linneiana (d'Orbigny) nepionic stage". This writer has the feeling that Pessagno's work needs revision. The present study dealt with hundreds of well preserved specimens, and threse clearly support the opposite view. The writer considers that the initial globigerine chambers which extend sometimes to the first or second chambers of the last whorl are the best morphologic character by which the two species are linked phylogenically. (See Pessagno (Op. cit.) p.304.)

The specimens figured by Takayanagi (1965), in present writers opinion, belongs in a different species and perhaps a new one. Its' nepionic and adult chambers, sutures, test shape, number of chambers and their rate of increase are different from those of the holotype and the specimens figured by Bolli (1957). Rare specimens similar to this form were found in the Zubair and Rumaila fields, but it was decided not to describe them at the present time. Pessagno (Op.cit) (see

synonymy) figured as M. concavata specimens which are actually referrable to G. concavata repanda Bolli.

G. concavata concavata is believed to have evolved from G. ventricosa by the development of a concave spiral side and more convex umbilical side, the development of strongly inflated, protruded chambers umbilically and a decrease in their numbers with growth.

G. concavata concavata probably evolved into G. concavata carinata by the increase in the concavity of the spiral side, a development of strongly carinate, umbilical shoulders and of further vertically situated umbilical chambers.

Occurrence. Rare in the Tanuma formation, very abundant in the lower part of the Sadi formation. The upper part of the Globotruncana renzi/ Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. The Coniacian of the Isle of Wight (England), Cuba; the Upper Coniacian - Santonian of Algeria, Jamaica; the lower Santonian of Tunisia, Italy; the Santonian of Trinidad, Switzerland, France, West Carpathian, Madagascar and the Campanian - Santonian of Palestine.

As stated by Esker (1969), other reports concerning the occurrence of G. concavata (Brotzen) in younger beds (Campanian or Maestrichtian) need re-examination.

Globotruncana concavata dentata var.nov.

pl.21, figs.1-3

Description. Test small, planoconvex, coiled in a very low trochospire, spiral side flat, umbilical side strongly convex; equatorial periphery quadrilobate, moderately lobate with two closely spaced, delicately beaded, marginal keels, the lower keel diverges umbilically at the

last chamber and forms delicate umbilical ridges, the upper keel diverges onto the spiral side of the test at the late portion of each chamber and is embedded in the sutural depressions; axial periphery truncate; chambers on the spiral side 11, arranged in $2\frac{1}{2}$ whorls, the initial chambers are small, very slightly protruding, globigerine, followed by slightly larger chambers; the last whorl is composed of 4 larger, crescentic-shaped, slightly inflated, slightly overlapping chambers, increasing rather rapidly in size as added; each chamber has an angular extension of the peripheral margin resembling a spine which is usually well developed on the first and last chambers of the last whorl; only chambers of the last whorl visible from the convex umbilical side, strongly protruding, inflated and trunco-conical in shape; sutures on the spiral side distinct, slightly curved, depressed; on the umbilical side the sutures are limbate, radial and depressed; umbilicus small, shallow, surrounded by delicately beaded ridges; wall calcareous, perforate except for the imperforate keels, peripheral band and tegilla; surface finely hisped on both the spiral and the umbilical sides; primary aperture interiomarginal, umbilical; tegilla with accessory apertures only poorly preserved.

Main variation

1. The spiral side is either flat, very slightly raised or even concave.
2. The periumbilical keel is either slightly or moderately developed.

Remarks. Concave specimens of G. concavata dentata var.nov. resemble G. concavata repanda Bolli in the test shape, number of chambers and the surface ornamentation, but differ in having a smaller test size, a

small umbilicus, spine-like marginal projections and chambers in the last whorl which are elongated and increase rather rapidly in size. Moreover, the early chambers of the last whorl in G. concavata reparda are strongly inflated, spherical to subspherical in shapes and strongly sloping towards the central area.

By decreasing the size of the test, flattening the spiral side, the development of spine-like marginal projections and a small umbilicus G. concavata concavata (Brotzen) might possibly have evolved into G. concavata dentata.

Occurrence. Abundant in the lower part of the Sadi formation. The upper half of the Globotruncana concavata subzone.

Globotruncana concavata primitiva Dalbiez

pl.20, figs.7-10

1948 Globotruncana ventricosa White. Cita. pp.162-163, pl.4, figs.9a-c
1955 Globotruncana (Globotruncana) ventricosa primitiva Dalbiez pp.161-171, t.f.6
1963 ? Globotruncana primitiva Dalbiez. Lehmann. pl.4, fig.1, t.f.31
1966 Globotruncana ventricosa primitiva Dalbiez. Salaj and Samuel. p.220, pl.20, figs.4a-b-c

Remarks. The most noticeable features in G. concavata primitiva are; the slightly raised or flat spiral surface, number and shape of chambers on the spiral side (15-18 arranged in $2\frac{1}{2}$-3 whorls), the geometrical position of the last chamber umbilically, which shows a roof-shaped appearance, the wide and deep umbilicus and curved and sigmoidal sutures on the umbilical side. Compared with G. indica Jacob and Sastry, G. concavata primitiva has a larger umbilicus, curved and sigmoidal sutures on the umbilical side and greater ventral convexity. However, the holotype figured by Jacob and Sastry (1950) does not agree with their type

description.

G. concavata primitiva is rather similar to G. cretacea Cushman (= G. mariei Banner and Blow), but this latter has greater dorsal convexity, a biconvex test (see Olsson 1964), a finely ornamented to nearly smooth surface and strong convergence of the marginal keel on the last chamber.

The writer has correlated his G. concavata primitiva with the type description rather than the type figure, the latter shows only a peripheral view.

Specimens figured by Lehmann (1963) as G. ventricosa primitiva Dalbiez show raised lapparenti-type sutures on the umbilical side and probably belong in the G. renzi group. The specimens figured by Esker (1969) from the late Coniacian of Jamaica as Marginotruncana sp. cf. M. primitiva (Dalbiez) are similar to Lehmann's.

Occurrence. Abundant in the Khasib and Tanuma formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. G. concavata primitiva was originally described from the Upper Coniacian of the Leket - Mellegue, northwestern Tunisia. The species is also reported from the Upper Coniacian of the West Carpathian, Bratislava.

Globotruncana concavata reparida Bolli

pl.21, figs.4-6

1957 Globotruncana reparida Bolli. p.56, pl.13, figs.2a-c
1967 Praeglobotruncana reparida (Bolli) Bandy. p.18, t.f.8(4)
1967 Marginotruncana concavata (Bolli) Pessagno. pp.304-305, pl.58, figs.7-9 (not figs.1-2,3-6)

Remarks. G. concavata reparida was first described by Bolli from the Upper Santonian - Lower Maestrichtian of the Naparima Hill formation

as G. reparda. This form, which is described here as a variety of G. concavata differs from Bolli's in its larger test size, slowly increasing chambers and lesser inflated last two chambers. However, specimens of G. concavata reparda of small test size and with moderately inflated chambers were also found in the Iraqi material.

Judging from the figured holotype, G. reparda shows slowly increasing chambers in the last whorl and its last two chambers are nearly flat in spiral view.

G. concavata reparda Bolli is morphologically rather similar to G. concavata concavata (Brotzen), but differs from it in its quadrate, peripheral outline, less inflated and lesser number of chambers in the last whorl and which increase slowly in size and slope more strongly towards the central area, and in the character of sutures on the spiral side which are depressed and almost straight, radial. Nevertheless, in some specimens of G. concavata reparda the last chamber shows only a trace of keels, and the axial periphery becomes rounded. In addition some small (probably juvinile) specimens show initially raised and later depressed sutures.

The specimens figured by Pessagno (1967, pl.58, figs.7-9) as Marginotruncana concavata (Brotzen) show a quadrilobate peripheral outline, a small number of chambers in the last whorl. The first two of which are inflated and subspherical, straight depressed sutures on both sides and a roughened, almost rugose surface, especially on the umbilical side. They are referrable to G. concavata reparda Bolli.

G. concavata reparda is believed to have evolved from G. concavata concavata in late Santonian times by reduction in the size of the test, in the number of chambers, by increasing the spiral concavity, the

inflation of chambers and development of straight radial sutures.

Occurrence. Rare to rather abundant in the lower part of the Sadi formation. The uppermost part of the Globotruncana concavata zone - Globotruncana fornicata subzone.

Previous record of Occurrence. The Upper Santonian - lowermost Maestrichtian of Trinidad; (the Santonian of Texas).

Globotruncana contusa (Cushman)

pl.27, figs.7-8

1926	Pulvinulina arca Cushman var. contusa	p.23 (no figure)
1927	Globotruncana arca (Cushman) var. contusa (Cushman)	Cushman. p.169 (no figure)
1946	Globotruncana arca (Cushman) var. contusa (Cushman)	Cushman. pp.150-151, pl.62, figs.6a-b
1966	Globotruncana contusa contusa (Cushman)	El-Naggar. pl.7, figs.2a-3c, pl.11, figs.1a-b including synonymy upto 1962

Remarks and Occurrence. Only four specimens of this index species are recorded from southern Iraq.

Cushman (1926, 1927, 1946) mentioned its occurrence in the Maestrichtian of Mexico. Cita (1948) recorded it from the Maestrichtian of northern Italy and Bolli (1951) from the Maestrichtian of Trinidad.

Maestrichtian occurrences of G. contusa (Cushman) are also known from the U.S.S.R., Denmark, Belgium, Holland, Austria, France, Switzerland, Tunisia, the United Arab Republic, Texas, New Jersey, Mexico and Cuba.

In southern Iraq G. contusa was found in the Sadi formation, e Globotruncana stuartiformis/Globotruncana stephensone zone

Two topotypic specimens belonging in G. contusa (Cushman) were examined during the course of this study.

Globotruncana convexa Sandidge

1932 Globotruncana convexa Sandidge. p.285, pl.44, figs.9-11
1966 Globotruncana cf. convexa Sandidge. El-Naggar. p.97-98, pl.1, figs.5a-c

Occurrence. The species occurs rarely in the Qurna formation, the lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. It was originally described from the Maestrichtian Ripley formation of Alabama. El-Naggar (1966) recorded it from the Maestrichtian of the Esna - Edfa region of U.A.R.

Globotruncana coronata Bolli

pl.22, figs.1-3

1945(1944) Globotruncana lapparenti Brotzen. sub.sp. coronata Bolli. p.233, t.f.1,21,22, pl.9, fig.15 (not fig.14)
1948 Globotruncana lapparenti coronata Bolli. Cita. p.156, pl.4, fig.3
1950 Globotruncana lapparenti coronata Bolli. Mornod. p.591, t.f.13a-c
1951 Globotruncana coronata Bolli. Sigal. p.34, fig.36
1953 Globotruncana coronata Bolli. Subbotina. p.180, pl.8, fig.1
1954 Globotruncana coronata Bolli. Hagn and Zeil. pp.43-44, pl.3, figs.4a-b, pl.7, fig.3 (not figs.1,2)
1954 Globotruncana lapparenti coronata Bolli. Ayala. pl.8, fig.1
1962 Globotruncana coronata Bolli. Herm. pp.76-77, pl.6, fig.5
1963(a) Globotruncana coronata Bolli. Lehmann. p.150, pl.8, figs.?2a-c 3a-c
1963(b) Globotruncana cf. coronata Bolli. Lehmann. Ibid. fig.2m, pl.4, fig.3, pl.5, fig.3
1965 Globotruncana coronata Bolli. Takayanagi. p.212, pl.24, figs.1-2 including additional synonymy from 1960 - 1963
1966 Globotruncana coronata Bolli. Salaj and Samuel. pp.203-204, pl.19, figs.5a-b-c
1966 Globotruncana lapparenti coronata Bolli. Caron. p.80, pl.4, fig.1a-c
1967 Globotruncana linneiana coronata Bolli. Bandy. p.19, t.f.8(10)
1967 Globotruncana coronata Bolli. Pessagno. pp.305-306, pl.65, figs.11-13, pl.100, fig.6
1969 Globotruncana coronata Bolli. Douglas. pp.177-178, pl.3, figs.6-8 (not fig.5)
1969 Globotruncana coronata Bolli. Douglas and Rankin. pp.202-203, figs.13A-C

Remarks. Globotruncana coronata was originally described by Bolli (1945) in syntypic series from the Turonian - Coniacian and Santonian of Scewerkalk, Switzerland as a variety of G. lapparenti Brotzen.

Pessagno (1967) designated one of Bolli's specimens (1945, pl.9, fig.15) as lectotype and the others (t.f.1, figs.21,22) as paralectotypes.

The Iraqi specimens referred to this species have relatively small, thin and strongly compressed tests; slightly convex to nearly flat sides; two keels becoming narrow on the last few chambers; a greater number of chambers and a wide umbilical cavity.

G. coronata morphologically is very similar to G. angusticarenata Gandolfi, but differs from it in its compressed, flattened, low biconvex test and in having the two keels which are distinctly widely spaced.

Nevertheless, by the development of a laterally compressed, thin test, and widely spaced two keels, G. angusticarenata might possibly have evolved into G. coronata. However, in the section studied, typical G. angusticarenata Gandolfi is absent, while Globotruncana cf. angusticarenata appears in stratigraphically younger beds.

Occurrence. Abundant in the Khasib, Tanuma and lower part of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone-Globotruncana concavata subzone.

Previous record of Occurrence. Most of the records are restricted to the Turonian, Coniacian and Santonian. It is known from the Turonian of Bavaria, Germany; the Turonian - Coniacian of the U.S.S.R.; the Turonian - Santonian of Italy, Switzerland, California, Texas, Mexico; the Turonian - Campanian of Algeria; the Coniacian of the Isle of Wight (England); the Coniacian - Santonian of West Carpathian (Bratislava) and the Coniacian - Campanian of Morocco, Austria. The Maestrichtian

occurrence of this species was reported by Tollmann (1950) from Austria.

Globotruncana cretacea (d'Orbigny)

pl.22, figs.4-5

1840 Globigerina cretacea d'Orbigny. p.34, pl.3, figs.12-14
1925 Globigerina cretacea d'Orbigny. var. saratogaensis Applin. in Applin, Ellisor and Kniker. p.98, pl.3, fig.8
1928 Globigerina voluta var. White. p.284, pl.38, fig.4
1936 Globotruncana globigerinoides. Brotzen. p.177, pl.12, figs.3a-c pl.13, fig.3
1956 Globotruncana saratogaensis (Applin) Bronnimann and Brown. p.544, pl.21, figs.1-3
1960 Globigerina cretacea d'Orbigny. Banner and Blow (= Globotruncana cretacea (d'Orbigny)) p.8-10, pl.7, figs.1a-c
1960 Globotruncana japanica Takayanagi. p.135, pl.10, figs.4a-c
1965 Globotruncana cretacea (d'Orbigny) Takayanagi. pp.213-214, pl.24, figs.3a-c including additional synonymy upto 1963.
1967 Archaeoglobigerina cretacea (d'Orbigny) Pessagno. pp.317-318 pl.70, figs.3-8
1967 Rugoglobigerina cretacea (d'Orbigny) Bandy. p.21, t.f.10(1)
1969 Globotruncana cretacea (d'Orbigny) Douglas and Rankin. pp.200-202, fig.12

Remarks. G. cretacea (d'Orbigny) is believed to have evolved from the Hedbergella trocoidea stock in very early Upper Cretaceous or possibly Middle Cretaceous times, by a slight increase in the lateral compression of the test, the development of faint marginal keels, an imperforate peripheral band and tegella. G. cretacea (d'Orbigny) might possibly have evolved into G. bulloides bulloides Vogler.

Occurrence. Rare in the Khasib, Tanuma, Sadi, uppermost Hartha and lowermost Qurna formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri zone.

Previous record of Occurrence. So far as the records of the species which are included into the synonymy are concerned G. cretacea occurs in the Upper Turonian - Lower Maestrichtian of Europe, North America

and Australia.

Globotruncana elevata (Brotzen)

pl.28, figs.1-4

1934 Rotalia elevata Brotzen. p.66, pl.3, fig.c
1955 Globotruncana (Globotruncana) elevata elevata (Brotzen) Dalbiez. p.169, t.f.9a-c
1956(a) Marginotruncana elevata (Brotzen) Hofker. pp.53,54,55, t.f.6
1956(b) Marginotruncana elevata (Brotzen) Hofker. p.B229, fig.70
1957 ? Globotruncana (Globotruncana) elevata elevata (Brotzen) Edgell. p.112, pl.4, figs.4-6
1960 ? Globotruncana (Globotruncana) stuarti elevata (Brotzen) Pessagno p.101, pl.5, figs.1,8
1963 Globotruncana elevata elevata (Brotzen) Graham and Church. p.63, pl.7, figs.13a-c
1964 Globotruncana stuarti elevata (Brotzen) Olsson. p.169, pl.5, figs.7a-c
1966 Globotruncana stuarti elevata (Brotzen) Ansary and Tewfik. p.50, pl.6, figs.2a-c
1966 ? Globotruncana elevata elevata (Brotzen) Wille-Janoschek. pl.81 figs.9-14, pl.93, figs.1-5, t.f.44, pp.102-103, pl.7, figs.1-3
1967 ? Globotruncana elevata (Brotzen) Pessagno. pp.336-338, pl.80, figs.1-2, 3-6
1969 Globotruncana elevata (Brotzen) Douglas. p.179, pl.1, figs.6a-d

Occurrence. Very rare, in the Sadi, Hartha, Qurna and Tayarat formations. Globotruncana stuartiformis/Globotruncana stephensoni zone - Globotruncana gansseri zone.

Previous record of Occurrence. The Upper Campanian of New Jersey; the Upper Campanian - Maestrichtian of Panama, Haiti, Puerto Rico, the Austro-German border, California; the Campanian - Maestrichtian of Austria Bavaria, France, Italy, Palestine, Tunisia, Australia, Colombia, Mexico, the U.S.S.R. and the Maestrichtian of Arkansas, Belgium and Trinidad.

Globotruncana fareedi El-Naggar

pl.30, figs.1-2

1966 Globotruncana fareedi El-Naggar. pp.100-102, pl.9, figs.4a-d

Remarks. The holotype and two paratypes in the El-Naggar's collection at the British Museum (Natural History) were examined.

Occurrence. The species occurs rarely in Middle Maestrichtian of the Qurna formation. Its types are from the Lower Maestrichtian, Middle Maestrichtian and the basal part of the Upper Maestrichtian of the Esna-Idfu region of U.A.R.

Globotruncana fornicata cesarensis Gandolfi

pl.22, figs.6-8, 10-11

1955 Globotruncana fornicata cesarensis Gandolfi. p.45, pl.2, figs.10a-c

1966 Globotruncana fornicata cesarensis Gandolfi. El-Naggar. pp.103-105, pl.13, figs.3a-4c, pl.14, figs.6a-c

Remarks and Occurrence. Abundant specimens of G. fornicata cesarensis Gandolfi was found associated with the other varieties of G. fornicata Plummer in the Santonian - Maestrichtian rocks of the Southern Iraq.

The form of G. fornicata cesarensis Gandolfi with a non-inflated spiral side recorded by El-Naggar (1966 pl.13, figs.3a-c) is also recorded in the present study. The hypotype, deposited at the British Museum of Natural History, London, is referrable to G. aegyptiaca duwi Occurrence. Globotruncana concavata subzone - Globotruncana gansseri zone.

Previous record of Occurrence. The variety was originally described by Gandolfi (1955) from the Campanian - Lower Maestrichtian of the Colon shale of northeastern Colombia. El-Naggar (1966) recorded it from the Lower Maestrichtian - Middle Maestrichtian of the Esna-Idfu region of the U.A.R.

Globotruncana fornicata fornicata Plummer

pl.22, fig.9; pl.23, figs.5-6, 9-10

1931 Globotruncana fornicata Plummer. p.198, pl.13, figs.4a-c,5,6

1951 Globotruncana fornicata Plummer. Drooger. p.7, pl.1, figs.9a-c

1953 Globotruncana fornicata Plummer. Hagn. p.98, pl.8, figs.8a-c t.f.22,23

1953 Globotruncana fornicata Plummer. Subbotina. pp.184-185, pl.8 figs.3a-c,4a-5c

1955 Globotruncana fornicata fornicata Plummer. Gandolfi. p.40, pl.2, figs.2a-c

1961 Globotruncana fornicata Plummer. Graham and Clark. p.112, pl.5 figs.10a-c

1962 Globotruncana (Globotruncana) fornicata Plummer. Pessagno. p.362, pl.4 figs.4,5,11

1963 Globotruncana fornicata Plummer. Lehmann. p.148, pl.7, figs.1a-2c,3a-4c, t.f.2v,w, 3n,r,i

1964 Globotruncana fornicata Plummer. Olsson. p.164, pl.2, figs.3,4, pl.3, figs.7a-8c

1966 Globotruncana fornicata fornicata Plummer. El-Naggar. pp.105-108, pl.13, figs.5a-c,6, pl.14, figs.1a-c

1967 Globotruncana fornicata Plummer. Pessagno. pp.338-341, pl.63, figs.1-9, pl.80, figs.7-9, pl.96, figs.2,4

Remarks and Occurrence. The species is rare and sparsely distributed in the Coniacian and Lower Santonian rocks of the Khasib and Tanuma formations and the lower part of the Sadi formation; abundant in the Upper Santonian part of the Sadi formation and rare through the rest of the succession. Globotruncana renzi/Heterohelix pseudoguembelini-formis zone - Globotruncana gansseri zone.

Previous record of Occurrence. G. fornicata fornicata was originally described by Plummer (1931) from the Campanian of the Upper Taylor formation of Texas. Bronnimann and Brown (1956 p.544) listed its geologic range as Coniacian to Campanian, possibly Maestrichtian. Apparently, this species has as world-wide Turonian - Maestrichtian distribution. For details see Ellis, Messina, et.al. 1969. Catalogue of Index Smaller Foraminifera, Part 1.

Globotruncana fornicata manaurensis Gandolfi

pl.23, figs.7-8

1955	Globotruncana fornicata manaurensis Gandolfi.	p.41, pl.2, figs.1a-c, t.f.9 (1a-c,2a-c)
1966	Globotruncana fornicata manaurensis Gandolfi.	El-Naggar. pp.109-110, pl.13 figs.2a-c
1966	Globotruncana fornicata manaurensis Gandolfi.	Salaj and Samuel p.206, pl.21, figs.1a,b,c

Remarks and Occurrence. Although the variety possibly falls within the range of variation of G. fornicata fornicata, it is separated mainly because of its distinct stratigraphic position. It occurs as a very rare form in the uppermost Lower Santonian and throughout the Upper Santonian of the Sadi formation, the uppermost part of the Globotruncana concavata concavata to the Globotruncana fornicata subzone.

Previous record of Occurrence. G. fornicata manaurensis Gandolfi was originally described from the Coniacian - Santonian of the Manaure shale of northeastern Colombia. El-Naggar (1966) recorded it from the Lower Maestrichtian of the Esna-Idfu region of the U.A.R. and Salaj and Samuel (1966) from the Santonian of the west Carpathians, Batislava.

Globotruncana fornicata plana var.nov.

pl.27, figs.1-3

Remarks. The variety differs from the typical G. fornicata Plummer in possessing a comparatively smaller and thin and flattened test. The two keels are well developed, beaded and occupy a narrow peripheral band, in some specimens they are reduced on the final chambers.

The writer has been informed by Al-Kassab (personal communication) that the same compressed type of G. fornicata was found in the Shiranish formation of northern Iraq.

Occurrence. Abundant specimens of this form was found restricted to the Coniacian of the Khasib and Tanuma formations of southern Iraq.

Globotruncana gagnebini Tilev

pl.28, figs.8-10

1951 Globotruncana gagnebini Tilev. pp.50-56, figs.14a-17d, pl.3, figs.2a-5a
1955 Globotruncana ventricosa ventricosa White. Gandolfi. pp.22-23, pl.1, figs.5a-c
1955 Globotruncana arca caribica Gandolfi. Ibid. p.64, pl.5, figs.5a-c
1956 Rugotruncana skewesae Bronnimann and Brown. pp.550-551, pl.23, figs.4-6
1957 Globotruncana gagnebini Tilev. Bolli. p.59, pl.14, figs.5a-c
1962 Globotruncana gagnebini Tilev. Herm. p.79, pl.7, fig.5
1963 Globotruncana aegyptiaca Nakkady. Van Hinte. pp.87-89, pl.8, figs.1a-2c
1964 Globotruncana gagnebini Tilev. Olsson. p.165, pl.4, fig.4
1966 Globotruncana gagnebini Tilev. El-Naggar. pp.112-113, pl.2, figs.1,2?,3,4, pl.3, figs.1,3,6
1967 Globotruncana aegyptiaca Nakkady. Pessagno. pl.79, figs.2-4 (not pl.83, figs.8-10)

Remarks. G. gagnebini was originally described by Tilev (1951) from the Maestrichtian rocks of Turkey, who gave a number of figures showing different variations. It differs from G. aegyptiaca duwi Nakkady in its higher number of chambers in the last whorl and which increase less rapidly in size. In addition, G. aegyptiaca duwi has a nearly triangular outline in umbilical view.

Gandolfi (1955) described as G. arca caribica a new form which possibly belongs in G. gagnebini Tilev. The specimen described by Bronnimann and Brown (1956) as Rugotruncana skewesae is possibly also referrable to this species.

G. gagnebini is believed to have evolved from G. bulloides cf. austinensis Pessagno (not G. marginata austinensis Gandolfi (1955)) by a flattening of the spiral chambers and an increase in their rate of enlargement.

In the Iraqi material, specimens with inflated spiral chambers were found at the lowest stratigraphic limit of the species. These are considered to be transitional specimens between G. bulloides cf. austinensis and G. gagnebini.

The writer has examined the hypotypes of G. gagnebini Tilev described by El-Naggar (1966) from the Maestrichtian of the Nile valley, U.A.R. and found them identical both with the type figures and the Iraqi form. He also examined G. cf. gagnebini Tilev, described by El-Naggar (Op.cit.) and found it is referrable to G. arca (Cushman).

Occurrence. Rare in the upper part of the Sadi formation and in the Hartha, Qurna and Tayarat formations.

Globotruncana stuartiformis/Globotruncana stephensoni zone - Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of Turkey, Texas, Alabama, New Jersey, Trinidad, Bavarian Alps, KarnTen and the U.A.R. Gandolfi (1955) recorded it from the Campanian - Maestrichtian of northeastern Colombia as G. ventricosa ventricosa and G. arca caribica.

Globotruncana gansseri gansseri Bolli

pl.28, figs.5-7

1931 Globotruncana arca (Cushman) Plummer. pp.195-198, pl.13, fig.9, (not figs.7,8-11)
1951 Globotruncana gansseri Bolli. pp.196-197, pl.35, figs.1-3
1955 Globotruncana gansseri gansseri Bolli. Gandolfi. pp.69-70, pl.6, figs.?5a-c,6a-c, 8a-c, t.f.11b
1956 Rugotruncana gansseri Bolli. Bronnimann and Brown. pp.549-550, pl.23, figs.7-9, t.f.23
1966 Globotruncana gansseri gansseri Bolli. El-Naggar. pp.117-119, pl.5, figs.1a-d
1966 Globotruncana gansseri gandolfii El-Naggar. pp.115-117, pl.5, figs.2a-d

Remarks. G. gansseri was originally described by Bolli (1951) from the Maestrichtian of the Gauyaguayare formation of Trinidad. Gandolfi (1955) described G. gansseri subgansseri as a new subspecies changing the name of G. gansseri to G. gansseri gansseri Bolli. Pessagno (1960) described G. gansseri dicarinata as another new subspecies but his figured holotype appears different from the type description. El-Naggar (1966) separated G. gansseri Bolli into four subspecies. He described G. gansseri gandolfii as a new subspecies. The writer has examined the holotype of G. gansseri gandolfii in the El-Naggar's collection at the British Museum of Natural History and has found it similar to G. gansseri gansseri Bolli. It is regarded herein as a junior synonym of the latter. The writer has also examined the hypotypes of G. gansseri gansseri Bolli, G. gansseri subgansseri Gandolfi and G. gansseri dicrainata Pessagno in the same Museum.

G. gansseri gansseri is believed to have evolved from G. rosetta (Carsey) as previously suggested by El-Naggar (Op.cit.) and Bandy (1967).

Occurrence. Abundant in the lower half of the Qurna formation; rare in the upper part of the Qurna and in the Tayarat formations.

Globotruncana gansseri zone.

Previous record of Occurrence. Apart from the type locality it was described from the Maestrichtian of Cuba, Puerto Rico, Haiti, Mexico, Texas, Arkansas, Alabama, New Jersey, the Austro-German border, Italy, Denmark, Bavaria, the U.A.R., Tunisia, India and Australia. From the Campanian - Maestrichtian of Colombia (Gandolfi 1955).

Globotruncana gansseri pettersi Gandolfi

pl.24, figs.10-12

1955 Globotruncana rosetta pettersi Gandolfi. p.68, pl.6, figs.3a-4c, t.f.11a

1961 Globotruncana cf. rosetta pettersi Gandolfi. Corminboeuf. pp.113-114, pl.1, figs.3a-c

1964 Globotruncana gansseri Bolli. Said and Sabry. p.387, pl.3, fig.3

1966 Globotruncana rosetta pettersi Gandolfi. El-Naggar. pp.127-128, (no figure)

Remarks. A few small, planoconvex specimens with a nearly quadrilobate equatorial periphery and single well developed marginal keel, are here referred to G. gansseri pettersi Gandolfi; originally described from the lower Colon shale of Colombia as G. rosetta pettersi. Its last whorl is composed of $4-4\frac{1}{2}$ comparatively large chambers, which increase slowly in size.

El-Naggar (1966) has examined topotypic material belonging in G. rosetta pettersi Gandolfi. He stated the presence of forms with two keels on the early part of the last whorl, becoming single keeled on the later chambers; and others with an entirely single keeled last whorl. Forms with two very close keels on the early stages fusing to a single keel on the last chambers were found in this study and considered transitional from G. rosetta to G. gansseri gansseri.

Gandolfi (1955) separated G. rosetta (Carsey) into three subspecies, describing G. rosetta insignis and G. rosetta pettersi as two new forms.

Van Hinte (1963) considered G. rosetta insignis Gandolfi to be a junior synonym of G. rosetta falsostuarti Sigal, while El-Naggar (Op.cit) included it in the synonymy of G. fareedi El-Naggar, although the former has the periority. Pessagno (1967) placed it in synonymy with G.

elevata (Brotzen).

Berggren (1962) was the only worker after Gandolfi (Op.cit) to refer to G. rosetta insignis as a separate form.

G. gansseri pettersi is morphologically very close to G. gansseri gansseri and possibly the direct descendant of it. However, the former has a smaller test size, smooth surface, nearly quadrilobate peripheral outline and its chambers increase slowly in size as added.

Occurrence. Rare in the upper half of the Qurna and in the Tayarat formations. Globotruncana gansseri zone.

Previous record of Occurrence. The Campanian of Colon shale, Colombia, the Maestrichtian of Switzerland and the U.A.R.

Globotruncana hilli Pessagno

1967 Globotruncana hilli Pessagno. pp.343-344, pl.64, figs.9-14, 21-23, pl.94, fig.1

1969 Globotruncana hilli Pessagno. Douglas. p.180, pl.7, figs.7a-8c

Remarks and Occurrence. Only three specimens of this small, parallel sided species, with its widely spaced, delicately beaded two keels, early spherical and later laterally compressed chambers in the final whorl, are recorded from the Middle Maestrichtian of the Qurna formation. Compared with the figured holotype, the type description and the topotypic material kindly forwarded by Dr. Pessagno, the Iraqi specimens have a truncated equatorial periphery throughout.

G. hilli was originally described from the Campanian - Maestrichtian of the Upper Taylor marl member of Texas. Pessagno (Op.cit) also reported its occurrence in Mexico and Alaska. Douglas (1969) reported this species from the Late Campanian of the Sacramento valley of northern California.

Globotruncana imbricata Mornod

pl.28, figs.11-12

1950 Globotruncana imbricata Mornod. p.589, t.f.5(2a-3d), pl.15, figs.21-34
1961 Praeglobotruncana imbricata (Mornod) Scheibnerova. p.62, pl.10, figs.3a-c
1965 Globotruncana imbricata Mornod. Takayanagi. pp.215-216, pl.24, figs.5a-c, pl.25, figs.1a-2c
1969 Globotruncana imbricata Mornod. Douglas. pp.180-181, pl.2, figs.4-7
1969 Praeglobotruncana imbricata (Mornod) Scheibnerova. pp.59-60, pl.8, figs.4a-c, pl.9, figs.1a-7c

Occurrence. G. imbricata is restricted to the Coniacian rocks of the Tanuma formation and associated with G. ventricosa White, G. concavata primitiva Dalbiez and G. renzi Gandolfi.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone

Previous record of Occurrence. The Turonian - Coniacian of California and the west Carpathian of Bratislava; the Lower Turonian of Bavaria and the Upper Turonian of Spain.

Globotruncana leupoldi Bolli

pl.29, figs.1-2

1945 Globotruncana leupoldi Bolli. pl.9, fig.17, t.f.1, figs.25,26
1966 Globotruncana leupoldi Bolli. El-Naggar. pp.121-122, pl.1, figs.4a-c

Occurrence. Very rare in the Qurna formation. Globotruncana gansseri zone.

Previous record of Occurrence. G. leupoldi was originally described from the Upper Campanian - Maestrichtian of the Wangschichten limestone of Switzerland. It is also known from the Maestrichtian of Egypt.

Globotruncana linneiana linneiana (d'Orbigny)

pl.24, figs.1-3

1839 Rosalina linneiana d'Orbigny. p.101, pl.5, figs.10-12 (in Ellis and Messina (1940) given as Rosalina linnei in plate explanation)

1918 Rosalina linnei d'Orbigny. de Lapparent. pp.1-17, t.f.2, fig.g

1936 Globotruncana linnei (d'Orbigny) Renz. pl.6, figs.32-34

1942 Globotruncana linnei (d'Orbigny) Gandolfi. pp.125-130, pl.3, fig.3, pl.4, figs.18,32,33

1952 Globotruncana lapparenti Brotzen. Sigal. p.35, fig.38

1953 Globotruncana linneiana (d'Orbigny) Subbotina. p.176, pl.5, figs.7a-9c, pl.6, figs.1a-4c

1956 Globotruncana linneiana (d'Orbigny) Bronnimann and Brown. pp.340-542, figs.13-17 (figs.13-15 = neotype)

1957 Globotruncana linnei (d'Orbigny) Sacal and Debourle. p.61, pl.26, figs.7,?8,9,?10,14-15,?16-18

1957 ? Globotruncana majzoni Sacal and Debourle. Ibid. p.61, pl.26, figs.6,21-22

1959 Globotruncana linneiana (d'Orbigny) Naggaba. pl.6, fig.6

1961 Not Globotruncana linneiana (d'Orbigny) Graham and Clark. p.113, pl.5, figs.11a-c

1962 Globotruncana linneiana linneiana (d'Orbigny) Barr. pp.571-572, pl.69, figs.7a-c pl.72, fig.5

1962 Globotruncana lapparenti linneiana (d'Orbigny) Pessagno. p.360, pl.3, figs.7-9

1963 Globotruncana linneiana (d'Orbigny) Bronnimann and Rigassi. pl.17, figs.5a-c

1963 Globotruncana linneiana (d'Orbigny) Lehmann. pp.149-150, pl.8, figs.4-5

1964 Globotruncana linneiana (d'Orbigny) Martin. p.81, pl.10, figs.3a-c

1964 Globotruncana linneiana (d'Orbigny) Olsson. pp.166-167, pl.7, figs.6a-8c

1965 Globotruncana linneiana (d'Orbigny) Takayanagi. pp.217-218, pl.25, figs.6a-c, pl.36, figs.?1a-c,2a-c

1965 Globotruncana linneiana linneiana (d'Orbigny) Van Hinte. p.84, pl.2, figs.4a-c

1966 Globotruncana linneiana (d'Orbigny) Ansary and Tewfik. p.53, pl.7, figs.2a-c

1966 Globotruncana linneiana (d'Orbigny) Caron. p.83, pl.5, figs.3a-c

1967 Not Globotruncana linneiana (d'Orbigny) Pessagno. pp346-349, pl.72, figs.1-2,3-4,7-9, pl.97, figs.11,12,13

1968 Globotruncana linneiana (d'Orbigny) Rao, Mamgain and Sastry. pp.24-25, pl.4, figs.10-12

1968 Globotruncana linneiana (d'Orbigny) Rasheed and Govindan. p.82, pl.7, figs.10-12

1969 Globotruncana linneiana (d'Orbigny) Douglas. pp.181-182, pl.3, figs.1a-c

1969 Globotruncana linneiana (d'Orbigny) Esker. p.216, pl.2, figs.1-3

Remarks. G. linneiana linneiana was originally described by d'Orbigny (1839) as Rosalina linneiana. In his plate explanation d'Orbigny (Op. cit) used Rosalina linnei while in the text Rosalia linneiana. However, the latter name is accepted here as valid according to International Code of Zoological Nomenclature (1961 Appendix D, Part 3, No.16a). Bronnimann and Brown (1956) considered Habana Bay (Bahia de la Habana), at which the only Cretaceous strata crop out in the area, as a tentative type locality. Among the topotypic specimens a neotype (pl.20, figs.13-15, Bronnimann and Brown 1956) was selected by them.

Bronnimann and Brown (Op.cit) considered G. canaliculata (Reuss) to be a junior synonym of G. linneiana d'Orbigny. According to Pessagno (1967) who selected the neotype (pl.74, figs.5-8 Pessagno (Op.cit)) of G. canaliculata from the lower part of the Gosau beds of Edelbachgraben, Austria, the depository of G. canaliculata is unknown and it seems probable that the type specimen is lost.

As can be seen from the original type figures, type description (in Trujillo 1961, p.341) neotype's figures and description G. canaliculata (Reuss) is a fairly distinct species. It is distinguished from other similar forms by its low and nearly equally biconvex test; its wedged-shaped chambers and straight, radial, depressed sutures on the umbilical side and by its small umbilicus.

Bolli (1945) followed by Subbotina (1953) Bronnimann and Brown (1956) Edgell (1957, Takayanagi (1960, 1965), Janoschek (1966) and Pessagno (1967) treated G. lapparenti Brotzen as separate species, while Trujillo (1960) Graham and Clark (1961), Barr (1962), Lehmann (1963),

Van Hinte (1963) regarded it conspecific with G. linneiana linneiana (d'Orbigny). In fact G. lapparenti Brotzen was originally described in syntypic series and several of de Lapparent's (1918) figures were used as syntypes. It was separated from G. linneiana linneiana (d'Orbig (d'Orbigny) on the basis of having a convex spiral side and narrowly elongated chambers, strongly convex on the umbilical side. Pessagno (1967 p.344) designated a lectotype (test-figure 2, fig.n, p.5, de Lapparent (1918)).

Douglas (1969) who examined materials from the type section for G. lapparenti Brotzen, did not recognise Pessagno's selections of a lectotype and paralectotype. He stated, "a lectotype of G. lapparenti has been designated by Pessagno (1967) ..... . However, several of the species present in the topotype material will yield a thin section profile very similar to these figures", thus he suggested that G. lapparenti and G. linneiana linneiana are only partly synonymous.

Subbotina (1953, p.177) remarked that G. lapparenti is very similar to G. linneiana but differs from it in its reniform chamber shape and sigmoidal ventral sutures.

It can be seen from the above discussion that the differences between these two species are very small and entirely based on the degree of development of the spiral convexity of the test and the shape and convexity of the chambers on the umbilical side. On the other hand, both G. linneiana linneiana and G. lapparenti share in having slightly to moderately convex spiral sides, two widely to medium spaced well developed keels, petaloid to subpetaloid chambers on the spiral side and subrectangular ones on the umbilical side.

However, until isolated specimens from the type section of de Lapparent are carefully examined, it is not possible to decide the validity of G. lapparenti.

G. pseudolinneiana (Pessagno) is distinguished from G. linneiana linneiana by its perfectly planiform, subcrescentic, elongated chambers on the spiral side; its thinner test and by its two, thickened, smooth or faintly beaded keels and sutures.

The specimens figured by Pessagno (1967) (see synonymy) as G. linneiana are different from the figured neotype and topotypes and possibly belong in G. pseudolinneiana (Pessagno), while that figured by the same author (pl.71, figs.6-13) as G. lapparenti Brotzen are referrable to G. angusticarenata Gandolfi.

The writer has found no significant difference between this species and G. majzoni Sacal and Debourle, hence this latter is regarded as a junior synonym of G. linneiana linneiana (d'Orbigny).

Occurrence. Abundant in the Khasib, Tanuma and the lower part of the Sadi formations, rare to very rare throughout the rest of the succession. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana gansseri zone.

Previous record of Occurrence. The species is almost limited in range to the Coniacian to Campanian of North America, Europe and the Caribbean region. However, Subbotina (1953) reported it from the Turonian - Maestrichtian of the Soviet Union while Bronnimann and Brown (1956) gave its range as Turonian to Campanian. It is also known from the Campanian - Maestrichtian of North Africa and Campanian of India and Pakistan.

Globotruncana linneiana tricarinata (Quereau)

pl.24, figs.4-5

1893 Pulvinulina tricarinata Quereau. pl.5, fig.3a (not figs.3b,c,d)
1918 Rosalina linnei type 2 de Lapparent. p.4, figs.1b,d-f, p.5, t.f.2d,n
1936 Globotruncana linnei (d'Orbigny) Renz. p.19, pl.6, figs.28-30, pl.8, fig.7 (not pl.6, figs. 33,34, pl.7, figs.2,3)
1941 Globotruncana linnei tricarinata (Quereau) Vogler. p.287, pl.33, figs.22-31
1945 Globotruncana lapparenti tricarinata (Quereau) Bolli. p.232, t.f.1(19,20), pl.9, fig.13
1959 Globotruncana tricarinata (Quereau) Hofker. p.295, t.f.20a-c, 27a-c
1960 Globotruncana lapparenti tricarinata (Quereau) Pessagno. p.100
1961 Globotruncana linneiana tricarinata (Quereau) Graham and Clark p.112, pl.5, figs.8a-c
1962 Globotruncana linneiana tricarinata (Queraeu) Barr. p.573, pl.70 figs.2a-c
1963 Globotruncana (Globotruncana) linneiana tricarinata (Quereau) Van Hinte. p.79, pl.6, figs.1a-c
1964 Globotruncana linneiana tricarinata (Quereau) Martin. p.83, pl.10, figs.2a-c
1965 Globotruncana tricarinata (Quereau) Takayanagi. pp.225-226, pl.27, figs.4a-c. Including additional synonymy upto 1964.
1965(a) Globotruncana (Globotruncana) tricarinata (Quereau) Van Hinte. p.4, pl.2, figs.1a-c
1965(b) Globotruncana tricarinata (Quereau) Van Hinte. Ibid. p.23, pl.3 figs.2a-c
1966 Not Globotruncana tricarinata tricarinata (Quereau) Salaj and Samuel. p.218, pl.19, figs.3a-c
1966 Globotruncana lapparenti tricarinata (Quereau) Wille-Janoschek pp.110-111, pl.2, figs.1-11
1968 Globotruncana tricarinata (Quereau) Barr. p.319, pl.37, figs.8a-c, pl.38, figs.1a-c
1968 Globotruncana tricarinata (Quereau) Rao, Mamgain and Sastry. pp.26-27, pl.3, figs.10-12
1968 Globotruncana tricarinata (Quereau) Rasheed and Govindan. Ibid. p.83, pl.7, figs.13-15

Remarks. G. linneiana tricarinata (Quereau) was originally described from the Campanian - Maestrichtian of Calcites des Gauches Rouges des

Prealpes and Prealpes fribourgeoes of Switzerland, on thin-sections and a syntypic series.

Gandolfi (1955) followed by Berggren (1962) and El-Naggar (1966) stated their doubts regarding the morphological characters, identity and the stratigraphical distribution of this species. So does this writer.

Pessagno (1967) designated the sectioned specimen figured by Quereau (1839) on plate 5, fig.3a, as the lectotype of Pulvinulina tricarinata Quereau. He stated, "the remainder of Quereau's figured specimens (3b-d) are poor and fragmental. For this reason paralectotypes have not been selected", then, referring to his "Form analysis data" presented in text figures 50, 51 (Op. cit) he added, "the reader can see that the lectotype of P. tricarinata falls well within the limits of G. linneiana".

Although the writer agrees that Quereau's figures are misleading and probably generalized, he disagrees with the method followed by Pessagno (Ibid) in selecting a lectotype and solving taxonomic problems. All the specimens figured by Pessagno (1967) as G. linneiana d'Orbigny belong in different species (see under G. linneiana linneiana). In cases where the type figure (or figures) are very poorly drawn, selection of them for lectotype will fail to fulfil the morphological requirements of the taxon.

G. linneiana tricarinata (Quereau) was originally described and figured as having a pronounced, well developed umbilical flange, which is formed by the umbilical extension of the ventral keel, a slightly raised spiral side, a strongly raised umbilical one and two moderately spaced carinae.

It is morphologically similar to G. linneiana linneiana (d'Orbigny), but differs in its flat to slightly raised spiral side and convex umbilical one, its strongly thickened, beaded periumbilical keel and more strongly developed marginal ones and its rapidly increasing chambers. By the development of these characters, G. linneiana tricarinata is believed to have evolved from G. linneiana linneiana.

Occurrence. Abundant in the Tanuma and the lowermost part of the Sadi formation, rare in the rest of the Sadi formation, the uppermost part of the Hartha formation and the lowermost part of the Qurna formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - the lowermost part of the Globotruncana gansseri zone.

Previous record of Occurrence. The Turonian - Maestrichtian of North America and Europe; the Coniacian - Maestrichtian of North Africa, Asia and Australia.

Globotruncana marginata (Reuss)

pl.21, fig.9; pl.23, figs.11-12

1845 Rosalina marginata Reuss. p.36, pl.8, figs.54a-b,74a-b, pl.3, figs.68a-b
1854 Rosalina marginata Reuss. Reuss. p.69, pl.26, figs.1a-c
1937 Globigerina marginata (Reuss) Loetterli. p.44-45, pl.7, figs.3a-c
1939 Globotruncana marginata (Reuss) Morozova. pp.79-80, pl.1, figs.7-9
1943 Globotruncana marginata (Reuss) Majzon. pl.1, figs.8a-c
1944 Globotruncana marginata (Reuss) Cushman. p.340, pl.53, figs.29a-b
1946 Rosalinella marginata (Reuss) Schijfsma. pp.97-98, pl.7, figs.10a-c
1950 Globotruncana marginata (Reuss) Asano. p.162, pl.1, figs.2a-c, 4a-c
1953 Globotruncana marginata (Reuss) Gauger. p.82, pl.9, figs.27-29
1953 Globotruncana marginata (Reuss) Hamilton. pl.29, figs.23-25
1956 Marginotruncana marginata (Reuss) Hofker. p.323, t.f.8a-d (not page 322, t.fs.6a-b,7, p.315, t.f.2)
1956 Globotruncana marginata (Reuss) Jirova. pp.248-249, pl.1, figs.1a-c, pl.2, figs.1a-c, 2a-c (not pl.2, figs.3a-c, pl.3,

figs.1a-c = G. cretacea (d'Orbigny))

1957 Globotruncana marginata (Reuss) Smitter. p.200, figs.22a-b

1958 Globotruncana marginata (Reuss) Witwicka. pl.17, figs.34a-c

1960 Not Globotruncana marginata (Reuss) Tollmann. pp.194-195, pl.21, fig.3

1962 Not Globotruncana marginata (Reuss) Barr. pp.574-575, pl.70, figs. 3a-c, pl.72, figs.7,8a-c

1962 Globotruncana marginata (Reuss) Herm. pp.85-86, pl.5, fig.5

1963 Not Globotruncana marginata (Reuss) Lehmann. p.151, pl.10, figs. 3a-c, p.139, t.f.?2x

1965 Globotruncana (Globotruncana) marginata (Reuss) Van Hinte. p.23, pl.1, figs.2a-c

1965 ? Globotruncana marginata (Reuss) Takayanagi. pp.218-219, pl.26, figs.?3a-c,?4a-c including additional synonymy upto 1963

1966 Globotruncana globigerinoides Brotzen. Ansary and Tewfik. p.55, pl.8, fig.2

1966 Globotruncana marginata (Reuss) Echer. p.29, pl.6, figs.5a-c, 6a-c

1967 Marginotruncana marginata (Reuss) Pessagno. pp.307-310, pl.54, figs.7-9,10-12,16-18 (not pl.6, figs.10-12)

1967 Globotruncana bulloides Vogler. Pessagno. pp.324-326, pl.64, figs.15-17 (not pl.67, figs.1-3, pl.73, figs.9,10, pl.75, figs. 4-8, pl.97, figs.14,15)

1969 Globotruncana marginata (Reuss) Douglas. pp.182-183, pl.8, figs.4a-c (not figs.5a-c)

Remarks. G. marginata was first described by Reuss (1845) from the Cretaceous of Bohemia as Rosalina marginata. He gave six figures showing only spiral and umbilical sides. Although he failed to show the marginal view and his figures are small and possibly generalized, (see also Bolli 1957), the type description clearly states the presence of the perpendicular truncate margin. Reuss (1854) described from the Cretaceous of Austria as Rosalina marginata, another specimenswhich clearly shows all the diagnostic features of G. marginata (Reuss).

Dana Jirova (1956) designated the neotype (pl.1, figs.1a-c, pp.248 - 249) of Rosalina marginata Reuss (1845) from the Emscherian (Coniacian) marls of Czechoslovakia, the marl cropping out near the village Luzice in northern Bohemia. Bolli et.al (1957), on the other hand, selected

the specimen illustrated in Reuss figs.68a-b (1845) as the lectotype of Rosalina marginata Reuss. However, the selection of the neotype has periority over Bolli's lectotype.

According to Douglas (1969) who examined topotypes, these correspond with the neotype and with the specimen figured by Cushman (1946, pl.62, figs.1-2).

Compared with those from the southern Iraq, the neotype shows a greater number of chambers on the spiral side and has a wider umbilicus. They coincide well with the specimens of G. marginata (Reuss) figured by Reuss (1854), Schijfsma (1944), Hagn and Zeil (1954) and Van Hinte (1955) (see synonymy).

G. marginata (Reuss) is morphologically close to both G. bulloides bulloides Vogler and G. cretacea (d'Orbigny). It is distinguished from the former by its slightly compressed chambers which increase gradually in size as added, its closely spaced, less developed marginal keels and by its radial to slightly curved, depressed sutures on the umbilical side. It differs from G. cretacea in having laterally compressed chambers, depressed sutures only on the umbilical side, rather well developed marginal keels and delicate umbilical rides. The specimens described by Barr (1962), Lehmann (1963) and Douglas (1969) (see synonymy) as G. marginata (Reuss) lack the characteristic depressed sutures on the umbilical side and the chambers on the spiral side are vaulted and increase rapidly in size as added. These specimens are referrable to G. bulloides bulloides Vogler. The specimens figured by Pessagno (1967 pl.64, figs.15-17) as G. bulloides Vogler are referrable to G. marginata Reuss.

G. marginata (Reuss) is believed to have evolved from Praeglobotruncana delrioensis, by the development of two marginal keels, raised sutures on the spiral side, by retained the compressed nature of its chambers and the depressed sutures on the umbilical side.

Examination of the holotype and two paratypes of G. culverensis Barr, in Barr's collection at the British Museum of Natural History, suggests that it represents a distinct morphologic type and should be considered a valid species.

Occurrence. Abundant in the Khasib, Tanuma and the lower half of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana fornicata subzone.

Previous record of Occurrence. The Cenomanian - Turonian of Holland, Colorado; the Turonian - Coniacian of Czechoslovakia, Bohemia; the Turonian - Santonian of Mexico; the Turonian - Campanian of Bavaria, Germany; the Turonian - Maestrichtian of the U.S.S.R. Texas, Alabama, Mississippi, California; the Santonian of Poland, West Australia; the Senonian - Campanian of France and the Campanian of North Australia, South Africa, the Austro-German border, Austria.

G. marginata is also know from the Upper Cretaceous of Nebraska, Colombia, Switzerland, Hungary, the Netherlands and Egypt.

Globotruncana mariei Banner and Blow

pl.29, figs.8-10

1931 Globotruncana arca (Cushman) Cushman. p.59, pl.11, figs.6a-c
1931 Globotruncana arca (Cushman) Plummer. pp.195-198, pl.13, fig.8 (not figs.7,9,11)
1938 Globotruncana cretacea Cushman. p.67, pl.11, figs.6a-c
1960 Globotruncana mariei Banner and Blow. p.8
1962 Globotruncana (Globotruncana) mariei. Banner and Blow. Berggren. pp.54-56, pl.9, figs.5a-c
1964 Globotruncana mariei Banner and Blow. Olsson. pp.167-168, pl.4 figs.8a-c,10a-c

1966 Globotruncana mariei Banner and Blow. El-Naggar. pp.124-125, including additional synonymy.

1966 Not Globotruncana mariei Banner and Blow. Caron. pp.85-87, pl.6, figs.1a-c (= G. renzi Gandolfi)

1967 Globotruncana rosetta (Carsey) Pessagno. p.352-354, pl.70, figs.9-12, pl.73, figs. 5-8, pl.98, fig.14

Remarks. Cushman (1931) described as G. arca (Cushman) (pl.11, figs.6a-c) a clearly different specimen, but later (1938) renamed it G. cretacea new species. Banner and Blow (1960) in "Revision of Globigerina cretacea d'Orbigny (1840)" proved that this species possess two marginal keels, enclosing an imperforate peripheral band, thus they considered it to be a true Globotruncana. Consequently G. cretacea Cushman became a junior homonym and the specimen was redescribed as Globotruncana mariei nom.nov.

G. mariei Banner and Blow has possibly evolved from G. arca (Cushman) as suggested by their morphological similarity and stratigraphical distribution.

An examination of the specimens of G. cretacea Cushman described by Nakkady (1951) from the Upper Cretaceous of Duwi, Egypt, in the British Museum (Natural History) showed that they include G. stuarti stuartiformis Dalbiez, G. aegyptiaca aegyptiaca Nakkady and G. gagnebini Tilev.

The writer has also examined the specimens of G. pseudocretacea Nakkady at the same museum and has found that there is little significant difference between this epcies and G. mariei Banner and Blow. However, G. pseudocretacea was mentioned by Nakkady (1951) without description or remarks, thus it does not fulfil the taxonomic requirement of species, and in this study it was considered to be invalid.

Occurrence. Rare in the middle and upper parts of the Sadi formation,

the Hartha formation and the lower part of the Qurna formation.

Globotruncana fornicata subzone - the lower part of Globotruncana gansseri zone.

Previous record of Occurrence. G. mariei was originally described from the Upper Campanian, Selma chalk of Tennessee. It is also known from the Campanian - Maestrichtian of Texas, Denmark, and the U.A.R. and the Maestrichtian of New Jersey.

Globotruncana obliqua Herm

pl.19, fig.3

1962 Globotruncana sp. Herm. p.85, pl.4, fig.6
1965 Globotruncana linneiana (d'Orbigny) obliqua Herm. pp.236-238, pl.8, figs.1-4, t.f.14
1967 ? Globotruncana loeblichi n.sp. Pessagno. pp.349-350, pl.73, figs.1-4, pl.97, fig.10
1968 Globotruncana obliqua Herm. Barr. pp.316-318, pl.39, figs.5a-d, 6a-d

Remarks. A few low, trochospiral, parallel-sided specimens with two well developed marginal keels, a lobate equatorial periphery and a truncate axial one are here referred to G. obliqua Herm, originally described as variety of G. linneiana (d'Orbigny). Its last whorl is composed of $4\frac{1}{2}$ large chambers, which are oblique to the axis of coiling and increase moderately in size as added.

Pessagno (1967) described as G. loeblichi n.sp. a form which most probably belongs in G. obliqua Herm.

Occurrence. In the uppermost part of the Khasib formation.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. It was originally described from the Lower Maestrichtian of northern Spain. It was also reported from the Upper Campanian of southern England and the Paris Basin; the Upper Campanian and Lower Maestrichtian of Libya and Tunisia and the Campanian

of Texas and Mexico.

Globotruncana pseudolinneiana (Pessagno)

pl.29, figs.11-12

1928 cf. Globotruncana canaliculata (Reuss) White. pp.282-287, pl.38, figs.3a-c
1967 Marginotruncana pseudolinneiana Pessagno. p.310, pl.65, figs.24-27, pl.76, figs.1-3
1967 Globotruncana linneiana (d'Orbigny) Pessagno. pp.346-349, pl.72, figs.1-2,3-4,7-9, pl.97, figs.11,12,13
1969 Globotruncana pseudolinneiana (Pessagno) Douglas. p.185, pl.3, figs.2-4
1969 Globotruncana pseudolinneiana (Pessagno) Douglas and Rankin. pp.207-209, figs.16A-C, figs.17A-C

Remarks. The specimens described here as G. pseudolinneiana (Pessagno) are distinguished by having a thin test, parallel sided, 6 crescentic to subcrescentic, elongated chambers in the last whorl, two widely spaced, delicately beaded or only slightly thickened keels, delicately beaded or only slightly thickened sutures and smooth chamber walls.

In the Iraqi material, only three specimens belonging in this species were found in the Khasib formation.

Previous record of Occurrence. It was originally described by Pessagno (Ibid) from the Coniacian - Lower Santonian of Mexico, Texas and from the LaterTuronian of California. Douglas (1969) reported its occurrence in the Upper Turonian - Lower Campanian of northern California, while Douglas and Rankin (1969) had it from the ?Coniacian - L. Santonian of Bornholm, Denmark.

Globotruncana ? pura Hofker

pl.30, fig.10

1956 Globotruncana pura Hofker. p.327, t.fs.16a-d
1965 Globotruncana pura Hofker. Takayanagi. p.221, pl.27, figs.1a-c

Occurrence. Rare in the upper part of the Sadi formation. The lower part of the Globotruncana stuartiformis/Globotruncana stephensoni zone.

Previous record of Occurrence. G.?pura Hofker was originally described from the Campanian of Hannover. It was also reported from the Campanian of the Netherlands and the Upper Santonian of California.

Globotruncana renzi Gandolfi

pl.23, figs.1-4

1942 Not Globotruncana renzi Thalmann. p.8, nomen nudum
1942 Globotruncana renzi Gandolfi. p.124, t.fs.45a-c, pl.4, fig.15 (not pl.3, figs.1a-c, pl.4, figs.16,28,29, pl.10, fig.2 = G. coldreriensis Gandolfi)
1945 Not Globotruncana renzi Thalmann. Thalmann. p.405 (type figure of Renz 1936 Op.cit. pl.8, fig.2)
1945 Globotruncana renzi Gandolfi. Bolli. p.225, pl.9, fig.5
1946 Not Globotruncana renzi Gandolfi. Thalmann. pp.128-129
1947(a) Globotruncana renzi Gandolfi and Thalmann. pp.385-386
1947(b) Not Globotruncana renzi Gandolfi and Thalmann. Thalmann. p.311-312
1954 Globotruncana renzi Thalmann and Gandolfi. Hagn and Zeil. pp.37-39, pl.3, figs.2a-c
1955 Globotruncana aff. cretacea Cushman. Gandolfi. p.62, pl.4, figs.7a-c
1957 Globotruncana renzi Gandolfi. Bolli. p.58, pl.14, figs.3a-c
1960 Globotruncana renzi Gandolfi. Trujillo. p.343, pl.5, figs.4a-c (not figs.3a-c)
1963 Globotruncana (Globotruncana) renzi renzi Gandolfi. Van Hinte p.66, pl.2, figs.1-2
1966 Globotruncana renzi Gandolfi. Caron. pp.77-79, figs.a,b,c,c (not figs.5a-c, pl.4, figs.4a-c)
1966 Globotruncana renzi Gandolfi. Salaj and Samuel. p.211, pl.18, figs.1a,b,c
1967 Not Globotruncana renzi renzi Gandolfi. Bandy. p.19, t.f.8(8)
1967 Marginotruncana renzi (Gandolfi) Pessagno. pp.310-313, pl.55, figs.4-7c, pl.65, figs.?20-23
1969 ? Globotruncana renzi Gandolfi. Casati and Tomai. pp.248,253-255, pl.13, fig.1
1969 Globotruncana renzi Gandolfi. Caron and Luterbacher. pp.27-29, pl.9, figs.11,11a-c (not figs. 12a-c)
1969 Not Praeglobotruncana renzi (Gandolfi) Douglas. pp.172-173, pl.2, figs.8a-c
1969 Not Marginotruncana renzi (Gandolfi) Esker. p.216, pl.1, figs.12-14

Remarks. Caron and Luterbacher (1969) restudied the specimens of G. renzi Gandolfi, in the Gandolfi's collection at the Museum of National History, Basle and found that they belong to three morphologically different species;

1. The specimen corresponding to test-figure 45a-c, C25559 represents an intermediate form, possibly belonging in G. praeconcavata; however, it could be a juvenile specimen of G. concavata (Brotzen).

2. The specimen corresponding to pl.3 figure 1a-c C25560, represents a real G. renzi because, "the main features which characterize G. renzi as a well defined and independent species are well represented".

3. The sectioned-specimen corresponding to pl.10 figure 2, belongs probably in the Praeglobotruncana stephani group.

At the time of description of G. renzi, Gandolfi (1942) failed to designate the holotype. But, according to the above two authors, the specimen illustrated in pl.3 fig.1 (C25560) was labelled as the holotype. However, labelling of a specimen in a collection does not constitute publication, unless all information that appears on the label(s) accompanying the specimen has been published. (Int. Code of Zool. Nomen. 1961, Art.9, no.5, p.9)

Caron and Luterbacher (Op.cit) considered the specimen (pl.3, fig.1 a-c, C25560 Gandolfi 1942) as the lectotype of G. renzi Gandolfi, for the following reasons; 1 - the main features are well represented; 2 - the majority of other authors describing G. renzi have referred to this specimen, and 3 - Gandolfi (1957) designated this specimen as the holotype of G. coldreriensis.

Since this specimen (see pl.3 fig.1) had previously been designated holotype of G. coldreriensis by Gandolfi (1957, p.64) its reselection

by Ellis and Messina (1958) as type of another taxonomic species violates Article 61b of the Code of Zoological Nomenclature, 1961. Moreover, in the present writer's opinion, once a specimen in syntypic series designated as holotype of a taxon, it should be permanently removed from that series. Consequently, selection of the specimen (pl.3, fig.1) by Ellis and Messina (Op.cit) as lectotype of G. renzi Gandolfi, and its redescription by Caron and Luterbacher (Op.cit) again violates the code of Zoological Nomenclature, but this time Article 74a(1). The designation by Pessagno (1967) of the specimen illustrated by Gandolfi (1942, test figure 45a-c, p.124) as lectotype of G. renzi Gandolfi, is considered valid in this study.

The name "G. renzi" was first used by Thalmann (1942 April) in the "Programme of an Annual Convention" and later by Gandolfi (1942, August 31 in "Riv.Ital. Pal."). The first name was considered invalid according to the Code of Zoological Nomenclature, 1961 (Art.9 no.4) as it appeared in an invalid publication.

Although Thalmann (1945) redescribed G. renzi Thalmann (not G. renzi Gandolfi) in the Journal of Paleontology and chose G. appeninica linnei Renz (pl.8, fig.2 1936) as the type of his species which is considered here as holotype, (Code. Zool. Nom. 1961, Art.73a,73b, p.77), his specific name cannot be regarded valid as it already was occupied by G. renzi Gandolfi (nomen.nudum.). G. renzi Gandolfi is distinguished from the morphologically rather similar G. concavata primitiva Dalbiez, which possibly evolved from the same ancestral stock, by its smaller test size, its generally compressed last chamber, its elongated, kidney-shaped chambers on the umbilical side; its angled axial periphery; its two closely spaced keels which become single on the last chamber and by

its raised, curved umbilical sutures.

Occurrence. Abundant in the Khasib and Tanuma formations.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. So far as the records of the species which are included into the synonymy are concerned, G. renzi occurs in the Turonian of Bavaria, California; the Upper Turonian - Coniacian of Czechoslovakia; the Upper Turonian - Lower Santonian of Texas, Italy; the Upper Coniacian of Austria and the Coniacian - Lower Santonian of Trinidad.

Gandolfi (1942) did not designate the type locality. His figure 45a-c (p.124) and pl.4, fig.15 were recorded from Coldrerio, northwest of Balerina, Cauto Ticino in southeastern Switzerland.

Globotruncana rosetta (Carsey)

pl.29, figs.5-7

1926 Globigerina rosetta Carsey. p.44, pl.5, figs.3a-c
1931 ? Globotruncana arca (Cushman) Plummer. p.195, pl.13, fig.11 (not figs.7a-c = G. stephensoni; not fig.8 = G. mariei; not fig.9 = G. gansseri gansseri)
1953 Globotruncana rosetta (Carsey) Subbotina. pp.197-200, pl.13, figs.5a-c
1955 ? Globotruncana rosetta rosetta (Carsey) Gandolfi. pp.66-67, pl.6, figs.1a-c (not t.f.10)
1956 Globotruncana rosetta (Carsey) Bronnimann and Brown. p.545, pl.21, figs.11-13
1960 ? Globotruncana (Globotruncana) rosetta (Carsey) Pessagno. p.100, pl.3, figs.4-7, pl.5, figs.6,9
1962 Globotruncana rosetta (Carsey) Barr. pp.575-576, pl.70, figs.4 a-c
1962 Globotruncana (Globotruncana) rosetta (Carsey) Berggren. p.56, pl.10, figs.1a-c
1962 Globotruncana (Globotruncana) rosetta (Carsey) Pessagno. p.362, pl.4, figs.6-8
1963 Globotruncana (Globotruncana) rosetta rosetta (Carsey) Van Hinte. pp.89-91, pl.9, fig.3 (not fig.1,2, not pl.10, fig.1 = G. falsostuarti Sigal)

1964 Globotruncana rosetta (Carsey) Olsson. pp.168-169, pl.4, figs.5a-c, 7a-c

1966 Globotruncana rosetta rosetta (Carsey) El-Naggar. pp.128-130, pl.8, figs.3a-d

1966 Globotruncana rosetta (Carsey) Ansary and Tewfik. pp.55-56, pl.8 figs.3a-c

Remarks. G. rosetta was originally described by Carsey (1926) from the Cenomanian - Maestrichtian of Central Texas as Globigerina rosetta. White (1928) removed it to the genus Globotruncana.

Most earlier workers erroneously included all single-keeled Campanian - Maestrichtian species of Globotruncana either in G. stuarti (de Lapparent) or in G. rosetta (Carsey), partly because G. stuarti was the earliest name applied to single-keeled Campanian - Maestrichtian species of Globotruncana and partly because of the failure of all workers to note the two closely spaced keels reducing to a single keel on the last one or two chambers. G. rosetta is a planoconvex species with depressed, nearly radial sutures on the ventral side (Carsey 1926, pl.5 figs.3a-c). G. rosetta is believed to have evolved from G. mariei Banner and Blow, as previously suggested by Berggren (1962) by further development of the umbilical convexity, flattening of the spiral side and by reduction of the lower keel on the final chambers into a single one.

El-Naggar (1966) followed by Bandy (1967) and Pessagno (1967) suggested the evolution of G. rosetta from G. ventricosa White. This writer believes that there are at least two noticeable characters in most of the species of Globotruncana which show similar evolutionary tendencies;

1. The development of petaloid or crescentic shaped chambers.
2. A tendency towards the reduction of the lower keel leading to

the development of a single keeled group. (In G. rosetta the lower keel is only partially reduced because of its transitional position between G. mariei and G. gansseri gansseri Bolli.)

G. ventricosa has two equally developed, thickened, beaded keels which shows no tendency towards the reduction of the lower keel. Its chambers are perfectly petaloid and strongly lobate. Moreover, most of the Middle Maestrichtian specimens of G. ventricosa show slight spiral convexity and well developed umbilical ridges similar to that of G. linneiana tricarinata (Quereau).

Hypotype specimens of G. rosetta (Carsey) in Barr's (1962) collection and that in El-Naggar's (Op.cit) collection at the British Museum of Natural History were examined by this writer.

Occurrence. Rare in the upper part of the Sadi, the Hartha, the Qurna and the Tayarat formations. Globotruncana stuartiformis/Globotruncana stephensoni zone - Globotruncana gansseri zone.

Previous record of Occurrence. This species appears to be almost restricted in range to the Campanian to Maestrichtian.

G. rosetta (Carsey) was originally described from the Upper Taylor marl (Upper Campanian) of central Texas. Carsey (Op.cit) also reported it from the Del Rio (Genomanian, Austin (Coniacian - Santonian) and Navaro formations. However, Bronnimann and Brown (1956) denied the occurrence of this species in Del Rio formation of Texas.

Globotruncana schneegansi Sigal

pl.24, figs.6-7

1952 Globotruncana schneegansi Sigal. p.33, t.f.34 (3 figures)
1957 Globotruncana schneegansi Sigal. Bolli. p.58, pl.14, figs.1a-c
1960 Globotruncana schneegansi Sigal. Trujillo. pp.343-344, pl.49, figs.9a-c

Fig.14b — Suggested phylogeny of some important species of Globotruncana in S. Iraq.

1967 Marginotruncana sigali (Reichel) Pessagno. pp.313-314, pl.56, figs.1-3 (not pl.54, figs.4-6, not pl.57, figs.1,2)

Remarks. The specimens described here as G. schneegansi Sigal are characterized by having a low biconvex test, lobate equatorial periphery, curved raised sutures on the spiral side and nearly sigmoidal, thickened sutures on the umbilical side.

Compared with the figured holotype, the Iraqi specimens have two very closely spaced keels on the first one or two chambers of the last whorl, a single keel on the rest and more strongly overlapping chambers.

Occurrence. It was found rare in a single sample from the Khasib formation. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone.

Previous record of Occurrence. The species was originally described by Sigal (1952) from the Turonian rocks of northern Algeria. Trujillo (1960) reported it from the Middle Turonian of California. It was also known from the Turonian and Coniacian of Germany, Switzerland, Tunisia and Trinidad.

Globotruncana stephensoni Pessagno

pl.24, figs.8-9

1967 Globotruncana stephensoni Pessagno. pp.354-356, pl.69, figs. 1-7, pl.96, figs.5-6

Remarks. G. stephensoni was originally described by Pessagno (1967) from the Taylor formation (Upper Taylor marl member) of Texas. It is distinguished by its convex spiral side; sharply angled axial periphery; umbilically shifted lower keel which is poorly developed and reduced on the last chambers; trapizoidal to subtrapizoidal, pitalliform chambers on the spiral side and unconnected or absent umbilical flanges.

In the type description, Pessagno (Op.cit) did not compare G. stephensoni with other morphologically similar species. An examination of the holotype and the descriptions both of G. rosetta insignis Gandolfi and G. goudkoffi Martin shows that the former has very low spiral convexity, is entirely single keeled and has a small umbilicus, while the latter has chambers elongated and crescentic on the spiral side and two keels throughout the equatorial periphery, the lower of which is so strongly shifted umbilically that it appears in the middle of the chambers.

El-Naggar (1966) examined the type specimens of G. falsostuarti Sigal and states that the holotype have an unequally biconvex test and a strongly protruding umbilical side. This is the only significant difference differentiating G. stephensoni from G. falsostuarti, the other characters such as keels, sutures and umbilical flanges being similar. The writer has examined the figured holotype of G. falsostuarti as well as the specimens figured by Funnell et.al (1969) and has found only small . difference between Sigals species and G. stephensoni Pessagno.

G. stephensoni is different from G. conica White in having a less convex spiral side, two keels in the early stages, reduced to a single one on the last chambers and a convex umbilical side. However, it should be noted that Funnell et.al (Op.cit) figured a G. conica White with traces of second keel, from western Spain. It is distinguished from G. arca (Cushman) by its angled axial periphery, two weak, narrowly spaced keels which are unequally developed and in having trapizoidal to subtrapizoidal chambers.

The holotype and three paratypes of G. orientalis El-Naggar (1966) was examined by the writer at the British Museum (Natural History).

Two of the paratypes are referrable to G. stephensoni (Pessagno) while the holotype shows a more convex spiral side, a flat umbilical side, a less lobate periphery, a weaker lower keel and well developed, continuous, umbilical flanges.

G. stephensoni Pessagno is believed to have evolved from G. arca (Cushman) by decrease of the umbilical convexity, the weakening of the two keels, the reduction of the lower keel on the last chambers and the development of trapizoidal to subtrapizoidal chambers. G. stephensoni probably evolved into G. conica White through G. orientalis El-Naggar by the flattening of the umbilical side and the complete reduction of the lower keel. (See under G. stuarti stuarti (de Lapparent).)

Occurrence. This species is rare in the upper part of the Sadi formation and continues up to the uppermost part of the Hartha and the lower half of the Qurna formations, where it is rather abundant. It dies out completely in the lower part of the Tayarat formation.

Globotruncana stuartiformis/Globotruncana stephensoni zone - Globotruncana gansseri zone.

Previous record of Occurrence. It is known from the Campanian - Lower Maestrichtian of Mexico, Texas and Arkansas (Pessagno 1967).

Globotruncana stuarti stuarti (de Lapparent)

pl.30, figs.3-4

1918	Rosalina stuarti de Lapparent.	p.12, t.f.4 (6 figures)
1928	Globotruncana rosetta (Carsey) White.	p.286, pl.39, figs.1a-c
1937 Not	Globotruncana stuarti (de Lapparent) Glaessner.	pp.39-40, pl.1, figs.13a-c
1943	Globotruncana stuarti (de Lapparent) Majzon.	pp.167-168, pl.1, figs.10a-c, pl.2, figs.3a-c
1951 Not	Globotruncana stuarti (de Lapparent) Bolli.	p.196, pl.34, figs.10-12
1951 Not	Globotruncana (Globotruncana) stuarti (de Lapparent) Noth.	p.78, pl.8, figs.12a-c

1953	Not	Globotruncana stuarti (de Lapparent) Subbotina. pp.201-203, pl.15, figs.3a-c,4a-c,5a-c
1955	Not	Globotruncana stuarti stuarti (de Lapparent) Gandolfi. pp.64-65, pl.5, figs.6a-c
1956	?	Globotruncana stuarti (de Lapparent) Said and Kenawy. p.151, pl.5, figs.22a-c
1959	Not	Globotruncana stuarti (de Lapparent) Olvera. pp.120-122, pl.8, figs.7-9
1959		Globotruncana stuarti (de Lapparent) Nagappa. pl.7, figs.1a-c, 2-3
1962		Globotruncana stuarti (de Lapparent) Berggren. pp.60-64, pl.10, figs.2a-c
1963		Globotruncana stuarti (de Lapparent) Kavary and Frizzell. p.56, pl.11, figs.9-10
1964		Globotruncana stuarti stuarti (de Lapparent) Olsson. pp.169-170, pl.5, figs.9a-c
1966		Globotruncana stuarti stuarti (de Lapparent) El-Naggar. pp.133-136, pl.8, figs. 4a-d, pl.9, figs. 1a-d including additional synonymy upto 1962
1966		Globotruncana stuarti stuarti (de Lapparent) Ansary and Tewfik. pp.49-50, pl.7, figs.4a-c
1967		Globotruncana stuarti (de Lapparent) Pessagno. pp.356-357, pl.81 figs.1-6
1969		Globotruncana stuarti (de Lapparent) Funnell, Friend and Ramsay. pp.33-34, pl.4, figs.7-9 t.f. 17

Remarks. G. stuarti stuarti was originally described by de Lapparent (1918) in syntypic series, from the Maestrichtian of Hendaye, France, as Rosalina stuarti. Arni (1933) removed it to the genus Globotruncana although his two figured sections hardly show the diagnostic characters of this species. Pessagno (1967) designated the specimen illustrated in the three lower figures of Text-figure 4, on page 12, as the lectotype of Rosalina stuarti de Lapparent.

G. stuarti stuarti is distinguished from G. stuarti stuartiformis Dalbiez by its large, biconvex test, non-lobate equatorial periphery, quadrangular, subtrapizoidal chambers and by the absence of a central cone. G. elevata (Brotzen) is somewhat similar to G. stuarti stuarti

but is characterized by having depressed sutures on the umbilical side, a strongly lobulate periphery and distinctly patelliform chambers in the last whorl. G. conica White has very strong spiral convexity, while its umbilical side is perfectly flat and sometimes even concave.

It is suggested here that G. conica developed from two separate lineages;

1. The G. arca - G. stephensoni - G. orientalis - G. conica lineage.
2. The G. stuarti stuartiformis - G. stuarti stuarti - G. conica lineage.

Both lineages share in increasing the spiral convexity of the test, in developing trapizoidal or subtrapizoidal chambers and a non-lobate peripheral outline and flattening the umbilical side. In addition, the G. arca group shows clearly a tendency towards complete reduction of the lower keel.

This writer feels that if one could definitely prove the synonymity of G. conica White, G. falsostuarti Sigal and G. esnahensis Nakkady on the one hand and the synonymity of G. arca (Cushman), G. orientalis El-Naggar and G. stephensoni Pessagno on the other, then G. stuarti stuartiformis Dalbiez will represent the ancester of G. conica via G. stuarti stuarti and G. arca will represent an independent lineage developed from G. linneiana linneiana (d'Orbigny) through G. linneiana tricarinata (Quereau) during Late Santonian time.

The evolutionary trend of parallelism in the development of the umbilical cover-plate in the G. stuarti lineage and in Rugoglobigerina rugosa, mentioned by Berggren (1962) is not demonstrated in this study because of the poor preservation of most of the Campanian and Maestrichtian specimens.

The writer has examined the holotype and paratypes of G. arca var. esnahensis Nakkady, and the hypotypes of G. arca (Cushman) Nakkady, in Nakkady's collection at the B.M. (N.H.) London. One of the paratypes shows two keels, the lower keel shifted towards the umbilicus, weakly developed and reduced on the last two chambers. This specimen is referrable to G. orientalis El-Naggar. Two of the hypotypes show a nearly planoconvex test-shape, a single keel, a protruding umbilical side with depressed sutures and perfectly petaloid chambers in the last whorl. These possibly belong in G. elevata (Brotzen). Another hypotype specimen has all the G. stuarti stuarti characters and definitely belongs in that species.

The writer also has examined the holotype and paratype of G. youssefi El-Naggar, G. arabica El-Naggar and the hypotype of G. lugeoni Tilev in El-Naggar's collection at the same museum and has found no significant reason to separate them. All show a planoconvex, strongly umbilicoconvex test shape, a slightly lobate, nearly ovoid equatorial periphery with a well developed, beaded, single keel shifted towards the spiral side and subcircular to roughly crescentic chambers which increase slowly in size. The so called "peculiarly shaped last chamber" in G. youssfi is deformed and represented only in the holotype. All have the same stratigraphic distribution.

Occurrence. Rare in the Hartha, Qurna and Tayarat formations. Upper part of the Lower Maestrichtian - Globotruncana gansseri zone.

Previous record of Occurrence. G. stuarti stuarti (de Lapparent) was originally described from the Maestrichtian of Hendaye, southwestern France. It was also recorded from the Upper Campanian - Maestrichtian of Italy, the Maestrichtian of the East Indies, Hungary, Switzerland,

Turkey, West Parkistan, Iran and Tunisia and from the Upper Maestrichtian of Denmark, west Spain, Trinidad, New Jersey, Texas and Mexico. It was also reported from the Campanian of Algeria and the Campanian - Maestrichtian of Egypt.

Globotruncana stuarti stuartiformis Dalbiez

pl.30, figs.5-7

1932 Globotruncana arca (Cushman) Cushman. p.343, pl.51, figs.13a-c
1937 Globotruncana stuarti (de Lapparent) Glaessner. pp.39-40, pl.1, figs.13a-c
1946 Globotruncana arca (Cushman) Cushman. p.150, pl.62, figs.5a-c (not figs.4a-c
1953 Globotruncana stuarti (de Lapparent) Subbotina. p.201, pl.15, figs.3a-5c
1955 ? Globotruncana stuarti parva Gandolfi. p.65, pl.5, figs.7a-c
1955 Globotruncana stuarti stuarti (de Lapparent) Gandolfi. pp.64-65 pl.5, figs.6a-c
1955 Globotruncana (Globotruncana) elevata stuartiformis Dalbiez. pp.169,171, t.f.10a-c
1959 Globotruncana stuarti (de Lapparent) Olvera. pp.120-122, pl.8, figs.7-9
1962 ? Globotruncana (Globotruncana) stuarti subspinosa Pessagno. p.362, pl.2, figs.7-9
1963 Globotruncana stuartiformis Dalbiez. Lehmann. p.151, pl.10, figs.2a-c
1964 Globotruncana stuarti stuartiformis Dalbiez. Olsson. p.170, pl.5 figs.6a-c,8a-c
1965 Globotruncana stuartiformis Dalbiez. Van Hinte. p.85, pl.2, figs.3a-c
1966 Globotruncana elevata stuartiformis Dalbiez. Wille-Janoschek. pp.103-104, pl.7, figs.6-8 including additional synonymy except G. stuarti (de Lapparent) Sigal (1952)
1966 ? Globotruncana stuarti parva Gandolfi. El-Naggar. pp.131-133, pl.9 figs.2a-b
1966 Globotruncana stuarti stuartiformis Dalbiez. El-Naggar. Ibid. pp.136-139, pl.9, figs.3a-c
1966 Globotruncana stuarti subspinosa Pessagno. El-Naggar. Ibid. pp.139-140, pl.10, figs.2a-c,3a-c
1966 ? Globotruncana stuarti stuartiformis Dalbiez. Ansary and Tewfik. p.50, pl.6, figs. 7a-c

1967 Globotruncana stuartiformis Dalbiez. Pessagno. pp.357-359, pl.80 figs.3-6, pl.90, figs.1-3, pl.93, figs.6-7, t.f.44, fig.17

1968 Globotruncana stuarti stuartiformis Dalbiez. Rasheed and Govindan p.83, pl.7, figs.1-3

1969 Globotruncana stuarti stuartiformis Dalbiez. Funnell, Friend and Ramsay. pp.34-35, pl.4, figs.10-12, t.f.18a-c

Remarks. G. stuarti stuartiformis was originally described by Dalbiez (1955) from the Campanian - Lower Maestrichtian rocks of Tunisia, as G. (G.) elevata subsp. stuartiformis. He (Op.cit) compared it with the closely related G. elevata (Brotzen) and G. stuarti stuarti de Lapparent; he separated it from the former by its less convex umbilical side, triangular shaped chambers of the last whorl and its central cone, whereas the latter has a less convex umbilical side, non-lobate periphery, trapizoidal chambers on the spiral side and no central cone.

Dalbiez (1955), Berggren (1962) and Olsson (1964) suggested the evolution of G. stuarti stuartiformis from G. elevata into G. stuarti stuarti, while El-Naggar (1966) favoured the development of G. stuarti stuarti from G. stuarti stuartiformis through G. stuarti subspinosa.

The writer has examined the hypotypes of G. stuarti parva Gandolfi, G. stuarti subspinosa Pessagno and G. stuarti stuartiformis Dalbiez, in the El-Naggars collection at the B.M.(N.H.) and found them all assignable to G. stuarti stuartiformis Dalbiez

Pessagno (1967) considered this species forms the basic stock from which other species of the G. stuarti lineage group evolved and suggested two directions of evolution;

1. G. stuartiformis - G. elevata - G. subspinosa - G. calcarata
2. G. stuartiformis - G. stuarti - G. conica

In southern Iraq, G. elevata is rare and accompanies G. stuarti stuartiformis upwards from the level of its first appearance.

Occurrence. Rare in the upper part of the Sadi, Hartha, Qurna and the lower part of the Tayarat formations.

Globotruncana stuartiformis/Globotruncana stephensoni zone.- Globotruncana gansseri zone.

Previous record of Occurrence. G. stuarti stuartiformis appears to be limited in range from Campanian to Maestrichtian. It is known from the Campanian of Morocco, Germany, Colombia; the Campanian - Maestrichtian of Tunisia, Italy, Austria, the U.S.S.R., Texas, Arkansas, Mexico, Puerto Rico, Panama, Cuba, Trinidad, Hispaniola, and the Upper Campanian - Lower Maestrichtian of New Jersey. It was also reported from the Upper Santonian - Maestrichtian of Switzerland, the Lower Maestrichtian of the Austro-German border, the Lower Maestrichtian - Middle Maestrichtian of Egypt and the Upper Maestrichtian of west Spain.

Globotruncana subcircumnodifer Gandolfi

pl.30, figs.8-9

1955	Globotruncana (Rugoglobigerina) circumnodifer subcircumnodifer Gandolfi. p.44, pl.2, figs.8a-c
1962	Globotruncana (Rugotruncana) subcircumnodifer (Gandolfi) Berggren. pp.67-69, pl.10, figs.4a-c
1965	Globotruncana subcircumnodifer (Gandolfi) Takayanagi. pp.224-225, pl.28, figs.1a-4c
1964	Globotruncana subcircumnodifer Gandolfi. Olsson. pp.170-171, pl.8, figs.1-2,4-6
1967	Rugotruncana subcircumnodifer (Gandolfi) Pessagno. pp.369-370 pl.62, figs.14-16, pl.74, figs.1-3
1969	Globotruncana subcircumnodifer Gandolfi. Barr.

Remarks. The poor development of the rugosity in the Iraqi specimens is probably due to ecologic factors and dolomitization.

Occurrence. Three specimens found in the upper part of the Sadi formation. Globotruncana stuartiformis/Globotruncana stephensoni zone.

Previous record of Occurrence. G. subcircumnodifer was originally described by Gandolfi (1955) from the Campanian of the Colon shale of northern Colombia. It was also reported from the Maestrichtian of Denmark and New Jersey; the Campanian of California and the Late Campanian - Maestrichtian of Texas, Arkansas, Mexico and Libya.

Globotruncana subpennyi Gandolfi

1955 Globotruncana (Rugoglobigerina) pennyi subpennyi Gandolfi. p.73, pl.7, figs.7a-c

1967 Rugotruncana subpennyi (Gandolfi) Pessagno. pl.76, figs.12-14 pl.91, figs.8-15

Remarks. Pessagno (1967) re-examined the holotypes of G. (Rugotruncana) gansseri dicarinata Pessagno and has found them to be conspecific with this species.

Occurrence. Very rare, in the Qurna formation. The lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. It was originally described from the Colon shale of northern Colombia. Pessagno (1967) reported the occurrence of this species in the Lower to Middle Maestrichtian of Mexico, in the Middle Maestrichtian of Texas and in the Early Maestrichtian of Arkansas and Puerto Rico.

Globotruncana ventricosa White

pl.25, figs.1-2

1928 Globotruncana canaliculata (Reuss) var. ventricosa White. p.284, pl.38, figs.5a-c

1948 Not Globotruncana ventricosa White. Cita. pp.162-163, pl.4, figs.9 a-c

1950 Globotruncana ventricosa White. Mornod. pp.590-591, t.f.12(1a-c) (not t.f.12(2a-c))

1952 Not Globotruncana ventricosa White. Carbonnier. pp.112,116,120, pl.6 figs.1a-c

1953 Globotruncana ventricosa White. Hagn. pl.8, figs.15a-c, opp.p. 96, t.f.26-27

1954 Globotruncana ventricosa White. Nakkady and Osman. pp.90-91, pl.19, figs.9a-c

1955 Not Globotruncana (Globotruncana) ventricosa ventricosa White. Dalbiez. pp.168,171, t.f.7a-c

1955 Not Globotruncana ventricosa ventricosa White. Gandolfi. pp.22-23, pl.1, figs.5a-c

1957 Globotruncana ventricosa White. Bolli. p.57, pl.13, figs.4a-c

1957 Globotruncana paraventricosa (Hofker) Edgell. p.114, pl.1, figs.1-3

1959 Globotruncana ventricosa White. Olvera. pp.122-123, pl.7, figs.9-10,12

1960 Globotruncana ventricosa ventricosa White. Tollmann. pp.195-196 pl.21, figs.6,7

1960 Globotruncana ventricosa White. Belford. pp.98-99, pl.29, figs.5-11

1967 Globotruncana ventricosa White. Pessagno. pp.362-364, pl.75, figs.21-26, pl.79, figs.9-14, pl.95, fig.10,11, ?pl.99, fig.2

1969 Globotruncana ventricosa White. Douglas. p.188, pl.7, figs.1a-c, 3a-c

Remarks. G. ventricosa was originally described by White (1928) from the Upper Cretaceous rocks of eastern Mexico as variety of G. canaliculata (Reuss). Pessagno (1967) relocated the type locality of this species and since he found it associated with G. calcarata Cushman, G. elevata (Brotzen), G. rosetta (Carsey), G. stuartiformis Dalbiez, Pseudotextularia elegans (Rzehak) and other less important forms, he reassigned the type level to the Late Campanian.

In southern Iraq G. ventricosa White appears in stratigraphically older strata.

White (Op.cit) stated, "this form is similar to G. canaliculata (Reuss), except that the ventral side is convex instead of flat".

Brotzen (1936) realized the great difference between G. canaliculata and G. ventricosa and raised this latter to specific rank. However, his figured specimens are closely related to G. marginata (Reuss). All the specimens figured by Majzon (1943), Subbotina (1953) and Hofker

(1956) as G. ventricosa White are also referrable to G. marginata (Reuss). Gandolfi (1955) and Graham and Clark (1961) described as G. ventricosa White, specimens which are actually G. gagnebini Tilev and G. rosetta (Carsey) respectively. Dalbiez (1955) included G. concavata concavata (Brotzen) in the synonymy of G. ventricosa White.

G. ventricosa is distinguished from G. concavata concavata by its flat to slightly raised spiral side and less convex umbilical one; its wider peripheral band and more thickened keels; the relatively smaller size of the chambers which are perfectly petaloid and increase rather slowly in size as added; the inclined nature of the chambers of the umbilical side which slope towards the umbilicus and its curved sutures on the umbilical side.

Bolli (1957) followed by Takayanagi (1965) and the majority of late authors regarded the number of chambers in the last whorl as a criterion in distinguishing G. concavata (Brotzen) from G. ventricosa White. However, this is not accepted in this study as different specimens of both species share in having on average 6 chambers in the last whorl.

Although Gandolfi (1955) suggested its development from G. tricarinata colombiana Gandolfi, G. ventricosa is believed to have evolved from G. linneiana linneiana (d'Orbigny) as previously suggested by Pessagno (1967).

Occurrence. Abundant in the Khasib, Tanuma and the lower part of the Qurna formations, rare in the Sadi and Hartha formations.

Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - the lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. The Campanian - Maestrichtian of Austria, California and Egypt; the Campanian of Mexico, Trinidad, Texas, Arkansas,

France, Isle of Wight, Czechoslovakia, Germany, Iran and Australia; the Santonian of Switzerland and the Upper Coniacian of Austrian Alps.

Genus Rugoglobigerina Bronnimann, 1952

Type species Globigerina rugosa Plummer, 1927

Rugoglobigerina bulbosa Belford

pl.25, figs.5-6

1960 Rugoglobigerina (Rugoglobigerina) bulbosa Belford. p.94, pl.26, figs.1-10, t.f.7(1-8)

1965 Rugoglobigerina bulbosa Belford. Takayanagi. pp.227-228, pl.29, figs.2a-3c

Description. Test medium-sized, coiled in a low trochospire; spiral side slightly raised to flat, umbilical side inflated; equatorial periphery quadrilobate, axial periphery rounded; chambers on the spiral side 12-14 arranged in $2\frac{1}{2}$ dextrally coiled whorls, the initial chambers are small slightly depressed, globierene, followed by 5, comparatively large, globular ones which increase rapidly in size as added; the last whorl composed of $4-4\frac{1}{2}$ usually 4, globular to subglobular chambers increasing slowly in size as added; the ultimate one occassionally smaller than the penultimate; on the umbilical side the chambers are 4, large, globular to subglobular, inflated; umbilicus small to medium-sized, quadrate, bordered by faintly truncated ridges with broken edges of tegilla still visible on its internal margins; sutures on the spiral side radial, depressed; on the umbilical side the sutures radial and deeply depressed; wall calcareous, finely perforate; surface rugose, the rugosity is often arranged meridionally; aperture interiomarginal umbilical.

Main variation: The main variation observed in specimens of R. bulbosa

is in the degree of inflation of the last chambers and in the size of the ultimate one.

Remarks. R. bulbosa was first described by Belford (1960) from the Santonian beds of the Toolonga Calcilutite of Western Australia. He postulates the close relationship between this form and the R. macrocephala group (and particularly R. macrocephala ornata Bronnimann).

R. bulbosa is distinguished from R. macrocephala ornata by the shape of chambers in the last whorl, their slow increase in size with growth and the equatorial periphery which is quadrilobate.

It differs from R. rugosa (Plummer) in its lesser number of chambers in the last whorl, increasing slowly in size as added; its smaller umbilicus and quadrilobate peripheral outline.

Occurrence. Abundant in the Khasib, Tanuma and the lower part of the Sadi formations. Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. The Santonian of Western Australia and the Turonian - Upper Coniacian of California.

Rugoglobigerina loetterli (Nauss)

pl.25, figs.11-12

1947 Globigerina loetterli Nauss. p.336, pl.49, fig.11a-c
1962 Rugoglobigerina loetterli (Nauss) Herm. p.57, pl.4, fig.2
1962 Hedbergella loetterli (Nauss) Tappan. p.196, p.55, figs.3-5
1965 Hedbergella loetterli (Nauss) Takayanagi. p.205, pl.21, figs. 5a-c
1965 ? Globotruncana (Rugoglobigerina) rugosa (Plummer) Van Hinte. p.85, pl.3, fig.4a-c
1969 Hedbergella loetterli (Nauss) Douglas. p.167, pl.5, figs.3a-c

Remarks. R. loetterli was first described by Nauss (1947) as Globigerina loetterli. He remarked that this species differs from Globigerina belli White (1928) in having subglobular chambers, a large umbilicus and

exceptionally small ultimate and penultimate chambers. R. loetterli (Nauss) is distinguished from Globigerina hoelzle (= Hedbergella hoelzle (Hagn and Zeil)(1954)) described from the Lower Turonian rocks of the Bavarian Alps of southern Germany by its lesser compressed test; smaller ultimate chamber; wider umbilicus; curved sutures and by its rugose surface ornament.

The species figured as G. (R.) rugosa by Van Hinte shows a low spiral side, slowly increasing chambers, a wide umbilicus and a small and smooth ultimate chamber. This is possibly referrable to R. loetterli (Nauss).

Occurrence. Rather abundant in the Tanuma and the upper part of the Khasib formations. Globotruncana renzi/Heterohelix pseudoguembelini-formis zone.

Previous record of Occurrence. It was originally described by Nauss (1947) from the Late Cretaceous Lloydminister shale of Alberta, Canada. According to Tappan (1962) the middle part of the Lloydminister shale is correlated with the Upper Cenomanian and Lower Turonian of the European standard sequence.

R. loetterli was also reported from the Coniacian and the Lower Santonian of Alaska, the Coniacian of California and the Lower Campanian of the Austro-German border.

Rugoglobigerina macrocephala macrocephala Bronnimann

pl.25, figs.7-10

1952 Rugoglobigerina (Rugoglobigerina) macrocephala macrocephala Bronnimann. pp.25-27, pl.2, figs.1-3, p.26, t.f.9a-i,k-s

1955 Rugoglobigerina (Rugoglobigerina) macrocephala macrocephala Bronnimann. Gandolfi. pp.45-46, pl.2, figs.12a-c

1961 Rugoglobigerina macrocephala Bronnimann. Corminboeuf. p.117, pl.2, figs.3a-c

1962 Rugoglobigerina macrocephala Bronnimann. Herm. p.58, pl.3, fig.1

1962 Rugoglobigerina macrocephala Bronnimann. Berggren. p.76, pl.12, figs.4-6, t.f.9(1-5), 10(1-5)

1962 Rugoglobigerina macrocephala macrocephala Bronnimann. Petri. pp.122-123, pl.17 figs.3a-c

1963 Rugoglobigerina macrocephala Bronnimann. Kavary and Frizzell. p.48, pl.9, fig.10

1963 Rugoglobigerina macrocephala Bronnimann. Bronnimann and Rigassi. pl.18, figs.2a-c

1964 Rugoglobigerina macrocephala Bronnimann. Olsson. p.172, pl.6, figs.9a-c

1966 Not Rugoglobigerina macrocephala macrocephala Bronnimann. Ansary and Tewfik. pp.58-59, pl.5, figs.3a-c

1967 Rugoglobigerina macrocephala Bronnimann. Pessagno. pl.66, figs. 1-2

Remarks. R. macrocephala macrocephala was originally described by Bronnimann (1952) from the Maestrichtian Guayaguayare beds of Trinidad. He stated that it differs from R. macrocephala ornata Bronnimann in its relatively small test and the coarsely and irregularly ornamental early chambers of the last volution.

Berggren (1962) and Olsson (1964) considered R. macrocephala ornata to be a junior synonym of R. macrocephala macrocephala. In spite of the apparent similarity and possible intergradation of these two forms, the present study showed clearly that the morphologic features warrant their separation.

Gandolfi (1955) described R. ornata subornata and R. macrocephala submacrocephala as two new subspecies and thus changed R. macrocephala ornata to R. ornata ornata. His two new subspecies were said to possess rugose surfaces, two finely beaded keels in early stage of the last whorl and a rounded, not truncated, axial periphery. He did not state whether the forms have meridionally arranged rugosity or not. This writer had

no opportunity to examine type materials of the two species, but if the case is as stated above, then they may be included in the genus Archaeoglobigerine, recently erected by Pessagno (1967) to include forms which have surface rugosity not alined in meridional pattern; a non-truncated axial periphery and weakly developed keels.

R. macrocephala macrocephala differs from R. rugosa (Plummer) in its lesser number of chambers in the last whrol, their very rapid increase in size and the smaller umbilicus. It differs from R. bulbosa Belford, in having a somewhat depressed initial chambers, in having chambers in the last whrrl which rapidly increase in size and in having less strongly developed surface rugosity.

Occurrence. Abundant in the Tamuma and the lower part of the Sadi formations; rare in the rest of the Sadi, Tamuma and the lower part of the Qurna formations. The upper part of the Globotruncana renzi/ Heterohelix pseudoguembeliniformis zone - the lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. The Turonian - Senonian and Maestrichtian of Trinidad; the Upper Maestrichtian of the Austro-German border and New Jersey; the Lower Maestrichtian of Brazil; the Maestrichtian of Denmark, Cuba, Texas and Iran and the Campanian of Colombia. It was also recorded from the Middle and Lower Maestrichtian of the Nile valley, Egypt.

Rugoglobigerina macrocephala ornata Bronnimann

pl.26, figs.1-3

1952 Rugoglobigerina (Rugoglobigerina) macrocephala ornata. Bronnimann. p.27, pl.2, figs.4-5, p.28, t.f.10a-i

1955 Rugoglobigerina (Rugoglobigerina) ornata ornata Bronnimann. Gandolfi. pp.49-50, pl.3, figs.7a-c

1962 Rugoglobigerina macrocephala ornata Bronnimann. Herm.

1966 Rugoglobigerina macrocephala macrocephala Bronnimann. Ansary and Tewfik. pp.58-59, pl.5, figs.3a-c

1966 Rugoglobigerina macrocephala ornata Bronnimann. Ansary and Tewfik. Ibid. p.59, pl.5, figs.4a-c

Remarks. R. macrocephala ornata Bronnimann differs from R. macrocephala macrocephala Bronnimann in the lesser number of chambers ($3\frac{1}{2}$-4) in the last whorl, the small ultimate and very large, ovoide, penultimate chambers, nearly triangular peripheral outline and the much more well developed surface rugosity.

It differs from R. bulbosa Belford in the character of the chambers in the last whorl and their very rapid increase in size (with the exception of the last) and the shape of the test.

Occurrence. Rare in the Tanuma, the Sadi, the Hartha and the lower part of the Qurna formations.

The upper part of the Globotruncana renzi/Heterohelix pseudoguembelini-formis zone - the lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. It was originally described from the Turonian - Senonian and Maestrichtian rocks of the upper part of the Guayaguayare formations, Trinidad. It was also reported from the Campanian - Maestrichtian of Colombia and Egypt, and the Upper Maestrichtian of the Austro-German border.

Rugoglobigerina plana Belford

pl.26, fig.8

1960 Rugoglobigerina (Rugoglobigerina) plana Belford. p.95, pl.27, figs.1-5, t.f.8(1-6)

Remarks. R. plana Belford is morphologically similar to both R. ordinaria (Subbotina) and Hd. aff. paradubia (Sigal) of the writer.

It is distinguished from the former by its subspherical as opposed to spherical chambers and a perfectly perforate margin as against traces of two keels in R. ordinaria. It differs from Hd. aff. paradubia in its flat to very slightly raised spiral side, much more strongly inflated chambers on the umbilical side and broadly rounded axial periphery. In addition Hd. aff. paradubia has an interiomarginal extraumbilical umbilical aperture and no tegilla has been noted in its umbilicus.

Occurrence. Restricted to the lower part of the Sadi formation. Globotruncana concavata subzone.

Previous record of Occurrence. R. plana was originally described by Belford (Op.cit) from the Santonian rocks of the Toolonga calcilutite, Western Australia. He also recorded its occurrence in Lower Campanian strata.

Rugoglobigerina pustulata Bronnimann

pl.29, figs.3-4

1952 Rugoglobigerina (Rugoglobigerina) reicheli pustulata Bronnimann. p.20, pl.2, figs.7-9, t.f.6a-m,7a-i

1960 Rugoglobigerina reicheli pustulata Bronnimann. Olsson. p.50, pl.10, figs.13-15

1962 Rugoglobigerina pustulata Bronnimann. Berggren. pp.78-80, pl.13 figs.1a-c, t.f.10(6-12)

1967 Rugoglobigerina rugosa pustulata Bronnimann. Bandy. p.22, t.f. 10(8)

Occurrence. Very rare in the upper part of the Qurna and lowermost part of the Tayarat formations. The upper part of the Globotruncana gansseri zone.

Previous record of Occurrence. R. pustulata was originally described by Bronnimann (1952) from the Upper Maestrichtian of the Guayaguayare

formation of Trinidad. It was also reported from the Maestrichtian of New Jersey, U.S.A. (Olsson 1960), the Upper Maestrichtian of Denmark (Berggren 1962) and the Campanian and Maestrichtian of Egypt (El-Naggar 1966. Ansary and Tewfik 1966).

Rugoglobigerina rugosa (Plummer)

pl.26, figs.4-7

1927 Globigerina rugosa Plummer. pp.38-39, pl.2, figs.10a-d
1952 Rugoglobigerina (Rugoglobigerina) rugosa rugosa (Plummer) Bronnimann. pp.28-29, t.f.11a-i, p.30, t.f.12a-i, p.31, t.f.13a-i
1953 Rugoglobigerina rugosa rugosa (Plummer) Hamilton. p.227, pl.30, figs.1-3
1955 Rugoglobigerina rugosa (Plummer) Weiss. p.307, pl.1, fig.9
1955 Globotruncana (Rugoglobigerina) rugosa rugosa (Plummer) Gandofli p.72, pl.7, figs.6a-c
1957 Rugoglobigerina rugosa (Plummer) Bolli, Loeblich and Tappan. p.43, pl.11, figs.2a-c
1957 Not Rugoglobigerina rugosa (Plummer) Edgell. pp.115-118, pl.4, figs.10-12
1960 Rugoglobigerina richeli pustulata Bronnimann. Olsson. p.50, pl.10, figs.13-15
1960 Rugoglobigerina rugosa rugosa (Plummer) Olsson. Ibid. p.50, pl.10 figs.16-18
1960 Rugoglobigerina cf. rugosa (Plummer) Takayanagi. p.134, pl.10, figs.2a-c
1961 Rugoglobigerina rugosa (Plummer) Graham and Clark. p.111, pl.5 figs.1a-c
1962 Rugoglobigerina rugosa rugosa (Plummer) Herm. p.60, pl.3, fig.2
1962 Rugoglobigerina rugosa (Plummer) Berggren. pp.71-75, pl.11, figs.1a-b,2,?3a-c,?4a-c,?5a-b, p.73, t.f.8, figs.?1a-b,2, ?3a-b,?4a-b,?5a-b
1963 Rugoglobigerina rugosa (Plummer) Bronnimann and Rigassi. pl.18, figs.1a-c
1963 Rugoglobigerina rugosa (Plummer) Kavary and Frizzell. p.49, pl.9 figs.14-15
1964 Rugoglobigerina rugosa (Plummer) Martin. p.83, pl.10, figs.6a-c
1964 Rugoglobigerina rugosa (Plummer) Olsson. p.173, pl.7, figs.5a-c ?3a-c,?4a-c (not figs.2a-c)
1965 Not Globotruncana (Rugoglobigerina) rugosa (Plummer) Van Hinte. p.85, pl.3, figs.4a-c
1965 Globigerina (Rugoglobigerina) rugosa (Plummer) Perlmutter and Todd. p.18, pl.5, figs.4a-c
1965 ? Rugoglobigerina rugosa (Plummer) Takayanagi. pp.228-229, pl.29, figs.5a-c

1966 Rugoglobigerina rugosa rugosa (Plummer) Ansary and Tewfik. p.58, pl.5, figs.1a-c

1967 Rugoglobigerina rugosa (Plummer) Pessagno. pp.366-367, pl.75, figs.2-3

1968 Rugoglobigerina rugosa (Plummer) Rasheed and Govindan. p.84, pl.8, figs.7-9

1969 Rugoglobigerina rugosa (Plummer) Douglas. pp.175-176, pl.6, figs.1-2

Remarks. The species was first described by Plummer (1927) from the Upper Navarro group (Upper Maestrichtian) of the western Gulf coastal plain of Texas as Globigerina rugosa. She stated, "the umbilical features of Globigerina rugosa are precisely those that mark Globigerina rosetta Carsey.....".

Carsey (1926) described Globigerina rosetta (= Globotruncana rosetta (Carsey))as follows, "..... umbilical margin of the chambers is marked on each chamber by an extended lip; apertures open from the chambers in the final whorl into the preceding umbilical vestibule".

It seems that Carsey was actually referring to the tegillum and the marginal accessory apertures.

Due to its rugose surface and the covering plate across the umbilicus (= umbilical tegilla), Bronnimann (1952) transfered G. rugosa into the genus Rugoglobigerina. He described R. (R.) rugosa pennyi and R. (R.) rugosa rotundata as two new subspecies of R. (R.) rugosa (Plummer) and thus changed the latters' name to R. (R.) rugosa rugosa.

Gandolfi (1955) stated that there is a close relationship between the species of Rugoglobigerina Bronnimann and Globotruncana Cushman and thus he considered the former as subgenus of Globotruncana. This view is not accepted here.

R. rugosa (Plummer) is distinguished from other species of Rugoglobigerina by the low trochospiral test, the prominent surface

rugosity, the $4\frac{1}{2}$-6 chambers rather rapidly increasing in size in the last whorl and by the wide and deep character of its umbilicus. It differs from R. macrocephala macrocephala Bronnimann in having a greater number of chambers in the last whorl, less rapidly increasing in size and a wider umbilicus.

R. rugosa differs from R. bulbosa Belford in having a greater number of chambers in the last whorl, a much rougher surface ornament and an ovate to subcircular test shape.

Specimens described by Edgell (1957) as R. rugosa (Plummer) belong in different species. Those figured by Berggren 1962 (see synonymy) are questionably referred to R. rugosa; they show some characters different from those given in the original description and figure (syntypes), from the variations described in detail by Bronnimann (1952) and the hypotypes studied here. Specimens figured by Van Hinte (1965) as G. (R.) rugosa (Plummer) are referrable to R. loetterli (Nauss).

Occurrence. Abundant in the Tamuma formation; rare in the Sadi, Hartha, Qurna and very lowest part of the Tayarat formation. The upper part of the Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - lower part of the Globotruncana gansseri zone.

Previous record of Occurrence. The Maestrichtian of Trinidad, Peru, Cuba, New York, Denmark, the Austro-German border, Egypt and Iran. The Campanian - Maestrichtian of Colombia, Mexico, Puerto Rico, California, Texas, Arkansas and southern India. The Turonian - Campanian of Hokkaido (Japan) and the Upper Campanian - Maestrichtian of New Jersey.

R. rugosa was also reported from the Maestrichtian of the Netherlands, France, Switzerland, the Caucasus (U.S.S.R.) and Nigeria, the Turonian of the Central Volga Valley area (U.S.S.R.) and the Turonian -

Upper Coniacian of California (Takayanagi 1965).

Rugoglobigerina tradinghousensis Pessagno

pl.26, figs.9-10

1967 Rugoglobigerina tradinghousensis Pessagno. p.367, pl.64, fig. figs.1-8

1969 ? Rugoglobigerina pilula Belford. Douglas. p.175, pl.6, fig.8 (not fig.9)

Remarks. R. tradinghousensis is distinguished by its small to medium test size, high spired character, small and deep umbilicus, rugose and/or hisped surface ornament which decreases gradually in strength towards the last chamber.

The specimens here described as R. tradinghousensis Pessagno differ from the holotype and paratypes in having the last chamber slightly compressed in a direction perpendicular to the periphery and in its less intensively rugose surface. However, the writer believes that such differences are brought about by changes which the specimen undergo after its death and during preservation.

Douglas (1969) considered R. tradinghousensis to be a junior synonym of R. pilula Belford, originally described from the Toolonga calcilutite of Western Australia. As can be seen from the original type figures of R. tradinghousensis, the topotypic material kindly presented by Dr. Pessagno and from the samples here studied, the two species should be considered separately in spite of their apparent similarity. On the other hand, the specimen figured by Douglas (Op.cit) as R. pilula Belford is referrable to R. tradinghousensis.

R. trandinghousensis differs from R. pilula in its lesser number of chambers in the last whorl (which are bent towards the umbilicus), its smaller umbilical opening and its nearly quadrilobate, peripheral

outline.

Occurrence. Rare to rather abundant in the upper part of the Tanuma and the lowermost part of the Sadi formations. The uppermost part of the Globotruncana renzi/Heterohelix pseudoguembeliniformis zone - Globotruncana concavata subzone.

Previous record of Occurrence. It was originally described from the Campanian of the Taylor marl Texas. It was also recorded from the Campanian of Arkansas (Pessagno 1967). Douglas (Op.cit) reported it from the Santonian - Campanian of California as R. pilula.

Genus Trinitella Bronnimann 1952

Type species Trinitella scotti Bronnimann 1952

Trinitella scotti Bronnimann

pl.30, figs.11-12

1952 Trinitella scotti Bronnimann. pp.57-58, pl.4, figs.4-6, p.58, t.f.30a-c

1956 Trinitella scotti Bronnimann. Bronnimann and Brown. p.555, pl.23 figs.13-15

1957 Rugoglobigerina scotti (Bronnimann) Bolli. Loeblich and Tappan. p.43, pl.11, figs.3a-4c

1962 Rugoglobigerina scotti (Bronnimann) Herm. p.62, pl.2, fig.2

1963 Trinitella scotti Bronnimann. Bronnimann and Rigassi. pl.16, figs.3a-c

1964 Trinitella scotti Bronnimann. Olsson. pp.173-174, pl.6, figs.10a-c

1967 Rugoglobigerina scotti (Bronnimann) Pessagno. p.367, pl.74, figs.9-14, pl.76, figs.4-6

Occurrence. Only four specimens have been found in the Middle Maestrichtian of the Qurna formation. Globotruncana gansseri zone.

Previous record of Occurrence. It was originally described from the Maestrichtian of the Guayaguayare, Trinidad. It was also recorded from the Maestrichtian of Cuba, Egypt, Texas; the Upper Maestrichtian of New Jersey, the Austro-German border, Mexico and the Lower Maestrichtian of Puerto Rico.

CHAPTER 6

A. Stratigraphy and Planktonic Foraminifera

The Upper Cretaceous succession in the Zubair and Rumaila fields of southern Iraq ranges in age from Coniacian to Upper Maestrichtian. It is divided into the following formations;

Top 1 - Tayarat formation

2 - Qurna formation

3 - Hartha formation

4 - Sadi formation

5 - Tanuma formation

6 - Khasib formation

The Upper Cretaceous - Tertiary boundary is marked by the occurrence of limonite coated, red quartz grains, iron oxides and great variety of debris (mud, clay, wood particles and other oxidized particles). It is suspected that the variety of debries, together with limonite coated quartz grains indicate an unconformity.

The Khasib, Tanuma, lower part of the Sadi, uppermost part of Hartha and lower half of Qurna formations yield abundant planktonic Foraminifera. The remainder of the sequence yields rare to very rare planktonics: most parts of the Hartha formation is completely devoid of microfossils.

On the basis of the stratigraphic ranges of the planktonic Foraminifera, the succession is subdivided into four concurrent-range zones and two subzones. In addition, one interval in the Sadi formation contains rare indeterminable forms and the Hartha formation contains one which is entirely non-fossiliferous. All these zones are described

for the first time from Iraq and Middle East. Their order in upward sequence is;

1 - Globotruncana gansseri zone

2 - The Non-fossiliferous interval

3 - Globotruncana stuartiformis/Globotruncana stephensoni zone

4 - The Indeterminable interval

5 - Sigalia carpatica zone

(b) Globotruncana fornicata subzone

(a) Globotruncana concavata subzone

6 - Globotruncana renzi/Heterohelix pseudoguembeliniformis zone

The European standard stage terminology was applied to the zonation. The relationship of the zonation to the lithostratigraphic units is shown in Encls. 1 and 2.

The main evolutionary tendencies in the species of Sigalia Riess, Ventilabrella Cushman, Heterohelix Ehrenberg, Globigerinelloides Cushman and Ten Dam and Globotruncana Cushman are indicated below.

1. Sigalia Riess and Ventilabrella Cushman

1 - A tendency to increase the size of the test.

2 - A tendency to develop proliferated chambers.

3 - A tendency to develop a laterally compressed test.

4 - A tendency to develop multiple apertures

5 - A tendency to develop serrated peripheral margins (in the genus Sigalia only).

6 - A tendency to develop raised, thickened, granular sutures (in genus Sigalia only).

2. Heterohelix Ehrenberg

1 - A tendency to increase the size of the test.

2 - A tendency to increase the surface striation.

3 - A tendency towards acceleration of the rate of chamber increase with growth.

4 - A tendency to develop a peripheral keel.

5 - A tendency to develop supplementary apertures.

3. Globigerinelloides Cushman and Ten Dam

1 - A tendency to develop vertically compressed chambers.

2 - A tendency to decrease the number of chambers.

3 - A tendency towards the production of chambers which increase rapidly in size with growth.

4 - A tendency to develop bipartite final chambers.

5 - A tendency to develop two extraumbilical apertures.

4. Globotruncana Cushman

1 - A tendency to weaken or reduce the umbilical keel (ventral keel)

2 - A tendency towards the development of petaloid chambers.

3 - A tendency towards the development of trapizoidal chambers.

4 - A tendency to decrease the number of chambers.

5 - A tendency towards the development of raised, thickened sutures.

Figs. 10-14 show the summarized phylogeny of those genera.

A total of 94 species and 26 varieties of planktonic Foraminifera are described, most of them for the first time from Iraq and Middle East. 9 species and 4 varieties are new to science. 121 benthonic Foraminifera are also identified and their ranges given.

B. Paleoecology

The comprehensive analysis of the occurrence and distribution of the different faunal elements including Bryozoa, Ostracoda, larger Foraminifera and, to a lesser extent, megafossils, has permitted the reconstruction of the past depositional and environmental conditions in southern Iraq of the Khasib, Tanuma, Sadi and Hartha formations and the lower part of the Qurna formation.

The analysis of the paleoecological curves of Zubair well no.8 reveals the presence of five foraminiferal biofacies. These are, from bottom to top;

1 - Porcellaneous biofacies

2 - Lower planktonic/open sea biofacies

3 - Calcareous benthonic/closed sea biofacies

4 - Non-fossiliferous biofacies

5 - Upper planktonic/open sea biofacies

The paleoecological interpretations and foraminiferal divisions were mainly based on bionomic grouping, foraminiferal number, planktonic/benthonic percentages and number of species and genera present.

The percentage distribution chart of Grimsdale and Morkhoven (1955) was the basis of the depth determinations which were tentatively placed in the bathymetric zones proposed by Bandy (1960). The approximate depths of these ecologic zones are as follows;

1	- Bay or Estuaries	
2	- Inner shelf	0 - 50 m
3	- Central and outer shelf	50 - 150 m
4	- Upper bathyal zone	150 - 610 m
5	- Middle bathyal zone	610 - 2,438 m

6 - Lower bathyal zone 2,438 - 4,000 m

7 - Abyssal zone below 4,000 m

1. The Porcellaneous biofacies comprises the lowermost part of the Khasib formation which includes the interval 7,385 - 7,410 ft. It is believed that this interval was deposited under warm, shallow water conditions of low salinity and in restricted or narrow connection with the open sea.

The fact that the biofacies is rich in specimens of small Foraminifera and Quinquiloculinae and shows reasonable percentages of planktonic forms suggests the "Inner shelf zone".

95 - 150 metres is suggested as the range of depositional depth for this biofacies.

2. The lower planktonic/open sea biofacies comprises most of the Khasib, Tanuma and lower part of the Sadi formations, included in the interval 7,385 - 6,890 ft.

It is believed that this interval was deposited in deep water in direct connection with the open sea, in the outer shelf - Middle bathyal zones.

In general, there are indications of a gradual deepening of the basin from the Khasib to the Sadi formations and an improvement of the living conditions for planktonic Foraminifera.

3. The Calcareous benthonic/closed sea biofacies comprises the middle and upper parts of the Sadi formation and the lower half of the Hartha formation, included in the interval 6,890 - 5,920 ft.

It is believed that these beds were laid down in shallow water in restricted connection with the open sea. The connection becomes completely closed at the top of the section.

The distinct fluctuations in value of the numerical data in the lower third of this interval are due to unstable conditions in the basin causing shallowing and the widening and narrowing of its connection with the open sea.

Since this biofacies overlies a deep water one, there must have been uplift or an increase in the rate of sedimentation at this time.

In general, the biofacies is characterized by a gradual decrease in the depth of deposition and in size of the foraminiferal specimens. On the other hand, there is a gradual increase in the number of the larger Foraminifer, in Bryozoa and the rate of sedimentation.

4. The non-fossiliferous biofacies, comprises most of the upper part of the Hartha formation and covers the interval from 5,920 to 5,740 ft. It is believed that it was deposited under lagoonal conditions.

5. Upper planktonic/open sea biofacies, covering the section from 5,740 to 5,350 ft., comprises the uppermost Hartha and lower part of Qurna formations.

It is believed that this interval was deposited in deep and colder water in direct connection with the open sea. The relatively gradual increase in the benthonic Foraminifera and the decrease in the planktonic ones may be due to a gradual shelfward movement of the basin. Since this biofacies overlies a barren interval, sudden subsidence due to major tectonic movement may be indicated.

For reasons stated elsewhere it is not possible at present to determine the paleoecology of the upper Qurna and Tayarat formations.

The first transgression of the Upper Cretaceous sea in southern Iraq started at the base of the Khasib formation (Coniacian) and the first regression at the base of the middle part of the Sadi formation(Santonian).

The deposition at the uppermost Hartha formation occurred during the first transgression of the Maestrichtian sea.

- 0 -

BIBLIOGRAPHY

Abbo, A.S. and Safar, V.M.

1967 Sand and shale correlation in the Zubair and Rumaila oil-fields, Iraq. 6th Arab Petrol. Congr., Baghdad. pp.1-16, figs.1-6

Adasani, M.

1965 The greater Burgan Field, Kuwait. 5th Arab Petrol. Congr. Cairo, 35(B-3), 27pp., 1 fig., 1 table.

1967 The north Kuwait oil fields. 6th Arab Petrol. Congr., Kuwait. fig.1-3, 1 table.

Albritton, C.C. and Phleger, F.B.

1937 Foraminiferal zonation of certain Upper Cretaceous days of Texas. Jour. Paleont. vol.2, no.4, pp.347-354, 3 text-figs.

Alexandrowicz, S.W.

1966 Stratygrafia srodkowej i gornej kredy w polskej czesci Pieninskiego pasa skalkowego. Zeszyty naukowe akademii gorniczo - hutnicz - ej Rozprawy 78, Krakow.

Alexandrowicz, S.W., Birkenmajer, K. and Geroch, S.

1962 Microfauna and age of brick-red Globotruncana marls (Puchov Marls) of Piening Klippen Belt of Poland. Acad. Polon. Sci., Bull., Sci. Geol. Geog., vol.10, no.2, p.91-92, 2 tables.

Al-Naqib, K.M.

1960 Geology of the southern area of Kirkuk Liwa, Iraq. Arab. Petrol. Congr. 2nd. Pub.

1967 Geology of the Arabian Peninsula, southwestern Iraq. U.S. Geol. Surv. Prof. Paper, 560-G., 54 pp., 4 pls., 1 fig.

Al-Sayyab, A. and Kureshy, A.A.

1969 Some Cretaceous pelagic Foraminifera of southern Iraq. Proc. 5th Arab Sci. Congr., (1966), Baghdad, pt.2, pp.413-425, pls.1-2

American Commission on Stratigraphic Nomenclature

1961(a) Code of Stratigraphic Nomenclature. Amer. Assoc. Petrol. Geol., Bull., vol.45, no.5, pp.645-665.

1961(b) Note 25 - Geochronology and Chronostratigraphic Units. Amer. Assoc. Petrol. Geol. Bull., vol.45, no.5, pp.666-673.

BIBLIOGRAPHY

Abbo, A.S. and Safar, V.M.

1967 Sand and shale correlation in the Zubair and Rumaila oil-fields, Iraq. 6th Arab Petrol. Congr., Baghdad. pp.1-16, figs.1-6

Adasani, M.

1965 The greater Burgan Field, Kuwait. 5th Arab Petrol. Congr. Cairo, 35(B-3), 27pp., 1 fig., 1 table.

1967 The north Kuwait oil fields. 6th Arab Petrol. Congr., Kuwait. fig.1-3, 1 table.

Albritton, C.C. and Phleger, F.B.

1937 Foraminiferal zonation of certain Upper Cretaceous days of Texas. Jour. Paleont. vol.2, no.4, pp.347-354, 3 text-figs.

Alexandrowicz, S.W.

1966 Stratygrafia srodkowej i gornej kredy w polskej czesci Pieninskiego pasa skalkowego. Zeszyty naukowe akademii gorniczo - hutnicz - ej Rozprawy 78, Krakow.

Alexandrowicz, S.W., Birkenmajer, K. and Geroch, S.

1962 Microfauna and age of brick-red Globotruncana marls (Puchov Marls) of Piening Klippen Belt of Poland. Acad. Polon. Sci., Bull., Sci. Geol. Geog., vol.10, no.2, p.91-92, 2 tables.

Al-Naqib, K.M.

1960 Geology of the southern area of Kirkuk Liwa, Iraq. Arab. Petrol. Congr. 2nd. Pub.

1967 Geology of the Arabian Peninsula, southwestern Iraq. U.S. Geol. Surv. Prof. Paper, 560-G., 54 pp., 4 pls., 1 fig.

Al-Sayyab, A. and Kureshy, A.A.

1969 Some Cretaceous pelagic Foraminifera of southern Iraq. Proc. 5th Arab Sci. Congr., (1966), Baghdad, pt.2, pp.413-425, pls.1-2

American Commission on Stratigraphic Nomenclature

1961(a) Code of Stratigraphic Nomenclature. Amer. Assoc. Petrol. Geol., Bull., vol.45, no.5, pp.645-665.

1961(b) Note 25 - Geochronology and Chronostratigraphic Units. Amer. Assoc. Petrol. Geol. Bull., vol.45, no.5, pp.666-673.

*Ansary, S.E.

1955 Report on the foraminiferal fauna from the Upper Eocene of Egypt. Inst. Desert d'Egypte, publ., Heliopolis, no.6, 160 pp.

Ansary, S.E., Andrawis, S.F. and Fahmy, S.E.

1964 Biostratigraphic studies of the Upper Cretaceous sections in the G.P.C. Wells in the Eastern Desert and Sinai. 4th Arab. Petrol. Congr., Beirut, 24(3B), pp.205-210, pls.1-5.

Ansary, S.E. and Fakhr, B.Y.

1958 Maestrichtian Foraminifera from Um El Huetat area, west of Safaga. Egypt. Jour. Geol., Cairo, vol.2, pp.105-145, pls.1-2.

Ansary, S.E. and Tewfik, N.M.

1966 Planktonic Foraminifera and some new species from the subsurface Upper Cretaceous of Ezz El Orban area, Gulf of Suez. (English with Arabic summary). Jour. Geol. U.A.R., vol.10 no.1, pp.37-75.

Applin, E.R., Ellisor, A.E. and Kniker, H.T.

1925 Subsurface stratigraphy of the coastal plain of Texas and Louisiana. Amer. Assoc. Petrol. Geol., Bull., vol.9, no.1 pp.79-122, 1 fig., pl.3.

Arni, P.

1933 Foraminiferen des Senons und Untereozans in pratigauflysch. Beitr. Geol. Karte Schweiz., n.F., lief.65, pp.1-18, figs.1-5, text-figs.1-11.

Ashworth, E.T.

1959 Occurrence of Globotruncana ventricosa in northwestern Peru. Micropaleont., vol.5, no.4, pp.497-499, text-figs.1-2.

Aurouze, G. and Klasz, I. de

1954 Sur la presence de Schackoines dans le Cretace superieur de France, de Baviere et de Tunisie. Soc. Geol. France, ser.6, t.4, pp.97-103, 1 fig., pl.6a.

Ayala, Castanares A.

1954 El genero Globotruncana Cushman, 1927 y su importancia en Estratigrafia. Asoc. Mex. Geol. Petrol., Boln. Mexico. vol.6, pp.353-474, pls.1-16.

1959 Estudio de Algunos Microfosiles planktonicos Cretacico Superior de la Republica de Haiti. Univ. Nacional Aut. de Mexico, Instit. Geol. Paleont. Mexicana no.4, pp.1-41 pls.1-12.

1962 Morfologia y Estructura de algunos Foraminiferos planctonicos del Cenomaniano de Cuba. Soc. Geol. Mexicana Bol., vol.25, no.1, pp.1-63, pls.1-13.

Bandy, O.L.

1951 Upper Cretaceous Foraminifera from the Carlsbad area, San Diego County, California. Jour. Paleont., vol.25, no.4, pp.488-513, pls.72-75.

1956 Ecology of Foraminifera in northeastern Gulf of Mexico. U.S. Geol. Surv. Prof. Paper., no.274-G, pp.179-204, pls.29-31.

1960(a) Planktonic foraminiferal criteria for paleoclimatic zonation. Tohoku Univ., Sci. Repts., Ser.2 (Geol.), Spec. Vol., no.4, pp.1-8, text-figs.1-2.

1960(b) General correlation of foraminiferal structure with environment. Internat. Geol. Congr., 21st, Copenhagn, Rept. Proc., pt.22, pp.7-19, text-figs.1-9.

1961 Distribution of Foraminifera, Radiolaria and Diatoms in sediments of the Gulf of California. Micropaleont., vol.7, no.1, pp.1-26, pls.1-5.

1964(a) Foraminiferal biofacies in sediments of Gulf of Batabano, Cuba and their geologic significance. Amer. Assoc. Petrol. Geol., Bull., vol.48, no.10, pp.1666-1679, text-figs.1-7.

1964(b) Cenozoic planktonic foraminiferal zonation. Micropaleont., vol.10, no.1, pp.1-17, text-figs.1-6, 1 table.

1967 Cretaceous planktonic foraminiferal zonation. Micropaleont., vol.13, no.1, pp.1-31, text-figs.1-13.

Bandy, O.L. and Arnal, R.E.

1960 Concepts of foraminiferal Paleoecology. Amer. Assoc. Petrol. Geol., Bull., vol.44, no.12, pp.1921-1932, text-figs.1-14.

Bandy, O.L. and Rodolfo, K.S.

1964 Distribution of Foraminifera and sediments, Peru-Chile Trench area. Deep-Sea Res., vol.11, no.5, pp.817-837, text-figs.1-5.

Banerii, R.K.

1966 The genus Globotruncana and Biostratigraphy of the lower Ariyalur stage (Upper Cretaceous) of Vridhachalam, south India. Jour. Geol. Soc. India, vol.7, pp.51-69, pls.3-5, figs.1-3, table 1.

1968 Late Cretaceous foraminiferal biostratigraphy of Pondicherry area, south India. Geol. Soc. India., Mem. no.2, pp.30-49, figs.1-4, 1 table.

1968 Statistical study of foraminiferal fauna from the lower Ariyalur stage (Late Cretaceous) of Vridhachalam area, south India. Geol. Soc. India, Mem. no.2, pp.50-65, figs.1-15, 1 plate, 4 tables.

Banner, F.T. and Blow, W.H.

1959 The classification and stratigraphic distribution of the Globigerinacea. Paleontology. vol.2, pt.1, pp.1-27, pls.1-3, text-figs.1-5.

1960 Some primary types of species belonging to the superfamily Globigerinacea. Contr. Cushman Found. Foram. Res. vol.11, pt.1, pp.1-41, pls.1-8.

Barr, F.T.

1962 Upper Cretaceous planktonic Foraminifera from the Isle of Wight, England. Paleontology vol.4, pt.4, pp.552-580, pls.69-72.

1966 Upper Cretaceous Foraminifera from the Ballydeenlea chalk, County Kerry, Ireland. Paleont., vol.9, pt.3, pp.492-510, pls.77-79.

1968 Late Cretaceous planktonic Foraminifera from the coastal area of Susa (Apollonia) northeastern Libya. Jour. Paleont. vol.42, no.2, pp.308-321, pls.37-40, 5 text-figs.

Barr, F.T. and Cordey, W.G.

1964 Some Upper Cretaceous Foraminifera from the Chapman collection (1892). Jour. Paleont., vol.38, no.2, pp.306-310, pl.49.

Bartenstein, H.

1948 Globotruncana calcarata Cushman, foraminifere caracteristique du Campanian. Soc. Geol. France. Comptes-rendus. pp.244-246, 1 text-fig.

Be, A.W.H.

1960 Ecology of Recent planktonic Foraminifera: Pt.2 - Bathymetric and seasonal distributions in the Sargasso sea off Bermuda. Micropaleont. vol.6, no.4, pp.373-392, text-figs.1-19.

1965 The influence of depth on shell growth in Globigerinoides sacculifer (Brady). Micropaleont. vol.11, no.1, pp.81-97, pls.1-2, text-figs.1-12.

Belford, D.J.

1960 Upper Cretaceous Foraminifera from Toolonga Calcilutite and Gingin Chalk, western Australia. Australia Bur. Min. Res. Geol. Geophys., Bull., no.57, pp.1-198, pls.1-35.

Berger, W.B.

1967(a) Foraminiferal ooze: solution at depth. Science, vol.156, no.3773, pp.383-385, text-figs.1-4.

1967(b) Planktonic Foraminifera: selective solution and paleoclimatic interpretation. Deep-Sea Res., vol.15, pp.31-43.

Berggren, W.A.

1960 Biostratigraphy, planktonic Foraminifera, and the Cretaceous - Tertiary in Denmark and southern Sweden. Internat. Geol. Congr. 21st, Copenhagen, Rept. Proc. pt.5, sec.5, pp.181-192, text-figs.1-2.

1962(a) Some planktonic Foraminifera from the Maestrichtian and type Danian stages of southern Scandinavia. Stockholm Contr. Geol. vol.9, no.1, pp.1-106, pls.1-14, text-figs.1-13.

1962(b) Stratigraphic and taxonomic - phylogenetic studies of Upper Cretaceous and Paleogene planktonic Foraminifera. Stockholm Contr. Geol. vol.9, no.2, pp.107-129.

1964 The Maestrichtian, Danian and Montian stages and the Cretaceous - Tertiary boundary. Stockholm Contr. Geol., vol.11, no.5, pp.103-176.

Bergquist, H.R.

1961 Foraminiferal zonation in Matanuska formation, Squaw Creek-Nelchina River area, south-central Alaska. Amer. Assoc. Petrol. Geol. Bull. vol.45, no.12, pp.1994-2011.

Bermudez, P.J.

1952 Estudio sistematico de los foraminiferos rotaliformes. Venezuela Minist. Minas c Hidrocarb., Bol. Geol. vol.2, no.4 pp.1-230, pls.1-35.

Berry, K.D.

1965 New foraminiferal zonation, Upper Mesozoic, Sacramento valley, California. Amer. Assoc. Petrol. Geol. Bull. vol.49, no.7, p.1080 (Abstract).

Bettenstaedt, F. and Wicher, C.A.

1955 Stratigraphic correlation of Upper Cretaceous and Lower Cretaceous in the Tethys and Boreal by the aid of microfossils. World Petrol. Congr., 4th Proc., section I/D, Paper no.5, pp.493-516, pls.1-5.

Bieda, E.

1958 Index Foraminifers and the age of the Mielnik Chalk (eastern Poland). Bull. surv. Geol. Pologne, Warszawa, vol.3, pp.17-89, 1 pl., figs.1-27 (Polish with Russian and English Summary).

Bolin, E.J.

1952 Microfossils of the Niobrara formation. S. Dak. Geol. Surv. Rept., no.70, 74 pp., 5 pls., 1 text-fig.

1956 Upper Cretaceous Foraminifera, Ostracoda and Radiolaria from Minnesota. Jour. Paleont., vol.30, no.2, pp.278-298, pls.37-39, 5 text-figs.

Bolli, H.M.

1945 Zur Stratigraphic der Oberen Kreide in den hoheren helvetischen Decken. Eclogae Geol. Helv. vol.37, no.2, pp.217-328, pl.9, text-figs.1-6.

1950 The direction of coiling in the evolution of some Globorotaliidae. Contr. Cushman Found. Foram. Res., vol.1, pts.3-4, pp.82-89, pl.15.

1951 The genus Globotruncana in Trinidad, B.W.I. Jour. Paleont. vol.25, no.2, pp.187-199, pls.34,35.

1957(a) The genera Praeglobotruncana, Rotalipora, Globotruncana and Abathomphalus in the Upper Cretaceous of Trinidad, B.W.I. pp.51-60, pl.12-14, text-fig.10, in Loeblich, A.R. Jr.et.al. Studies in Foraminifera. U.S. Nat. Mus. Bull. no.215, pp.3-50, pls.1-11, text-figs.1-9.

1957(b) The foraminiferal genera Schackoina Thalmann, emended and Leupoldina, n.gen., in the Cretaceous of Trinidad, B.W.I. Eclogae. Geol. Helv. vol.50, no.2, pp.271-278, pls.1-2 .

1959 Planktonic Foraminifera from the Cretaceous of Trinidad, B.W.I. Bull. Amer. Paleont. vol.39, no.179, pp.257-277, pls.20-23.

1966 Zonation of Cretaceous to Pliocene marine sediments based on planktonic foraminifera. Asoc. Venezolana Geol. Min. Petr. Bol. Inform., vol.9, no.1, pp.3-32.

Bolli, H.M. and Cita, M.B.

1960 Upper Cretaceous and Lower Tertiary planktonic Foraminifera from the Paderno d'Adda section, northern Italy. Internat. Geol. Congr. 21st. Copenhagen, Rept., Proc., pt.5, pp.150-161, text-figs.1-3.

Bolli, H.M., Loeblich, A.R., Jr. and Tappan, H.

1957 Planktonic Foraminifera families Hantkeninidae, Orbulinidae Globorotaliidae and Globotruncanidae. U.S. Nat. Mus. Bull., no.215, pp.3-50, pls.1-11, text-figs.1-9.

Bolze, J. and Sigal, J.

1964 Precision sur la Stratigraphie et les Foraminiferes du Cretace entre Zaghuaj et le Ressas (Tunisie orientale). Soc. Geol. France, C.R. Somm., ser.1, pp.31-32.

Bradshaw, J.S.

1959 Ecology of living planktonic Foraminifera in the north and equatorial Pacific Ocean. Contr. Cushman Found. Foram. Res., vol.1, pt.10, pp.25-64, pls.6-8.

Bronnimann, P.

1952 Globigerinidae from the Upper Cretaceous (Cenomanian - Maestrichtian) of Trinidad, B.W.I. Bull. Amer. Paleont., vol.34, no.140, pp.1-70, pls.1-4, text-figs.1-30.

Bronnimann, P. and Brown, N.K., Jr.

1953 Observations on some planktonic Heterohelicidae from the Upper Cretaceous of Cuba. Contr. Cushman Found. Foram. Res. vol.4, pt.4, pp.150-156, text-figs.1-14.

1956 Taxonomy of the Globotruncanidae. Eclogae Geol. Helv., vol.48 (1955), no.2, pp.503-561, pls.20-24, text-figs.1-24.

1958(a) Hedbergella, a new name for a Cretaceous planktonic foraminiferal genus. Washington Acad. Sci. Jour., vol.48, no.1, pp.15-17, text-fig.1.

1958(b) Taxonomy of the Globotruncanidae. Micropaleont., vol.4, no.2, pp.201-203.

Bronnimann, P. and Rigassi, D.

1963 Contribution to the geology and paleontology of the area of the city of La Habana, Cuba and its surroundings. Eclogae Geol. Helv., vol.56, no.1, pp.13-480, pls.1-26.

Brotzen, F.

1934 Foraminiferen aus dem Senon Palastinas. Deutsch Palastina - Ver. Zeitschr., vol.57, no.1, pp.28-72, pls.1-4.

1936 Foraminiferen aus dem schwedischen untersten Senon von Eriksdal in Schonen. Sver. Geol. Unders., Avh., ser.C., no.396, (Arsbok 30, no.3), pp.1-206, pls.1-14, text-figs.1-69.

1942 Die Foraminiferengattung and die systematik der Rotaliiformes. Sver. Geol. Unders. Avh., ser.C, no.451 (Arsbok 36, no.8), pp.1-60, pl.1, text-figs.1-18.

Brown, R.D., Jr. and Rich, E.I.

1960 Early Cretaceous fossils in submarine slump deposits of late Cretaceous age, northern Sacramento valley, California. U.S. Geol. Surv. Prof. Paper., no.400-B, pp.318-320, text-figs.1-2.

Butt, A.A.

1966 Foraminifera of the type Turonian. Micropaleont., vol.12, no.2, pp.168-182, pls.1-4.

Carbonnier, A.

1952 Sur un gisement de Foraminiferes d'age Cenomanian superieur de la region de Taza (Maroc). Soc. Geol. France, Bull., ser.6, vol.2, no.1-3, pp.111-122, pls.5-7.

Carman, K.W.

1929 Some Foraminifera from the Niobrara and Benton formations of Wyoming. Jour. Paleont., vol.3, no.3, pp.309-315, pl.34.

Caron, Michele.

1965 Les ouvertures chez le genre Praeglobotruncana (Foraminiferes) Soc. Geol. France, C.R., Somm., vol.7, p.217

1966 Globotruncanidae du Cretace superieur du synclinal de la Gruyere (Prealpes Medianes, Suisse). Rev. Micropal., vol.9, no.2, pp.68-93, pls.1-6, text-figs.1-6.

Carpenter, W.B., Parker, W.K., and Jones, T.R.

1862 Introduction to the study of the Foraminifera. Roy. Soc. London, pp.1-319, pls.1-22, 97 text-figs.

Carsey, D.O.

1926 Foraminifera of the Cretaceous of Central Texas. Univ. Texas Bull. 2612, pp.1-56, pls.1-8.

Casey, Raymond.

1964 The Cretaceous Period. In: Harland, W.B., Smith, A.G. and Wilcock, B., Eds., the Phanerozoic time scale. Geol. Soc. London, Quart. Jour., vol.120S, pp.193-202

Casey, Richard.

1963 Studies on ecology of planktonic Foraminifera and Radiolaria off southern California coast. Amer. Assoc. Petrol. Geol. Bull., vol.47, no.9, p.1768 (Abstract).

Casati, P. and Tomai, M.

1969 Il Giurassico ed il Cretacico del versante settentrionale del vallone Bellunese e del gruppo del M. Brandol. Riv. Ital. Paleont. Stratig., vol.75, no.2, pp.205-340, pls.3-15.

Christadoulou, G. and Marangoudakis

1966 A Globotruncana fauna from Kiveri-Argos area, Greece. Eclogae Geol. Helv., vol.59, no.1, pp.303-308, figs.1-4, pl.1

Church, C.C.

1952 Cretaceous Foraminifera from the Franciscan Calera limestone of California. Contr. Cushman Found. Foram. Res., vol.3, pt.2, pp.68-70, 2 text-figs.

Cita, M.B.

1948 Richerche stratigrafiche e micropaleontologiche sul Cretacico e sull Eocene de Tignale (Lago di Garda). Riv. Ital. Pal., vol.54, no.2, pp.49-74; no.3, pp.117-133; no.4, pp.143-168, pls.2-4.

1963 Tendances evolutives des Foraminiferes planctiques (Globotruncanae) du Cretace superieur. In: Evolutionary trends in Foraminifera. Amsterdam. Elsevier Publ. Co., pp.112-138, text-figs.1-19.

1966 Le genere Stensioina le Cretace superieur Italien. Eclogae Geol. Helv., vol.59, no.1, pp.247-257, figs.1-7, 2 tables.

Cati, F.

1964 Una microfauna Campaniana dei Monti Berici (Vicenza). Giorn. Geol., ser.2, vol.32, no.1, pp.199-271, pls.34-42.

Civrieux, J.M.S. de

1952 Estudio de la microfauna de la seccion-tipo del Niembre Socuy de la formacion Colon., Distrito Mara, Estado Zulia. Venezuela, Minist. Minas e Hidrocarb., Bol. Geol., vol.2, no.5, pp.231-310, 12 text-figs., 11 pls.

Cole, W.S.

1938 Stratigraphy and micropaleontology of two deep wells in Florida. Florida, Geol. Surv. Bull. no.16, 48 pp., 3 figs. 12 pls.

Colom, G.

1952 Los caracteres micropaleontologicos de algunes formaciones del Secundario de Espana. Inst. Geol. Min. Espana, Bol., vol.64, pp.259-344, pls.1-14, text-figs.1-3.

1955 Jurassic-Cretaceous pelagic sediments of the western Mediterranean zone and the Atlantic area. Micropaleont. vol.1, no.2, pp.109-124, pls.1-5, text-figs.1-4.

Corminboeuf, P.

1961 Tests isoles de Globotruncana mayaroensis Bolli, Rugoglobigerina, Trinitella et Heterohelicidae dans le Maestrichtian des Alpettes. Eclogae Geol. Helv., vol.54, no.1, pp.107-122, pls.1,2.

Crespin, I.

1953 Lower Cretaceous Foraminifera from the "Great Artesian Basin", Australia. Cont. Cushman Found. Foram. Res., vol.4 pt.1, pp.26-36, pls.5-6.

Cushman, J.A.

1925 Some new Foraminifera from the Velasco shale of Mexico. Contr. Cushman Found. Foram. Res., vol.1, pp.18-22, pl.3.

1926 Some Foraminifera from the Mendez shale of estern Mexico. Contr. Cushman Found. Foram. Res., vol.2, pt.1, pp.16-26, pls.2,3.

1927(a) Some new genera of the Foraminifera. Contr. Cushman Lab. Foram. Res., vol.2, pt.4, pp.77-81, pl.11.

1927(b) An outline of a reclassification of the Foraminifera. Contr. Cushman Found. Foram. Res., vol.3, pt.1, pp.1-105, pls.1-21.

1927(c) New and interesting Foraminifera from Mexico and Texas. Contr. Cushman Found. Foram. Res., vol.3, pt.2, pp.111-119, pls.22,23.

1927(d) Some characteristic Mexican fossil Foraminifera. Jour. Paleont., vol.1, no.2, pp.147-172, pls.23-28.

1927(e) The American Cretaceous Foraminifera figured by Ehrenberg. Jour. Paleont., vol.1, no.3, pp.213-217, 3 pls.

1928 The American - Cretaceous Foraminifera figured by Ehrenberg. Jour. Paleont., vol.1, no.3, pp.213-217, pls.34-36.

1931 A preliminary report on the Foraminifera of Tennessee. Tennessee, Div. Geol. Bull.41, pp.1-116, pls.1-13.

1932 The Foraminifera of the Annona Chalk. Jour. Paleont., vol.6, no.4, pp.330-345, pls.50,51.

1933 Some new foraminiferal general Contr. Cushman Found. Foram. Res., vol.9, pt.2, pp.32-38, pls.3-4.

1936 Geology and Paleontology of the Georges Bank Canyons., pt.4 Cretaceous and Late Tertiary Foraminifera. Geol. Soc. Amer. Bull., vol.47, no.3, pp.413-440, pls.1-5.

1938(a) Cretaceous species of Gumbelina and related genera. Contr. Cushman Found. Foram. Res., vol.14, pt.1, pp.1-28, pls.1-4.

1938(b) Additional new species of American Cretaceous Foraminifera. Contr. Cushman Found. Foram. Res., vol.14, pt.2, pp.31-50, pls.5-8.

1938(c) Some new species of rotaliform Foraminifera from the American Cretaceous. Contr. Cushman Found. Foram. Res., v.14, pt.3, pp.66-71, pls.11-12.

1939 New American Cretaceous Foraminifera. Contr. Cushman Found. Foram. Res., vol.15, pt.4, pp.89-93, pl.16.

1944(a) The foraminiferal fauna of the type locality of the Pecan Gap Chlk. Contr. Cushman Found. Foram. Res., vol.20, pt.1, pp.1-17, pls.1-3.

1944(b) Foraminifera of the lower part of the Mooreville Chalk of the Selma Group, Mississippi. Contr. Cushman Found. Foram. Res., vol.20, pt.4, pp.83-96, pls.13,14.

1946 Upper Cretaceous Foraminifera of the Gulf Coastal region of the United States and adjacent areas. U.S. Geol. Sur. Prof. Paper., no.206, pp.1-241, pls.1-66.

1947 A foraminiferal fauna from the Santa Anita formation of Venezuela. Contr. Cushman Found. Foram. Res., vol.23, pp.1-18, pls.1-4.

1948 Foraminifera, their classification and economic use. 605 pp., 55 pls. Cambridge/Mass.

1949 The foraminiferal fauna of the Upper Cretaceous Arcadelphia Marl of Arkansas. U.S. Geol. Surv. Prof. Paper, Washington, 221-A. pp.1-10, pls.1-4.

Cushman, J.A., and Church, C.C.

1929 Some Upper Cretaceous Foraminifera from near Coalinga, California. California Acad. Sci. Proc., ser.4, vol.18, pp.497-531, pls.36-41.

Cushman, J.A. and Deaderick, W.H.

1944 Cretaceous Foraminifera from the Marlbrook Marl of Arkansas. Jour. Paleont., vol.18, no.4, pp.328-342, pls.50-53.

Cushman, J.A. and Goudkoff, P.P.

1944 Some Foraminifera from Upper Cretaceous of California. Contr. Cushman Found. Foram. Res., vol.20, pt.3, pp.53-64, pls.9-10.

Cushman, J.A. and Hedberg, H.D.

1941 Upper Cretaceous Foraminifera from Santander del Norte, Colombia, S.A. Contr. Cushman Found. Foram. Res., vol.17, pt.4, pp.79-100, pls.21-23.

Cushman, J.A. and Jarvis, P.W.

1928 Cretaceous Foraminifera from Trinidad. Contr. Cushman Found. Foram. Res., vol.4, pp.84-103, pls.12-14.

1932 Upper Cretaceous Foraminifera from Trinidad. Proc. U.S. Nat. Mus., vol.80, art.14, pp.1-60, pls.1-6.

Cushman, J.A. and Renz, H.H.

1947 Further notes on the Cretaceous Foraminifera of Trinidad. Contr. Cushman Found. Foram. Res., vol.23, pt.2, pp.31-50, pls.11,12.

Cushman, J.A. and Ten Dam, A.

1948 Globigerinelloides, a new genus for the Globigerinidae. Contr. Cushman Found. Foram. Res., vol.24, pt.2, pp.42-43, pl.8, figs.4-6.

Cushman, J.A. and Todd, R.

1943 Foraminifera of the Corsicana Marl. Contr. Cushman Found. Foram. Res., vol.19, pt.3, pp.49-42, pls.9-12.

1948 A foraminiferal fauna from the New Almaden district, California. Contr. Cushman Found. Foram. Res., vol.24, pt.4, pp.90-98, pl.16, figs.4-25.

1951 Species of the genera Allomorphina and Quadrimorphina. Contr. Cushman Found. Foram. Res., vol.25, pt.3, pp.59-72, pls.11-12.

Cushman, J.A. and Wickenden, R.T.D.

1930 The development of Hantkenina in the Cretaceous with a description of a new species. Contr. Cushman Found. Foram. Res., vol.6, pt.2, pp.39-43, pl.6, figs.1-6.

Dalbiez, F.

1955 The genus Globotruncana in Tunisia. Micropaleont., vol.1, no.2, pp.161-171, text-figs.1-10.

Degens, E.T.

1965 Geochemistry of sediments. Prentice Hall, Englewood Cliffs, N.J., 342 pp.

Diver, W.L.

1968 The foraminiferal planktonic/benthonic ratios across the Lower/Middle Chalk boundary in the Redhill area, Surrey. Univ. London M.Sc. Thesis, pp.1-32, figs.1-11.

Douglas, R.G.

1967 Upper Cretaceous Biostratigraphy of northern California. First Plankt. Confr., Geneva, pp.127-149, figs.1-6.

1969 Upper Cretaceous planktonic Foraminifera in northern California: Part 1 - Systematic. Micropaleont. vol.15, no.2, pp.151-209, pls.1-11, 6 text-figs.

Douglas, R.G. and Rankin, C.

1969 Cretaceous planktonic Foraminifera from Bornholm and their zoogeographic significance. Lethaia. Internat. Jour. Paleont. Stratig., vol.2, no.3, pp.185-217, 18 figs.

Douglas, R.G. and Sliter, W.V.

1966(a) Regional distribution of some Cretaceous Rotaliporidae and Globotruncanidae (Foraminiferida) within North America. Tulane Stud. Geol., vol.4, no.3, pp.89-131, pls.1-5

1966(b) Distribution of Late Cretaceous Rotaliporidae and Globotruncanidae in California and northwestern Mexico. Amer. Assoc. Petrol. Geol., vol.50, no.3, p.611 (Abstract).

Drooger, C.W.

1951 Upper Cretaceous Foraminifera of the Midden - Curacao beds near Hato, Curacao (N.W.I.). Kon. Nederl. Akad. Wetensch. Proc.ser. B, Bd.54, pp.66-72, pl.1.

Dunnington, H.V.

1955 Close zonation of Upper Cretaceous globigerinal sediments by abundance ratios of Globotruncana species groups. Micropaleont., vol.1, no.3, pp.207-219.

Dunnington, H.V., Wetzel, R. and Morton, D.M.

1959 Lexique stratigraphique international, Asie, Iraq. Internat. Geol. Congr. Comm. Stratig. vol.3, Fasc.10a, 333pp.(1960).

Dupeuble, P.A.

1967 Foraminiferes planctoniques (Globotruncanidae et Heterohelicidae) du Maestrichtien superieur en Aquitaine occidentale. First Plank. Confr., Geneva., pp.153-161, pls.1-4.

Edgell, H.S.

1957 The genus Globotruncana in northwest Australia. Micropaleont., vol.3, no.2, pp.101-126, pls.1-4.

1962 A record of Globotruncana concavata (Brotzen) in northwest Australia. Rev. Micropaleont., vol.5, no.1, pp.41-50, 2 figs, 2 tables.

*Egger, J.G.

1900 Foraminiferen und Ostrakoden aus den Kreidemergeln der Oberbayerischen Alpen. K. Bayer. Akad. Wiss. Munchen, Abh., Cl.II, vol.21(1902), pt.1 (1899), pp.1-230, pls.1-27.

*Ehrenberg, C.G.

1840 Die Bildung der europaischen, libyschen und arabischen Kreidefelsen and des Kreidemergels aus mikroskopischen Organismen .... K. Akad. Wiss. Berlin, Abh., (1838), pp.59-147, pls.1-4, 1 chart.

1843 Verbreitung und Einfluss des Mikroskopischen Lebens in Sud und Nord Amerika. K. Preuss. Akad. Wiss. Berlin, Abh., (1841), pt.1, pp.291-446, pl.1-4.

1844 Eine Mitthelung uber 2 neue lager von Gebirgsmassen aus infusorien als Meeres-Absatz in Nord-Amerika und eine Vergleichung derselben mit den organischen Kreide - Gebilden in Europa und Afrika. K. Preuss. Akad. Wiss. Berlin, Ber., pp.57-98.

1854 Mikrogeologie .... pp.1-374, pls.1-40, L. Voss, Leipzig.

1856 Uber den Grunsand und seine Erlauterung des organischen Lebens. K. Akad. Wiss. Berlin Abh., (1855) pp.85-176, pls.1-7.

Eicher, D.L.

1965 Foraminifera and Biostratigraphy of the Graneros shale. Jour. Paleont., vol.39, no.5, pp.875-909, pls.103-106, text-figs.1-6.

1966 Foraminifera from the Cretaceous Carlile shale of Colorado. Contr. Cushman Found. Foram. Res., vol.17, pt.1, pp.16-31, pls.4-6, text-figs.1-2.

1967 Foraminifera from Belle Fourche shale and equivalents, Wyoming and Montana. Jour. Paleont., vol.41, no.1, pp.167-188, pls.17-19, text-figs.1-6.

1969(a) Paleobathymetry of Cretaceous Greenhorn sea in eastern Colorado. Amer. Assoc. Petrol. Geol. Bull., vol.53, pp.1075-1090.

1969(b) Cenomanian and Turonian planktonic Foraminifera from the western interior of the United States. First Plank. Confr. Geneva, pp.163-174, text-figs.1-5.

Eicher, D.L. and Worstell, P.

1970(a) Cenomanian and Turonian Foraminifera from the Great Plains, United States. Micropaleont., vol.16, no.3, pp.269-324, pls.1-13.

1970(b) Lunatriella a Cretaceous heterohelicid from the western interior of the United States. Micropaleont., vol.16, no.1, pp.117-121, pl.1.

Ellis, B.F. and Messina, A.R.

1940 et. seq., Catalogue of Foraminifera. Amer. Mus. Nat. Hist. N.Y.

Ellis, B.F., Messina, A.R., Charmatz, R. and Ronai, L.E.

1968 Catalogue of index smaller Foraminifera. Amer. Mus. Nt. Hist., N.Y., vol.1, sect.1, Cretaceous planktonic Foraminifera.

El-Naggar, Z.R.

1966 Stratigraphic and planktonic Foraminifera of the Upper Cretaceous - Lower Tertiary succession in the Esna-Idfu region, Nile valley, Egypt, U.A.R. British Mus. (Nat.Hist.)

Geol. Suppl.2, pp.1-291, pls.1-23, text-figs.1-18.

El-Naggar, Z.R. and Haynes, J.

1967 Globotruncana calciformis in the Maestrichtian Sharawna shale of Egypt. Contr. Cushman Found. Foram. Res., vol.18, pt.1, pp.1-13, pls.1-4.

Esker, G.C. III

1968 A new species of Pseudoguembelina from the Upper Cretaceous of Texas Contr. Cushman Found. Foram. Res., vol.19, pt.4, pp.168-169, text-figs.1-5.

1968 Designation of a lectotype of Globotruncana rosetta (Carsey). Ibid., pp.170-171, text-figs.1-3.

Evans, G., Kinsman, D.J.J. and Shearman, D.J.

1964 A reconnaissance survey of the environment of recent carbonate sedimentation along the Trucial Coast, Persian Gulf. In: L.M.J.U. van Straaten (Editor), Deltaic and shallow marine deposits. Elsevier, Amsterdam, pp.129-135.

Fisher, M.J.

1969(a) Benthonic Foraminifera from the Maestrichtian chalk of Galicia Bank, west of Spain. Paleont., vol.12, pt.2, pp.189-200, text-figs.1-3, 1 table.

1969(b) Upper Cretaceous Foraminifera from the Iberian continental margin. Breviora Geol. Asturica, vol.8, no.1, pp.11-13.

Fisher, R.A., Corbet, A.S. and Williams, C.B.

1943 The relation between the number of species and the number of individuals in a random sample of an animal population. Jour. Animal Ecol., vol.12, pp.42-58.

Fox, S.K., Jr.

1954 Cretaceous Foraminifera from Greenhorn, Carlile and Cody formations, south Dakota, Wyoming. U.S. Geol. Sur., Prof. Paper, Washington, no.254-E, pp.97-124, pls.24-26.

Frizzell, D.L.

1954 Handbook of Cretaceous Foraminifera of Texas. Univ. Texas Bur. Econ. Geol. Rep. Inv., no.22, p.1-230, pls.1-21, 4 tab.

Funnell, B.M.

1964 Studies in north Atlantic Geology and paleontology: 1 - Upper Cretaceous. Geol. Mag., vol.101, no.5, pp.421-434.

Funnell, B.M., Friend, J.K. and Ramsay, A.T.

1969 Upper Maestrichtian planktonic Foraminifera from Galicia Bank, west Spain. Paleont., vol.12, pt. pp.19-41, pls.1-5, text-figs.1-22.

Gallitelli, E.M.

1955 Schackoina from the Upper Cretaceous of the northern Apennines, Italy. Micropaleont., vol.1, no.2, pp.141-146, pl.1.

1956 Bronnimannella, Tappanina and Trachelinella. Three new foraminiferal genera from the Upper Cretaceous. Contr. Cushman Found. Foram. Res., vol.7, pt.2, pp.35-39, pl.7.

1957 A revision of the foraminiferal family Heterohelicidae. U.S. Nat. Mus., Bull., no.215, pp.133-154, pls.31-34.

Galloway, J.J.

1933 A manual of Foraminifera. Bloomington, Indiana, Principia Press., 495 pp., pls.1-42.

Galloway, J.J. and Morrey, M.

1931 Late Cretaceous Foraminifera from Tabasco, Mexico. Jour. Paleont., vol.5, no.4, pp.329-354, pls.37-40.

Gandolfi, R.

1942 Ricerche micropaleontologiche e stratigrafiche sulla Scaglia e sul Flysch cretacici dei dintorni di Balerna (Canton Ticino). Riv. Ital. Pal., vol.48, mem.4, pp.1-160, pls.1-14, text-figs.1-49.

1955 The genus Globotruncana in northeastern Colombia. Bull. Amer. Pal., vol.36, no.155, pp.1-118, pls.1-10, text-figs. 1-12.

1957 Notes on some species of Globotruncana. Contr. Cushman Found. Foram. Res., vol.8, pt.2, pp.59-65, pls.8-9.

Gauger, D.J.

1953 Microfauna of the Hilliard. In: Peterson, R.H., Gauger, D.J. and Lankford, R.R., Utah. Geol. Min. Surv. Bull., no.47, (Contr. Micropal., no.1) pp.51-90, pls.4-11, table 3, text-fig.7.

Germeraad, J.H.

1946 Geology of central Seran. In: L. Rutten and W. Hotz Amsterdam. ser.3, no.2, Amsterdam, Rijks. Univ. Utrecht. Proefschr., 135 pp., 12 pls., 5 tables.

Geroch, S., Jednorowska, Antonina, Ksiazkiewicz, Marian and Liszkowa Janina.

1967 Stratigraphy based upon microfauna in the western Polish Carpathians. Poland. Inst. Geol. Biul., vol.5, no.211, pt.2, pp.185-267, text-figs.35-42.

Glaessner, M.F.

1936 Die Foraminiferengattungen Pseudotextularia und Amphimorphina. Probl. Pal., Moscow Univ. Lab. Pal., vol.1, pp.95-134, pls.1,2,3.

1937(a) Planktonforaminiferen aus der Kreide und dem Eozan und ihre stratigraphische Bedeutung. Lab. Moscow Univ., Pal., Publ., Studies Micropaleont., vol.1, no.1, pp.27-52, pls.1-2, 6figs.

1937(b) Studien uber Foraminiferen aus der Kreide und dem Tertiary de Kaukasus. Moscow Univ. Probl. Pal., vols.2-3, pp.349-410 pls.1-4.

1945 Principle of Micropaleontology. Melbourne Univ. Press. 296 pp., pls.1-14.

1966 Notes on Foraminifera of the genus Hedbergella. Eclogae Geol. Helv., pp.179-184, pl.1.

Graham, J.J.

1962 A review of the planktonic Foraminifera from the Upper Cretaceous of California. Contr. Cushman Found. Foram. Res., vol.13, pt.3, pp.100-109, 1 table, pls.19,20.

Graham, J.J. and Church, C.C.

1963 Campanian Foraminifera from the Stanford University Campus, California. Stanford Univ. Publ., Geol. Sci., vol.8, no.1, pp.1-107, pls.1-8, text-figs.1-2.

Graham, J.J. and Clark, D.K.

1961 New evidence for the age of the "G-1 zone" in the Upper Cretaceous of California. Contr. Cushman Found. Foram. Res., vol.12, pt.3, pp.107-114, pl.5.

Grimsdale, T.F.

1951 Correlation, age determination and the Tertiary pelagic Foraminifera. Copyright by E.J. Brill, Leiden, Netherlands. Sect.1, preprint 7, pp.1-12.

Grimsdale, T.F. and van Morkhoven, F.P.C.

1955 The ratio between pelagic and benthonic Foraminifera as a means of estimating depth of deposition of sedimentary rocks. World Petrol. Congr., 4th Proc., section I/D, Paper 4, pp.473-491.

Hada, Y.

1957 Biology of the arenaceous Foraminifera. Jour. Sci., vol.3, B, pp.31-50.

Haddings, Assar.

1932 The pre-Quaternary sedimentary rocks of Sweden: 4 - Glauconite and glauconitic rocks. Medd. Lunds Geol.-Mineral. Inst., no.51.

Haake, F.W.

1962 Untersuchungen an der Foraminiferen fauna im Wattgebiet zwischen Langeoog und dem Festland. Kiel Univ. Meyniana vol.12, pp.25-64, pls.1-6, figs.1-9, 5 tables.

Hagn, H.

1954 Die Foraminiferen der Pinswanger Schichten (unteres Obercampan); ein Beitrang zur Mikropalaontologie der helvetischen Oberkreide Sudbayerns. Palaeontogr., Bd.104, Abt.A, Lf.1-3, pp.1-119, 27 figs., pls.1-8.

Hagn, H. and Zeil, W.

1954 Globotruncana aus dem Ober-Cenoman und Unter-Turon der Bayerischen Alpen. Eclogae Geol. Helv., vol.47, no.1, pp.1-60, pls.1-7.

Hamilton, E.L.

1953 Upper Cretaceous, Tertiary and Recent planktonic Foraminifera from mid-Pacific flat-topped seamounts. Jour. Paleont., vol.27, no.2, pp.204-237, pls.29-32.

Haque, A.F.M.

1959 Some late Cretaceous smaller Foraminifera from West Pakistan. Geol. Surv. Pakistan, Mem., vol.2, pt.3, pp.1-33, pls.1-2, fig.1, 3 tables.

Harth, E.

1967 Outline of southeastern Middle East stratigraphy. I.P.C. Pub. Chapter 1, pp.11-19, 1 map, 1 fig.

Hay, W.W.

1960 The Cretaceous-Tertiary boundary in the Tampico embayment. Internat. Geol. Congr. 21st Copenhagen Rep. Proc., pt.5, pp.70-77.

Haynes, J. and El-Naggar, Z.R.

1964 Reworked Upper Cretaceous and Danian planktonic Foraminifera in the type Thanetian. Micropaleont., vol.10, no.3, pp.354-356.

Hedberg, H.D.

1948 Time-stratigraphic classification of sedimentary rocks. Geol. Soc. Amer. Bull., vol.59, no.5, pp.447-462.

1965 Chronostratigraphy and Biostratigraphy. Geol.Mag. vol.102, no.5, pp.451-461.

Heide, S.V.D.

1954 The original meaning of the term Maestrichtian (Dumont, 1849) Geol. en Mijnb., Den Haag (n.s.) 16, pp.509-511.

Hendricks, S.B. and Ross, C.S.

1941 Chemical composition and genesis of galuconite and celadonite. Amer. Min. vol.26, pp.683-708.

Henson, F.R.S.

1938 Stratigraphical correlation by small Foraminifera in Palestine and Adjoining countries. Geol. Mag., London, vol.75, pp.227-233.

1948 Larger imperforate Foraminifera of south west Asia, families Lituolidae, Orbitolinidae and Meandropsinidae. Brit. Mus. (Nat.Hist.) London, 127 pp., 16 pls.

Herb, R.

1963 Uber Vorkommen von Amdenerschichten im mittleren Santisgebirge. Eclogae Geol. Helv. vol.56, no.2, pp.904-906, pls.1-2.

1965 Die Oberkreide des Helvetikums von Amden (Kt. st. Gallen). Ver. Schweiz. Petr.-Geol. U-Png., Bull., vol.31, no.81, pp.152-159, text-figs.1-3.

Herm, D.

1962 Stratigraphische und micropalaeontologische Untersuchungen der Oberkreide im Lattengebirge und Nierental (Gosaubecken von Richenhall und Salzburg). Bayer. Akad. Wiss. Math. - Nat. Kl., Abh., n.ser., no.104, pp.1-119, pls.1-9.

1965 Micropalaontologisch - stratigraphische Untersuchungen im Kreideflysch zwischen Dera and Zumaya (Prov. Guipuzcoa, Nordspanien). Zeitschr. Deutsch. Geol. Gesell., vol.115, pt.1, pp.277-348, pl.8, text-figs.1-16, 2 tables.

Hiltermann, H.

1952 Stratigraphische Fragen des Campan und Maastricht unter besonderer Berucksichtigung der Mikropalaontologie. Geol. Jh., Bd.67, pp.47-66, figs.1-5, tab.1.

1956 Biostratigraphie der Oberkreide auf Ground von Mikrofossilien Palaont. Zeitschr., vol.30, pp.19-32, figs.1-6.

Hiltermann, H. and Koch, W.

1960 Oberkreide-biostratigraphie mittels Foraminiferen. Internat. Geol. Congr. 21st Copenhagen Rep. Proc., pt.5, pp.69-76, 4 tables.

Hinte, J.E. van

1963 Zur stratigraphie und mikropalaontologie der Oberkreide und des Eozans des Krappfeldes (Karnten). Jb. Geol. Bund. Dond.8, pp.1-147, pls.1-22.

1965(a) The type Campanian and its planktonic Foraminifera. K. Nederl. Akad. Wetensch., Proc., Ser.B, vol.68, no.1, p.20, pl.2, fig.3a-c; pl.3, fig.3a-c.

1965(b) Remarks on the Kainach Gosau (Styria, Austria) K. Nederl. Akad. Wetensch., Proc., ser.B, vol.68, no.2, p.83, pl.1, figs.3a-c.

1966 Some Foraminifera and correlation of the type Campanian. Proc. 2nd. W. African Micropaleont. Coll., (Ibadan, 1965) ser.B, vol.70, pp.86-92.

1967(a) A Globotruncana zonation of the Senonian subseries. First Plankt. Confr., Geneva, pp.257-266, 3 figs.

1967(b) The nature of biostratigraphic zones. First. plankt. Confr. Geneva, vol.2, pp.267-272, figs.1-4.

Hofker, J.

1949 On Foraminifera form the Upper Senonian of South Limburg (Maestrichtian). Mem. Inst. Roy. Sci. Nat. Belg., Bruxelles, vol.112, pp.1-69, figs.1-23.

1956(a) Foraminifera from the Cretaceous of southern Limburg, Netherlands, 19, planktonic Foraminifera of the Chalk Tuff of Maestricht and environments. Natuurh. Maandbl.Maestricht/ Limburg, vol.45, no.5,6, pp.51-57, text-figs.1-24.

1956(b) Die Globotruncana von Nordwest-Deutschland und Holland. Neues Jb. Geol. Pal., Abh., vol.103, H.3, p.312-340, 26 figs.

1956(c) Die Pseudotextularia - zone der Bohrung Maasbull I und ihre foraminiferen fauna. Paleont. Zeitschr., Stuttgart, vol.30, pp.59-79, pls.5-10, text-fig.1.

1956(d) Lesr Foraminiferes de la zone de contact Maestrichtian - Campanian dans l'Est de la Belgique et le sud des Pays-Bas. Ann. Soc. Geol. Belg., Liege., vol.80, pp.191-233, figs.1-79.

1957(a) Foraminiferen der Oberkreide von Northwestdeutschland und Holland. Beih. Geol. Jahrb., Heft.27, pp.1-464, text-figs. 1-495.

1957(b) Foraminifera from the Cretaceous of southern Limburg, Netherlands, 25, some more planktonic Foraminifera from the lower Md. in the quarry wrfs. Houthem. Natuurh. Maandbl., Limburg, vol.46, pp.32-39.

1958 Foraminifera from the Cretaceous of southern Limburg, Netherlands, 33, on some other Foraminifera from the Maestrichtian Tuff. chalk showing evidence of Tertiary age of that sediment. Natuurh. Maandbl., Limburg., vol.47, pp.42-44, figs.1-8.

1959(a) Foraminifera from the Cretaceous of southern Limburg, Netherlands, 48. Natuurh. Maandbl., vol.48, no.7-8, pp.89-95 text-figs.1-9.

1959(b) On the splitting of Globigerina. Contr. Cushman Found. Foram. Res., N.Y., vol.10, pt.1, pp.1-9, figs.1-25.

1960(a) The Foraminifera from the lower boundary of the Danish Danian. Medd. Dansk. Geol. Foren. Copenhagen., vol.14, H.3, p.212-242, figs.1-47.

1960(b) The type localities of the Maestrichtian (Maestrichtian chalk tuff) and the Montian (Tuffeau de Ciply, Calcaire de Mons, Lagunair and Lacustre Montain). J. Paleont., vol.34, pp.584-588, fig.1

1960(c) The taxonomic status of Praeglobotruncana, Planomalina, Globigerinella and Biglobigerinella. Micropaleont. N.Y. vol.6, no.3, pp.315-322, pls.1-2.

1961(a) Globotruncanidae Brotzen, 1942 as toothplate Foraminifera. Contr. Cushman Foram. Res., vol.12, pp.123-126.

1961(b) Les Foraminiferes du Tuffeau arenace de Folx-Les-Caves. Ann. Soc. Geol. Belg., vol.84, pp.549-580.

1962(a) Studien an planktonischen foraminiferen. Neues Jb. Geol., Pal., Abh., vol.114, H.1, pp.81-134, figs.1-85.

1962(b) Correlation of the Tuff chalk of Maestricht (type Maestrichtian) with the Danske Kalk of Denmark (type Danian), the stratigraphic position of the type Montain, and the planktonic foraminiferal break. Jour. Paleont., vol.36, no.5 pp.1051-1089, text-figs.1-28.

1963 Mise au point concernant les genres Praeglobotruncana Bermudez, 1952, Abathomphalus Bolli, Loeblich and Tappan, 1957, Rugoglobigerina Bronnimann, 1952 et quelques especes de Globorotalia. Rev. Micropaleont. Paris, vol.5, pp.280-288, pls.1,2.

1966 Maestrichtian, Danian and Paleocene Foraminifera. Paleontographica Supplement., vol.10, pp.1-376, pls.1-86, 178 figs., 113 tables.

1968 Studies of Foraminifera. Part 1 - General problems. Pub. Van Het Natuurh, Genoot., Limburg, Reeks XVIII, Alf. 1 and 2, 135 pp., 15 text-figs., 24 pls.

Hornibrook, N. de B.

1958 New Zealand Upper Cretaceous and Tertiary foraminiferal zones and some overseas correlations. Micropaleont., vol.4, no.1 pp.25-38, pl.1.

International Code of Zoological Nomenclature

1961 XV International congress of Zoology. pp.1-176.

International Subcommission on Stratigraphic Terminology. Hedberg, H.D., Chairman.

1960 Statement of principles of stratigraphic classification and terminology. 21st Internat. Geol. Congr., vol.25, Copenhagen, pp.10-29.

Jacob, K. and Sastry, M.V.A.

1950 On the occurrence of Globotruncana in Uttattur stage of the Trichinopoly Cretaceous, south India. Science and Culture, Calcutta., vol.16, no.6, pp.266-268, test-figs.1-2.

Jbr, A.S.

1965 Biostratigraphic studies of the Middle - Upper Cretaceous in the Al-Khafji field, Neutral zone, Arabian Gulf. 5th Arab Petrol. Congr., 34(3B), pp.1-10, 2 range charts.

Jedlitschka, H.

1935 Beitrag zur Kenntn is der mikrofauna der subbeskidischen Schichten. Naturw. Ver. Troppau (C.S.R.) Mitt., Czechoslovakia, vol.40, no.27, pp.31-48, 1 pl., 1 table.

Jefferies, R.P.S.

1962 The paleoecology of the Actinocamax plenus subzone (lowest Turonian) in the Anglo-Paris Basin. Paleontology., vol.4, pp.609-647, pls.77-79.

Jenkins, D.G.

1968 Variations in the numbers of species and subspecies of planktonic Foraminiferida as an indicator of New Zealand Cenozoic paleotemperatures. Palaeogeog. Palaeoclimat. Palaeoecol., vol.5, no.3, pp.309-313, 1 figure.

Jennings, P.H.

1936 A microfauna from the Monmouth and basal Rancocas groups of New Jersey. Bull. Amer. Paleont., vol.23, no.78, pp.161-234, pls.28-34.

Jirova, Dana

1956 The genus Globotruncana in Upper Turonian and Emscherian of Bohemia. Univ. Carolina, Geol., vol.2, no.3, pp.239-256, pls.1-3.

Johnson, M.W. and Brinton, E.

1963 Biological species, water masses and currents. In: Hill, M.N., ed., The sea. Interscience Pub., N.Y. and London. vol.2, pp.381-414.

Johnson, R.G.

1960 Models and methods for analysis of the mode of formation of fossil assemblages. Geol. Soc., Amer. Bull., vol.71, no.7, pp.1075-1085, 2 figs.

Jones, J.I.

1960 The significance of variability in Praeglobotruncana gautierensis (Bronnimann), 1952, from the Cretaceous Eagle Ford group of Texas. Contr. Cushman Found. Foram. Res. vol.11, pt.3, pp.89-103, 7 figs., 2 tables, pl.15.

Kaever, M.

1961 Morphologie, Taxionomie und Biostratigraphie von Globorotalites und Conorotalites (Kreide-Foram.) Geol. Jh. vol.78, pp.387-438, pls.18-21, figs.1-8, 3 tables.

Kalantari, A.

1969 Foraminifera from the Middle Jurassic - Cretaceous successions of Koppet - Dagh region (N.E. Iran). Nat. Iran. Oil Co., Geol. Lab., Tehran, no.3, pts.1,3, text-figs.1-28, pls.1-26.

Kalinin, N.A.

1937 Foraminifera from the Cretaceous of Baktygaryn (Aktyubinsk Oblast U.S.S.R.) Moscow, Univ., Paleont. Lab., vol.1, no.2, pp.60-61, pls.1-8, 2 tables.

Kaplan, J.R., Emery, K.O. and Rittenberg, S.C.

1963 The distribution and isotopic abundance of sulphur in Recent marine sediments off southern California. Geochim. Cosmochim. Acta., vol.27, pp.297-331.

Karczewska, J. and Ziembinska-Tworzydlo, M.

1969 Upper Cretaceous Charophyta from the Nemegt Basin, Gobi desert. Paleont. Polon., no.21, pp.121-144, figs.1-12, pls.30-34.

*Kaufmann, F.J.

1865 Die Urwelt der Schweiz. Zurich In: Heer, O., F. Schulthess 1865, p.198.

Kavary, E. and Frizzell, D.L.

1964 Upper Cretaceous and Lower Cenozoic Foraminifera from west central Iran. Univ. Missouri, Sch. Mines Metal., Tech.Ser. no.102 (1963), pp.1-89, 3 figs., pls.1-13.

Keijzer, F.G.

1945 Upper Cretaceous smaller Foraminifera from Buton (D.E.I.) Knink. Neder. Akad. Wetensch., Holland. Reprinted from Proc. vol. XLVIII, pp.338-339.

Keller, B.M.

1946 The Foraminifera of the Upper Cretaceous deposits in the Sotchi region. Soc. Nat. Moscow, Bull., n.ser., vol.51, no.3, pp.83-105 (Russian text), pp.105-108 English summary, pls.1-3.

Kent, H.

1967(a) Microfossils from the Niobrara formation (Cretaceous) and equivalent strata in northern and western Colorado. Jour. Paleont., vol.41, no.6, pp.1433-1456, pls.183-184, text-figs.1-8.

1967(b) Distribution of keeled Globotruncanidae in Coniacian and Santonian strata of the western interior region of North America.. First Plank. Confr., Geneva, pp.325-327, figs.1-2.

Kerdany, M. and Fahmy, S.

1965 Paleoenvironmental trends in G. Zeit area (An appraisal of paleoecological studies for Oil exploration) 5th Arab Petrol. Congr., ser.no.32 (B-3), pp.1-7, 3 figs.

Kikoine, J.

1947 Less Globotruncana du Cretace superieur nord pyreneen. Soc. Geol. France C.R. Somm., nos.1-2, pp.19-23, figs.1-3

1948 Les Heterohelicidae du Cretace superieur pyreneen. Soc. Geol. France, Bull., ser.5, vol.18, pp.15-35, pls.1,2.

Kinsman, D.J.J.

1965 Dolomitization and evaporite development, including anhydrite in lagoonal sediments, Persian Gulf. Geol. Soc. Amer., Spec. Papers, vol.82, pp.108-109.

Klasz, I. De

1953(a) Einige neve oder wenig bekannte Foraminiferen aus der helvetischen Oberkreide der bayerischen Alpen sudlich Traunstein (Oberbayern). Geol. Bavarica, no.17, pp.223-244, pls.4-7.

1953(b) On the foraminiferal genus Gublerina Kikoine. Geol. Bavarica no.17, pp.251-275, pl.8.

1955 A new Globotruncana from the Bavarian Alps and north Africa. Contr. Cushman Found. Foram. Res., vol.6, pt.1, pp.43,44, pl.7.

1961 Presence de Globotruncana concavata (Brotzen) et Gl. concavata carinata Dalbiez (Foraminiferes) dans le Coniacien de Gabon Afrique equatoriale) Soc. Geol. France, C.R. Somm., pp.123-124

Klaus, J.

1960 Le Complexe schisteux intermediaire dans le synclinal de la Gruyere (Prealpes medianes)(Stratigraphie et Micropaleontologie avec l'Estude speciale des Globotruncanides de l'Albien, du Cenomanien, et du Turonien). Eclogae Geol. Helv., vol.52, no.2, pp.753-851, pls.1-8.

1961 Le repartition stratigraphique des Globotruncanides au Turonien et au Coniacien. Eclogae Geol. Helv., vol.53(1960) no.2, pp.694-704, text-fig.1.

Knipscheer, H.C.G.

1956 Biostratigraphie in der Oberkreide mit Hilfe der Globotruncanen. Paleont. Zeitschr., vol.30, pp.50-56, pl.4, text-figs.1-4.

Kupper, K.

1955 Upper Cretaceous Foraminifera from the "Franciscan series" New Almaden district, California. Contr. Cushman Found. Foram. Res., vol.6, pt.3, pp.112-118, pl.18.

1956 Upper Cretaceous pelagic Foraminifera from the "Antelope shale" Glenn and Colusa Counties, California. Contr. Cushman Found. Foram. Res., vol.7, pt.2, pp.40-47, pl.8.

Lalicker, C.C.

1948 A new genus of Foraminifera from the Upper Cretaceous. Jour. Paleont., vol.22, no.5, p.624, pl.92.

*Lapparent, J. de

1918 Etude lithologique des terrains Cretaces de la region d'Hendaye. France, Carte Geol., Mem., pp.1-153, pl.1-10, text-figs.1-26.

Lees, G.M.

1953 The Middle East. In: The World's Oil fields, the Eastern hemisphere. Sci. Petr., vol.6, pt.1, pp.68-72.

Lees, G.M. and Falcon, N.L.

1952 The geographical history of the Mesopotamian plains. Geog. Jour., vol.118, pp.24-39, figs.1-8, pls.1-4.

Lehmann, R.

1963 Etude des Globotruncanides du Cretace superieur de la province de Tartaya (Maroc occidental). Serv. Geol. Maroc Notes Mem., vol.21, no.156, pp.133-181, pls.1-10, text-figs.1-3.

1966(a) Les Foraminiferes pelagiques du bassin cotier de Tarfaya. Serv. Geol. Maroc Notes Mem., no.175, pp.153-175, 2 pls., 2 figs.

1966(b) Description des Globotruncanides et Heterohelicides d'une faune maestrichtienne du Prerif (Maroc). Eclogae Geol. Helv., vol.59, no.1, pp.309-317, pls.1-2.

LeRoy, L.W.

1953 Biostratigraphy of the Maqfi section, Egypt. Geol. Soc. Amer. Mem., vol.54, pp.1-73, 4 figs., pls.1-14.

Lipps, J.H. and Warme, J.E.

1966 Planktonic foraminiferal biofacies in the Okhotsk sea. Contr. Cushman Found, Foram. Res., vol.17, pt.4, pp.125-134, test-figs.1-5.

Loeblich, A.R., Jr.

1946 Foraminifera from the type Pepper shale of Texas. Jour. Paleont., vol.20, no.2, pp.130-139, pl.22, 3 text-figs.

1951 Coiling in the Heterohelicidae. Contr. Cushman Found. Foram. Res., vol.2, pt.3, pp.106-111, pl.12.

Loeblich, A.R., Jr., and Tappan, H.

1946 New Washita Foraminifera. Jour. Paleont., vol.20, pp.238-258, test-figs.1-4, pls.35-37.

1961(a) Cretaceous planktonic Foraminifera; Part 1 - Cenomanian. Micropaleont., vol.7, no.3, pp.257-304, pls.1-8.

1961(b) Remarks on the systematics of the Sarcodina (Protozoa) renamed homonyms and new validated genera. Biol. Soc. Washington, Proc., vol.74, pp.213-234.

1961(c) Suprageneric classification of the Rhizopoda. Jour. Paleont. vol.35, no.2, pp.24-330.

1961(d) The genera Microaulopora Kuntz, 1895, and Guembelina Kuntz, 1895 and the status of Guembelina Egger (1899. Jour. Paleont., vol.35, no.3, pp.625-627, 1 text-fig.

1964 Sarcodina, chiefly "thecamoebians" and Foraminiferida. In: Moore, R.C., Ed. Treatise on inverterbrate paleontology. N.Y. Geol. Soc. Amer., pt.C Protista 2, vol.1, pp.1-510, text-figs.1-399; vol.2, pp.511-900, text-figs. 400-653.

Loetterle, G.J.

1937 The micropaleontology of the Niobrara formation in Kansas, Nebraska and South Dakota. Nebraska Geol. Sur., Bull., ser.2, no.12, pp.1-73, pls.1-11.

Lomax, E.L.

1953 The Zubair field of Basrah Petroleum. World Petrol., pp.46-50, 10 figs.

Loriga, C.B. and Mantovani, M.G.

1965 Le biofacies del Cretacico della valle del Vaiont (Belluno). Riv. Ital. Pal., vol.71, no.4, pp.1225-1248, pls.110-114, figs.1,2.

Low, D.

1964 Redescription of Anomalina eaglefordensis Moreman. Contr. Cushman Found. Foram. Res., vol.15, pt.3, pp.122-123.

Lowman, S.W.

1949 Sedimentary facies in Gulf Coast. Amer. Assoc. Petrol. Geol. Bull., v.33, no.12, pp.1939-1997, 35 figs.

Macfadyen, W.A.

1938 Water supplies in Iraq. Govt. of Iraq, Ministry of Economics and Communications, Iraq Geol. Dept., Pub. no.1, pp.1-206.

Majzon, L.

1943 Adatok egyes Karpataljai flisretegekhez, tekintettel a Globotruncanakra. Hungary, Magyar K. Foldt. Int. Evk., Budapest. vol.37, no.1, pp.3-168, pls.1-2.

1961 Globotruncana bearing sediment in Hungary. Inst. Geol. Hungrie, Ann., vol.42, pp.745-787, 7 pls. 4 tables.

Marianos, A.W. and Zingula, A.P.

1966 Cretaceous planktonic Foraminifera from Dry Creek, Tehama County, California. Jour. Paleont., vol.40, no.2, pp.328-342, pls.37-39, text-figs.1-3.

Marie, P.

1936 Sur la presence du genere Rosalina dans la craie du bassin de Paris. Soc. Geol. France, C.R. Somm., vol.8, pp.135-137.

1937 Deux niveaux distingues a l'aide des Foraminiferes dans le Maestrichtian du bassin de Paris. Soc. Geol. France, C.R. Somm., vol.5, pp.257-276.

1938 Sur quelques Foraminiferes nouveaux ou peu connus du Cretace du bassin de Paris. Soc. Geol. France, Bull., ser.5, vol.8, pp.91-104, pls.7-8.

1941 Les foraminiferes de la Craie a Beleminitella mucronata du Bassin de Paris. Mus. Nat. Hist. Nat. Mem., vol.12, no.1, pp.1-296, pls.1-37, text-figs.1-7, tables 1-8.

1960 Sur les facies a Foraminiferes du Coniacien subrecifal de la region de Foissac (Gard) et sur le nouveau genera Sornayina. Soc. Geol.France, Bull., ser.7, vol.1, no.3 (1959), pp.320-326, pl.19b, text-figs.1-2, table 1.

1961 Presence de Globotruncana elevata (Brotzen) dans le Santonian de Corbieres. Soc. Geol. France C.R. Somm., pp.124-125.

Martin, L.

1964 Upper Cretaceous and Lower Tertiary Foraminifera from Fresno County, California. Jb. Geol. Bund., sond.9, pp.1-128, pls.1-16, text-figs.1-5, A-D.

Martirosyan, J.A.

1958 Les Globotruncana des depots du Cretace de la partie sud-occidentale de la R.S.S. d'Armenie. Izvestiza Akad. Nauk. Armen S.S.R., vol.11, no.6, pp.7-17, 4 pls., (Russian with Armenian summary).

Maslakova, N.I.

1963 Taxonomy of the genus Hedbergella. Pal. Zhur., no.4, pp.112-116, text-figs.1-2 (Russian)

Matoba, Y.

1967 Younger Cenozoic foraminiferal assemblages from the Choshi district, Chiba prefecture. Tohoku Univ. Sci. Rep., 2nd ser. (Geol.), vol.38, no.2, pp.221-263, 8 figs., 1 table, pls.25-30.

Mcgugan, A.

1957 Upper Cretaceous Foraminifera from northern Ireland. Jour. Paleont., vol.31, no.2, pp.329-348, 4 figs., pls.31-35.

1964 Upper Cretaceous zone Foraminifera, Vancouver Island, British Colombia, Canada. Jour. Paleont., vol.38, no.5, pp.933-951, pls.150-152, text-figs.1-4.

Mello, J.F.

1969 Foraminifera and stratigraphy of the upper part of the Pierre shale and lower part of the Fox Hills sandstone (Cretaceous) north-central, south Dakota. U.S. Geol. Surv., Prof. Paper. 611, 121 pp., pls.1-12, figs.1-14, tab.1-2.

Michael, E.

1968 Variations in the number of species of benthonic Foraminifera in the Barremian of northwestern Germany. Palaegeogr. Palaeoclimat. Palaeoecol., vol.4, no.4, pp.287-303, 5 figs. 2 tables.

Miletic, P.

1963 An outline of the geology and hydrogeology of the Southern Desert area of Iraq. Geol. Vjes. Zagreb, svez.15, Broj.2, INGRA group, Zagreb. pp.369-390, 6 tables, 2 maps.

Milton, D.I.

Geology of the Arabian Peninsula, Kuwait. U.S. Geol. Surv. Prof. Paper 560-F, 7 pp., 1 table.

Mohler, H.P.

1966 Stratigraphische Untersuchungen in den Giswiler Klippen (Prealpes Medianes) und ihrer helvetisch-ultrahelvetischen unterlage. Mat. Carta Geol. Svizzera., n.s., n.129, 6 tav., 9 figs., 3 tables.

Moorkens, T.L.

1967 Quelques Globotruncanidae et Rotaliporidae du Cenomanien, Turonien et Coniacien de la Belgique. First Plankt. Confr., Geneva, vol.2, pp.435-459, pls.1-3, 2 tables.

Moreman, W.L.

1927 Fossil zones of the Eagle Ford of north Texas. Jour. Paleont. vol.1, no.1, pp.89-101, pls.13-16.

Morkhoven, F.P.C.M. van

1958 A simplified method of grinding Foraminifera. Micropaleont., vol.4, no.2, pp.209-210, fig.1.

Mornod, L.

1950 Les Globorotalides du Cretace superieur du Montsalvens, (Prealpes fibourgeoises). Eclogae Geol. Helv., vol.42, no.2 pp.573-596, text-figs.1-14, pl.15.

Morozova, W.G.

1939 On the stratigraphy of the Upper Cretaceous and Lower Tertiary deposits in the Emba oil bearing district based on the fauna of Foraminifera. Bull. Mosk. Obsc. Ispyt. Prir. N.S. 47 Otd.Geol., Moscow., vol.17, pp.59-86, pls.1,2.

Morrow, A.L.

1934 Foraminifera and Ostracods from the Upper Cretaceous of Kansas. Jour. Paleont., vol.8, no.2, pp.186-205, pls.29-31.

Mosebach, R.

1952 Wasserige H_2S-Losungen und das verschwinden Kalking - tierischer Hartteile aus werdenden sedimenten. Senckenberg. Lethaea. vol.33, pp.13-22.

Mountjoy, E.W. and Chamney, T.P.

1969 Lower Cretaceous (Albian) of the Yukon. Stratigraphy and Foraminiferal subdivisions, Snake and Peel rivers. Geol. Surv. Canada., Paper 68-26. 71 pp., 4 figs., 3 tables.

Murray, J.

1897 On the distribution of the plagic Foraminifera at the surface and on the floor of the ocean. Nat. Sci., (A monthly review of Science Progress), v.11, p.17-27.

Murray, J.W.

1965 The Foraminiferida of the Persian Gulf. 2 - The Abu Dhabi region. Palaeogeog. Palaeoclimat. Palaeoecol., vol.1, no.4, pp.307-332.

1966(a) The Foraminiferida of the Persian Gulf. 3 - The Halat al Bahrani region. Palaeogeog. Palaeoclimat. Palaeoecol., vol.2 no.1, pp.59-68.

1966(b) The Foraminiferida of the Persian Gulf. 4 - Khor al Bazam. Palaeogeog. Palaeoclimat. Palaeoecol., vol.2, no.2, pp.153-169, figs.1-14.

1968 Living Foraminifera of Lagoons and Estuaries. Micropaleont. vol.14, no.4, pp.435-455.

1970 The Foraminifera of the hypersaline Abu Dhabi lagoon, Persian Gulf. Lethaia. Internat. Jour. Paleont. Stratig., vol.3, pp.51-68, figs.1-10.

Myers, E.H.

1943(a) Biology, ecology and morphogenesis of a pelagic Foraminifera. Biol. Sci., Stanford Univ. Pub., vol.9, no.1, pp.5-30.

1943(b) Life activities of Foraminifera in relation to marine ecology. Proc. Amer. Phil. Soc., vol.86, no.3, pp.439-458, text-figs. 1-7, pl.1.

Nagappa, Y.

1959 Foraminiferal biostratigraphy of the Cretaceous - Eocene succession in the India-Pakistan-Burma region. Micropaleont. vol.5, no.2, pp.145-192, pls.1-11, text-figs.1-11.

Nakkady, S.E.

1949 The foraminiferal fauna of the Esna shales of Egypt, part 1, Bull. Inst. Egypt., Le Caire, vol.31, pp.209-247.

1950 A new foraminiferal fauna from the Esna shales and Upper Cretaceous chalk of Egypt. Jour. Paleont., vol.24, no.6, pp.675-692, pls.89-90.

Nakkady, S.E. and Osman, A.

1954 The genus Globotruncana in Egypt, taxonomy and stratigraphic value. Internat. Geol. Congr. 19th, Algiers. (1952), C.R., sec.13, pp.75-95, pls.19-20.

Natland, M.L.

1938 New species of Foraminifera from off the west coast of North America and from the later Tertiary of the Los Angelos basin. Scripps Inst. Oceanogr., Bull., Tech. Ser., vol.4, no.5, pp.137-164, pls.3-7.

Nauss, A.W.

1947 Cretaceous microfossils of the vermilion area, Alberta. Jour. Paleont., vol.21, no.4, pp.329-343, pls.48-49, text-figs.1-3, table 1.

Neagu, T.

1968 Biostratigraphy of Upper Cretaceous deposits in the southern eastern Carpathians, near Brasov. Micropaleont., vol.14, no.2, pp.225-241, pls.1-2, text-figs.1-3.

Noel, K. Brown.

1967 Heterohelicidae Cushman 1927, amended, a Cretaceous planktonic foraminiferal family. First Plank. Confr. Geneva, pp.21-66, figs.1-15, pls.1-4.

Noth, R.

1951 Foraminiferen aus Unter-und Oberkreide des Osterreichischen Anteils an Flysch, Helvetikum und Vorlandvorkommen. Jb. Geol. Bund. sond.3, pp.1-91, pls.1-9, 2 tables.

Oba, T.

1967 Planktonic Foraminifera from the deep-sea cores of the Indian Ocean. Tohoku Univ. Sci. Rep., 2nd.ser. (Geol.), vol.38, no.2, pp.193-219, 10 figs., 3 tables, pls.17-24.

Oberhauser, R.

1963 Die kreide im Ostalpenraum Osterreichs in mikropalaontologischer scht. Jb. Geol. Bund., pp.1-88.

Olsson, R,K.

1960 Foraminifera of latest Cretaceous and earliest Tertiary age in the New Jersey Coastal Plain. Jour. Paleont., vol.34, no.1, pp.1-58, pls.1-12.

1963 Latest Cretaceous and earliest Tertiary stratigraphy of New Jersey Coastal Plain. Amer. Assoc. Petrol. Geol. Bull., vol.47, no.4, pp.643-665, 6 figs., 3 tables.

1964 Late Cretaceous planktonic Foraminifera from New Jersey and Delaware. Micropaleont., vol.10, no.2, pp.157-188, pls.1-7.

1965 Planktonic Foraminifera, paleoecology, paleogeography and correlation. Amer. Assoc. Petrol. Geol. Bull., vol.49, no.3 pt.1, p.355 (Abstract)

Olvera, Y.E.

1959 Foraminiferos del Cretacico superior de la Cuenca de Tampico-Tuxpan, Mexico. Asoc. Mex. Geol. Petrol., Bol., vol.11, no.3-4, pp.101-102, pl.4, fig.15; pl.5, figs.1-2.

Omara, S.

1955 Facies analysis of the Upper Cretaceous and basal Eocene of the Nezzazat area (east coast of the Gulf of Suez, Egypt) based on percentage of characteristic foraminiferal families and genera. Bull. Fac. Sci., Cairo, vol.33, pp.83-87.

Orbigny, A. d'

*1839 In: R. de la Sagra. "Histoire physique, politique et naturelle de l'ile de Cuba". Paris: A. Bertrand. pp.1-224, vol.2, pp.1-224, pls.1-12 (in atlas).

*1840 Memoire sur les Foraminiferes de la Craie Blanche du Bassin de Paris. Soc. Geol. France. Mem., vol.4, pt.1, pp.1-51, pls.1-4.

Orville, L., Bandy, O.L. and Ronald, L. Kolpack

1963 Foraminifera and sedimentological trends in the Tertiary section of Tecolote Tunnel, California. Micropaleont., vol.9 no.2, pp.117-170, 46 test-figs., 4 tables.

Osman, A.

1954 Upper Cretaceous Foraminifera of western Sinai. Bull. Fac. Eng., Cairo Univ., vol.1, pp.335-365.

1955 New Upper Cretaceous Foraminifera from western Sinai. Bull. Fac., Eng., Cairo Univ., vol.2, pp.323-340.

Owen, R.M.S. and Nasr, S.N.

1958 The stratigraphy of the Kuwait-Basrah area. Amer. Assoc. Petrol. Geol., (In: Habitat of Oil), spec.pub., pp.1252-1278, figs.1-6.

Pap, A. and Kupper, K.

1953 Die Foraminiferen fauna von Guttaring und Klein St. Paul (Karnten) S.B. Osterr. Akad. Wiss. Math. Naturwiss., Wien., vol.162, pp.31-48, 65-82, 345-357, pls.1-8.

Parker, F.L.

1948 Foraminifera of the continental shelf from the Gulf of Marine to Maryland. Mus. Comp. Zool. Bull., vol.100, no.2 pp.213-241.

1954 Distribution of the Foraminifera in the northeastern Gulf of Mexico. Harvard Coll., Mus. Comp. Zool. Bull., vol.111, no.10, pp.453-588, pls.1-13.

Peck, R.E.

1957 North American Mesozoic Charophyta. U.S. Geol. Surv. Prof. Paper., 294-A, pp.1-44.

Parker, F.L. and Athearn, W.D.

1959 Ecology of marsh Foraminifera in Poponesset Bay, Massachusetts Jour. Paleont., vol.33, pp.333-343, pl.50, 5 figs.

Perlmutter, N.M. and Todd, R.

1965 Correlation and Foraminifera of the Monmouth group (Upper Cretaceous) Long Island, N.Y. U.S. Geol. Surv. Prof. Paper 483-I, p.1-21, 8 pls.

Pessagno, E.A. Jr.

1960(a) Stratigraphy and micropaleontology of the Cretaceous and lower Tertiary of Puerto Rico. Micropaleont., vol.6, no.1, pp.87-110, pls.1-5, text-figs.1-2.

1960(b) Thin-sectioning and photographing smaller Foraminifera. Micropaleont., vol.6, no.4, pp.419-423, pls.1,2, text-figs. 1-3.

1962 The Upper Cretaceous stratigraphy and micropaleontology of south-central Puerto Rico. Micropaleont., vol.8, no.3, pp.349-368, pls.1-6.

1967 Upper Cretaceous planktonic Foraminifera from the western Gulf Coastal Plain. Paleontogr. Americana, vol.5, no.37, pp.345-445, pls.48-100, text-figs.1-63, tables 1-2.

1969 Upper Cretaceous stratigraphy of the Western Gulf Coast area of Mexico, Texas and Arkansas. Geol. Soc. Amer. Mem., 111, pp.1-139, 12 sheets.

Petri, S.

1962 Foraminiferos Cretaceous de Sergipe FFCLUSP, Bolet. no.265, Geol. no.20, pp.1-140, pls.1-21.

Phleger, F.B.

1951 Part 1 - Foraminifera distribution. In: Phleger, F.B. and Parker, F.L., Ecology of Foraminifera, northwest Gulf of Mexico. Geol. Soc. Amer. Mem., no.46, pp.1-88, pls.1-2, text-figs.1-33.

1954 Foraminifera and deep-sea research. Deep-sea Res., vol.2 pp.1-23.

1960 Ecology and distribution of Recent Foraminifera. Baltimore: Johns Hopking Press, pp.1-297, pls.1-11.

Plummer, H.J.

1927 Foraminifera of the Midway formation in Texas. Univ. Texas Bull., 2644, pp.1-206, pls.1-15.

1931 Some Cretaceous Foraminifera in Texas. Univ. Texas Bull., 3101, pp.109-203, pls.8-15.

Pokorny, V.

1963 Principles of zoological micropalaeontology. Earth Sciences, vol.1, 652 pp., 549 text-figs. (English translation, by Allen, K.A.)

Polski, W.

1959 Foraminiferal biofacies off the north Asiatic coast. Jour. Paleont., vol.33, no.4, pp.569-587, pl.78, text-figs.1-8.

Powers, R.W., Ramirez, L.F., Redmond, C.D. and Elberg, E.L., Jr.

1966 Geology of the Arabian Peninsula, sedimentary geology of Saudi Arabia. U.S. Geol. Surv. Prof. Paper, 560 - D., 147pp. pls.1-10, figs.1-14, 1 table.

Pozaryska, Krystyna

1954 O przeqodnich otwornicach Z Krady gorney Polski srodkowej. Warzawa. Acta Geol. Polonica, vol.4, no.2, pp.249-276, 1 pl.

1967 The Upper Cretaceous and Lower Paleogene in central Poland. Inst. Geol., vol.211, pp.41-44.

Pozarkski, W. and Witwicka, E.

1956 Globotruncana of the Upper Cretaceous in central Poland. Bull. Serv. Geol. Pologne, Warsqawa, vol.102, pp.5-30, (Polish with Russian and English summary)

*Quereau, E.C.

1893 Die Klippenregion von Iberg (Sihlthal). Beitr. Geol. Karte (Schweiz. Geol. Komm), no.33, pp.3-153, pl.5.

Rasheed, D.A.

1963 Some calcareous Foraminifera belonging to the families Rotaliidae, Globigerinidae, Globorotaliidae and Anomalinidae from the Cullygoody (Dalmiapuram) limestone, south India. Madras, Univ., Jour., vol.33, no.3, sec.B, pp.231-248, pls.1-4.

Rao, B.R., Mamgain, V.D. and Sastry, V.A.

1968 Globotruncana in Ariyalur group of Trichinopoly Cretaceous, south India. Geol. Soc. India, Mem. no.2, pp.18-29, pl.1-4

Rasheed, D.A. and Govindan, A.

1968 Upper Cretaceous Foraminifera from Vridhachalam, south India. Geol. Soc. India, Mem. no.2, pp.66-84, pls.1-8, text-figs.1-16

Reichel, M.

1938 Les Hantkeninides de la Scaglia et des Couches rouges (Cretace superieur). Eclogae Geol. Helv., vol.40 (1947), no.2, pp.391-409, pl.8, 11 text-figs.

1950 Observations sur les Globotruncana du gisement de la Breggia (Tessin). Eclogae Geol. Helv., vol.42 (1949), no.2, pp.596-617, pls.16-17, text-figs.1-7.

Reiss, Z.

1952 On the occurrence of Globotruncana calcareta Cushman 1927 in the Upper Cretaceous of Israel. Israel. Res. Council Bull., vol.2, no.3, pp.270-271, text-fig.1.

1955 Micropaleontology and the Cretaceous - Tertiary boundary in Israel. Geol. Surv. Israel, Jerusalem, vol.5, pp.105-109.

1957(a) The Bilamellidea, nov. superfam. and remarks on Cretaceous globorotaliids. Contr. Cushman Found. Foram. Res., vol.8, pt.4, pp.127-145, pls.18-20.

1957(b) Notes on Foraminifera from Israel. Bull. Res. Counc. Israel, 6B, pp.239-244.

1958(a) Classification of lamellar Foraminifera. Micropaleont. vol.4, no.1, pp.51-70, pls.1-5, tab.1.

1958(b) Notes on Foraminifera from Israel. Bull. Geol. surv., Israel 17, p.3-10, figs.1a-c.

1963 Reclassification of perforate Foraminifera. Ministry of Development, State of Israel, Geol. Survey. Bull., no.35, pp.5-11, pls.1-8.

Renz, H.H.

1942 Stratigraphy of northern South America, Trinidad and Barbados. 8th Amer. Sci. Congr., Pr. Geol. Sci., vol.4, pp.513-571.

Renz, O.

1936 Stratigraphische und mikropalaeontologische Untersuchung der Seaglia (Obere Kreide-Tertiar) im zentralen Appennin. Eclogae Geol. Helv., vol.29, no.1, pp.1-149, pls.1-15.

Renz, O., Luterbacher, H. and Schneider, A.

1963 Stratigraphisch - palaeontologische Untersuchungen im Albien und Cenomanien des Neuenburger Jura. Eclogae Geol. Helv., vol.56, no.2, pp.1073-1116, 4 figs., pls.1-9.

Resig, J.M.

1958 Ecology of Foraminifera of the Cruz Basin, California. Micropaleont., vol.4, no.3, pp.287-308, text-figs.1-16, 2 tables.

*Reuss, A.E.

1845 Die versteinerungen der bohmischen Kreideformation. Deutschland, E. Schweizerbart, Abth.1, pp.1-58, pls.1-13.

1854 Beitrage zur characteristik der Kreideschichten in der Ostalpen, besonders im Gosauthale und am Wolfgangsee. K. Akad. Wiss. Wien, Math. - Natur. Kl., Denkschr., Bd.7, pt.1, pp.1-156, pls.1-31.

Reyment, R.A.

1960 Notes on some Globigerinidae, Globotruncanidae and Globorotalliidae from the Upper Cretaceous and Lower Tertiary of Western Nigeria. Nigeria, Geol. Survey, Rec., (1957), pp.68-86, pls.15-17.

Romein, B.J.

1962 On the type locality of the Maestrichtian (Dumont 1849), the Upper boundary of that stage and on the transgression ofaa Maastrichtian S.L. in southern Limburg. Meded. geol. Stich., Maastricht/Limburg, (N.S.) no.15, pp.77-84, figs.1-5.

*Rzehak, A.

1891 Die Foraminiferenfauna der alttertiaren Ablagerungen von Bruderndorf in Niederosterreich, mit Berucksichtigung des angeblichen Kreidevorkommens von leitzersdorf. Vienn. Naturh. Hofmus., Bd.6, pp.1-12.

1895 Uber linige merkwuridige Foraminiferen aus dem Osterreichischen Tertiar: Ann. Naturh. Hofmus., Bd.10, pp.213-230, pls.6-7.

Sacal, V. and Debourle, A.

1957 Foraminiferes O'Aquitaine, 2nd partie: Peneroplidae a Victoriellidae. Soc. Geol. Frans. n.ser. Mem., no.78, pp.1-88, pls.1-35.

Said, E.

1949 Foraminifera of the northern Red Sea. Contr. Cushman Found. Foram. Res., spec.publ., no.26.

Said, R. and Barakat, M.G.

1957 Cenomanian Foraminifera from Gebel Asagil, northern Sinai, Egypt. Egypt. Jour. Geol. (Geol. Soc. Egypt.), vol.1, no.1, pp.65-83, pl.1.

Said, R. and Kenawy, A.

1956 Upper Cretaceous and Lower Tertiary Foraminifera from northern Sinai, Egypt. Micropaleont. vol.2, no.2, pp.105-173, pls.1-7, text-figs.1-6.

1957 Foraminifera from the Turonian rocks of Abu-Roash, Egypt. Contr. Cushman Found. Foram. Res., vol.8, pt.2, pp.77-79, 82-86, pl.13.

Said, R. and Kerdany, M.T.

1961 The geology and micropaleontology of the Farafra Oasis, Egypt. Micropaleont., vol.7, no.3, pp.317-336, pls.1,2.

Said, R. and Sabry, H.

1964 Planktonic Foraminifera from the type locality of the Esna shale in Egypt. Micropaleont., vol.10, no.3, pp.375-395, pls.1-3.

Saito, T.

1963 Miocene planktonic Foraminifera from Honshu, Japan. Tohoku Univ. Sci. Rep., vol.35, no.2, pp.123-209, 15 text-figs., 16 tables, pls.53-56.

Salaj, J.

1962 Mikrobiostratigraphische studien der Kreide in der Kridjna - und Manin - Einheit. Geol. Prace. Zosit., 62, pp.245-259, 2 tables.

1967 Zones planktiques Cretace et du Paleogene de Tunisie. First Plankt. Confr., Geneva, vol.2, pp.588-593, 2 tables.

Salaj, J. and Samuel, O.

1962 Mikrobiostratigraphische studien der Kreide in der Kridjna - und Manin - Einheit. Geol. Prace. Zosit., 62, pp.245-259 2 tables.

1963(a) Contribution to the stratigraphy of Cretaceous of the Klippen belt and Central West Carpathian. Geol. Sbornik, vol.14, no.1, 109-125 Bratislava.

1963(b) Mikrobiostratigrafia strednej a vrchnej Kriedy Z vychodnej casti bradlovcho pasma. Geol. prace. Zprovy 30, pp.93-112, Bratislava, 3 figs, 1 table, pls.6-8.

1966 Foraminifera der Westkarpaten - Kreide. Geol. Ustav Dionyza Stura, pp.1-291, pls.1-48, test-figs.1-18, tabs.1-37.

Sandidge, J.R.

1932 Foraminifera from the Ripley formation of western Alabama. Jour. Paleont. vol.6, no.3, pp.265-287, pls.41-44.

Sastry, M.V., Rao, B.R. and Mamgain, V.D.

1964 On the occurrence of Globotruncana in Ariyalur stage of Trichinopoly Cretaceous, south India.. Curr. Sci., vol.33, no.9, pp.275-276.

Scheibnerova, V.

1961 Microfauna strednej a vrehnej Kriedy bradloveho psma Zapadnych karpat na Slovensku. Acta Geol. Geogr. Univ. Comeniana, Geol., no.5, pp.3-108, pls.1-14 (in Czechoslova with Russian and English resume).

1962 Stratigraphy of the Middle and Upper Cretaceous of mediterranean province on the basis of Globotruncanids. Geol. sborn. vol.13, no.2, pp.197-226, 7 figs.

1969 Middle and Upper Cretaceous microbiostratigraphy of the Klippen Belt, West Carpathians. Acta. Geol. Geogr. Univ. Comeniana., Geol. no.17, pp.5-98, pls.1-20, figs.1-28, 3 tables (in Czechoslova and English).

Schijfsma, E.

1946 The Foraminifera from the Hervian (Campanian) of southern Limburg. Netherlands Geol. Stichting. Medad., ser.C, sect.5, no.7, pp.1-174, pls.1-10, text-figs.1-5.

1955 La position stratigraphique de Globotruncana helvetica Bolli en Tunisie. Micropaleont., vol.1, no.4, pp.321-334, text-figs.1-13.

Schlanger, S.O.

1965 Dolomite - Evaporite relations on Pacific islands. Tohoku Univ. Sci. Rep., 2nd ser. (Geol.), vol.37, no.1, pp.15-29, 9 figs.

Schmidt, F., Hiltermann, H. and Koch, W.

1955 Biostratigraphie der Grenzschichten Maastrich/Campan in Luneburg und in der Bohrung Brunhilde. Geol. Jb. Bd.70, pp.339-384, 7 figs, 2 tables, pls.27-29.

Segerstrale, S.G.

1957 Baltic Sea. In: Hedgpeth, J.W., Ed., Treatise on marine ecology and paleoecology. vol.1, Ecology. Geol. Soc. Amer. Mem., vol.1, no.67, ch.24, pp.751-800, pls.1-4, text-figs. 1-21.

Seibold, E.

1964 Chemische bestandteile der marinen sedimente. Lehrbuch der Allgemeinen Geol., Enke, Stuttgart. pp.331-356.

Seiglie, G.A.

1959 Notas sabre algunas especies de Heterohelicidae del Cretacico Superior de Cuba. Bol. Assoc. Mex. Geol. Petrol., vol.11, nos.1-2, pp.51-62, pls.1-4, text-figs.1-41.

Shaw, A.B.

1953 Preliminary survey of the Foraminifera of the lower shale of the Niobrara formation in the Laramie Basin. Wyoming Geol. Assoc., 8th Ann. Field Confr., pp.47-55, 2 pls., 1 fig.

Shearman, D.J.

1966(a) Origin of marine evaporites by diagenesis. Applied earth Science, vol.75, pp.B208-B215.

1966(b) Origin of marine evaporites by diagenesis, (Report of discussion at 1966 general meeting). Reprint. Applied earth Science, vol.75, pp.B82-B86.

Shearman, D.J., Twyman, J. and Karimi Z.K.

1970 The genesis and Diagenesis of oolites. Geol. Assoc. 7062, in Press.

Shepard, F.P. and Moore, D.G.

1955 Central Texas coast sedimentation, characteristics of sedimentary environment, recent history and diagenesis. Amer. Assoc. Petr. Geol. Bull., vol.39, no.8, pp.1463-1593, figs.1-75.

Shifflett, E.

1961 Living, dead and total Foraminifera Heald Bank, Gulf of Mexico. Micropaleont., vol.7, no.1, pp.45-54.

Sigal, J.

1948 Notes sur les genres Foraminiferes Rotalipora Brotzen, 1942 et Thalmanninella. Instit. France. Petrol. Rev., vol.3 no.4, pp.95-103, pls.1-2.

1952 Apercu stratigraphique sur la micropaleontologie dueCretace. 19th Congr. Geol. Internat., Monogr. Reg., Alger, ser.1, no.26, pp.1-42, text-figs.1-46.

1955-1956 Notes micropaleontologiques nord africains. Soc. Geol. France, C.R. Somm.

1955(a) 1 - Du Cenomanien au Santonien: zones et limites en facies pelagiques, no.7-8, pp.157-160.

1955(c) 3 - Rosalines a une carene du Cenomanien et du Senonien inferieur, no.11-12, pp.226-227.

1956(a) 4 - Biticinella breggiensis (Gandolfi), no.3, pp.35-36, 1 fig.

1956(b) 5 - A propos de Globotruncana helvetica Bolli. no.3, pp.36-37.

1958 La classification actuelle des familles de Foraminiferes planctoniques du cretace. Soc. Geol. France. C.R. Somm., no.12, pp.262-265.

1966 Contribution a une monographic des Rosalines. 1. le genre Tianella Reichel souche des Rotalipores. Eclogae Geol. Helv., vol.59, no.1, pp.185-218, pls.1-6.

1967 Essai sur l'etat actuel d'une zonation stratigraphique a l'aide de principales especes de Rosalines (Foraminiferes). Soc. Geol. France C.R. Somm., no.2, p.48, 1 fig., Paris.

Skinner, H.C.

1962 Arkadelphia Foraminiferida. Tulane Stud. Geol., vol.1, no.1, 72 pp., 6 pls., 2 text-figs.

Sluis, J.P. van der

1950 Geology of east Seran, In: Rutten, L. and Hotz, W., no.3, ser.3 (Geol.), no.3, pp.7-66, 1 fig., 1 map, pls.1-2, Amsterdam.

Smith, F.D.

1955 Planktonic Foraminifera as indicators of depositional environment. Micropaleont., vol.1, no.2, pp.147-151, 2 text-figs.

Smitter, Y.H.

1955 Foraminifera from the Upper Cretaceous beds occurring near the Itongazi River, Natal. Palaeontologia Afric. Univ. Witwatersrands, Pal. Res., vol.3, pp.103-107, fig.38.

1957 Upper Cretaceous Foraminifera from Sandy Point, St. Lucia Bay, Zululand. So. Afric. Sci., vol.53, no.7, pp.195-201, figs.1-26.

Smout, A.H.

1958 Typical fossils of Basrah area. In: Owen and Nasr 1958, Habitat of Oil. Amer. Assoc. Petrol. Geol., spec. pub. 1 range chart.

Stainforth, R.M.

1948 Description, correlation and paleoecology of Tertiary Cipero marl formation, Trinidad. Amer. Assoc. Petrol. Geol. Bull., vol.32, no.7, pp.1292-1330, 2 text-figs.

1952 Ecology of arenaceous Foraminifera. Micropaleont., vol.6, no.1, pp.42-44.

Steineke, M. and Bramkamp, R.A.

1952 Mesozoic rocks of eastern Saudi Arabia (Abstract). Amer. Assoc. Petrol. Geol. Bull., vol.36, no.5, p.909.

Steineke, M., Bramkamp, R.A. and Sander, N.J.

1958 Stratigraphic relations of Arabian Jurassic Oil. Amer. Assoc. Petrol. Geol., spec.pub., (In: Habitat of Oil) pp.1294-1328, figs.1-6, 1 table.

Stelck, C.R. and Wall, J.H.

1954 Kaskapau Foraminifera from Peace River area of western Canada. Res. Council of Alberta, Rept.no.68, pp.1-38, pls.1-2, 4 text-figs.

Stenestad, E.

1967 The genus Heterohelix Ehrenberg 1843 (Foraminifera) from the Senonian of Denmark. First, Plank. Confr., Geneva, pp.644-661, figs.1-15, pls.1-3.

Subbotina, N.N.

1953 Fossil Foraminifera from U.S.S.R., Globigerinidae, Hantkeninidae and Globorotaliidae. Trudy, Vses. Neft. Nachno-Issled.Geol. Razved. Inst., n.ser., no.76, pp.1-296, pls.1-41 (Russian).

1964 Foraminifera from Cretaceous and Paleogene deposits of the west Siberian lowland. Turdy Vses. Neft. Nachno-Issled.Geol. Razved.Inst., no.234, 321 pp., pls.I-LXVI.(Russian).

Takahashi, J.

1939 Synopsis of glauconitization, Recent marine sediments, Tulsa. Amer. Assoc. Petrol. Geol. Bull., pp.503-512.

Takayanagi, Y.

1960 Cretaceous Foraminifera from Hokkaido, Japan. Tohoku Univ., Sci. Rep., 2nd ser.(Geol.),vol.32, no.1, pp.1-154, 22 figs. 12 tables, pls.1-11.

1965 Upper Cretaceous planktonic Foraminifera from the Putah Creek subsurface section along the Yolo-Solano county line, California. Tohoku Univ., Sci. Rep., 2nd ser.(Geol.), vol.36, no.2, pp.161-237, pls.20-29, text-figs.1-9.

Takayasu, Uchio

1960 Ecology of living benthonic Foraminifera from the San Diego, California area. Contr.Cushman Found.Foram.Res., spec. pub. no.5, 72 pp., pls.1-10, 9 tables.

Tappan, H.

1940 Foraminifera from the Grayson formation of northern Texas. Jour. Paleont., vol.14, no.2, pp.93-126, pls.14-19.

1943 Foraminifera from the Duck Creek formation of Oklahoma and Texas. Jour. Paleont., vol.17, no.5, pp.476-517, pls.77-83.

1951 Northern Alaska index Foraminifera. Contr. Cushman Found. Foram. Res., vol.2, pt.1, pp.1-8, pl.1.

1960 Cretaceous biostratigraphy of northern Alaska. Amer. Assoc. Petrol. Geol. Bull., vol.44, no.3, pt.1, pp.273-297, pls.1-2, text-figs.1-7.

1962 Foraminifera from the Arctic slope of Alaska. Part 3, Cretaceous Foraminifera. U.S. Geol. Surv. Prof. Paper no.236-C, pp.91-209, pls.29-58, text-figs.10-18.

Taylor, D.J.

1964 Foraminifera and the stratigraphy of the western Victorian Cretaceous sediments. Roy. Soc. Victoria, Proc., vol.77, pt.2, pp.535-602, 8 pls., 7 figs.

Ten Dam, A. and Sigal, J.

1949 Sur une espece nouvelle du genre de Foraminiferes Biglobigerin erinella Lalicker 1948. Soc. Geol. France, C.R. Somm., Paris, no.11, pp.234-235, 1a-c,2,3.

Thalmann, H.E.

1932 Die Foraminiferen - Gattung Hantkenina Cushman, 1924, und ihre regional - stratigraphische Verbreitung. Eclogae Geol. Helv., vol.25, no.2, pp.287-292.

1942 The genus Globotruncana and its species. Amer. Assoc. Petr. Geol., Ann. Convention. (27th Denver, April 1942, Program). pp.51-52 (Not valid publication). (In: Ellis, F. and Messina, R., Catalogue of Foraminifera, Supplement no.2, 1958.).

1945 Bibliography and index to new genera, speciés and varieties of Foraminifera for the year 1942. Jour. Paleont., pp.396-410.

1946 Additional homonyms in Foraminifera erected since 1940. Contr. Cushman Found. Foram. Res., vol.22, pt.4, pp.123-132.

1947(a) Index to new genera, species and varieties of Foraminifera for the year 1945. Jour. Paleont., vol.21, no.4, pp.385-386.

1947(b) Nitteilungen ubr Foraminifera V; 23. Eclogae Geol. Helv., vol.39, no.2, pp.309-312.

1959 New names for foraminiferal homonym Iv. Contr. Cushman Found. Foram. Res., vol.10, pt.4, pp.130-131.

Thomas, N.L. and Rice, E.M.

1927 Changing characters in some Texas species of Gumbelina. Jour. Paleont., vol.1, pp.141-144, 1 text-figure.

Tilev, N.

1951 Etude des Rosalines Maestrichtiennes (genre Globotruncana) du sud-est de la Turquie (Sondage de Romandag). Lausanne Univ., Mus. Geol., Lab. Geol., Min., Geophys. Bull., no.103, pp.1-101, pls.1-3.

1953 Etude des Rosalines Maestrichtiennes (genre Globotruncana) du sud-est de la Turquie (Sondage de Romandag). Bull. Lab. Geol. Min. Geophys. Mus. Geol. Univ. Lausanne, vol.103, 101 pp., pls.1-3.

Todd, R. and Low, D.

1964 Cenomanian (Cretaceous) Foraminifera from the Puerto Rico Trench. Deep-sea Research, vol.11, pp.395-414, pls.1-4.

Tollmann, A. von

1960 Die foraminiferen des Oberconiac aus der Gosau des Ausseer Weinenbach.tales in Steiermark. Jb. Geol. Bund., vol.103, pp.133-203, pls.1-21.

Tourtelot, H.A.

1962 Preliminary investigation of the geologic setting and chemical composition of the Pierre shale, Great Plains region. U.S. Geol. Surv., Prof. Paper 390, 74 pp., 4 pls., 22 figs.

Troelsen, J.C.

1955 Globotruncana contusa in the White Chalk of Denmark. Micropaleont., vol.1, no.1, pp.76-82, text-figs.1,2.

Trujillo, I.

1960 Upper Cretaceous Foraminifera from near Redding, Shasta County, California. Jour. Paleont., vol.34, no.2, pp.290-346, pls.43-50.

*Tutkovski, P.A.

1887 (Foraminifera of the Tertiary and Cretaceous deposits of Kiev; II - Foraminifera of the bluish clay from Podol borings) (Russian) Soc. Nat. Kieft, Mem., Kiev, vol.9, no.1-2 pp.1-62, pls.1-9.

1925 Die fossilen microfaunen der Ukraine, ihre geologische Bedeutung und ihre Untersuchungsmethoden, part.1, Akad. Sci. Ukraine, cl.Sci. Phys. Math., Mem., tome 1, fasc.8, pp.3-24, pls.1-42.

Twenhofel, W.H.

1950 Principles of sedimentation. 2nd Ed., New York, McGraw-Hill. 585 pp.

Upshow, C.F. and Stehli, F.G.

1962 Quantitative biofacies mapping. Amer. Assoc. Petrol. Geol. Bull., vol.46, no.5, pp.694-699.

Urey, H.C., Lowestam, H.A., Epstein, S. and McKinney, C.R.

1951 Measurement of paleotemperatures and temperatures of the Upper Cretaceous of England, Denmark and the southeastern United States. Geol. Soc. Amer. Bull., vol.62, no.4, pp.399-416, pl.1, text-fig.1.

Vassilenko, V.P.

1961 Foraminifery Verkhnego mela poluostrova Mangyshlaka (Opisanie, skhemy filogenii nekotorykh grupp i stratigrafischeskii analiz). Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. (VNIGRI), Trudy, no.171, pp.1-487, pls.1-41, text-figs.1-40 (Russian).

Visser, A.M.

1951 Monograph of the Foraminifera of the type-locality of the Maestrichtian (south Limburg, Netherlands). Leidse Geol. Med., vol.16, pp.197-359, pls.1-16.

Vogler, J.

1941 Betirage zur Geologie von Niederlandisch - Indien: Ober Jura and Kreide von Misol. Palaeontographica. Suppl., vol.4 Abt.4, pp.245-293, pls.1,2, text-figs.1-13.

Voigt, E.

1965 Zur Temperatur - Kurve der Oberen Kreide in Europa. Geol. Rundsch., vol.54, pp.270-317, figs.1-12.

Voorwijk, G.H.

1937 Foraminifera from the Upper Cretaceous of Habana, Cuba. Kon. Akad. Wetensch. Amsterdam, Proc., vol.40, no.2, pp.190-198, pls.1-3.

Wall, J.H.

1967 Cretaceous Foraminifera of the Rocky Mountain foothills, Alberta. Alberta Res., Council, Bull., no.20, pp.1-185, pls.1-19, text-figs.1-4.

Walton, W.R.

1955 Ecology of living benthonic Foraminifera, Todos Santos Bay, Baja California, Mexico, Jour. Paleont., vol.29, pp.952-1018, pls.99-104.

1964 Recent Foraminiferal ecology and paleoecology. In: J. Imbrie and N. Newell, Approaches to paleoecology, pp.151-237.

Weiss, L.

1955 Planktonic index Foraminifera of northwestern Peru. Micropaleont. vol.1, no.4, pp.301-319, pls.1-3, text-fig.1

Wessem, A. van

1943 Geology and paleontology of central Camaguey, Cuba. Utrecht. Univ., Geogr. Geol. Meded., Physiogr. - geol. Reeks, ser.2, no.5, pp.1-90, pl.1-3.

Wheeler, H.E.

1958 Primary factors in biostratigraphy. Amer. Assoc. Petrol. Geol. Bull., vol.42, no.3, pp.640-655, 4 figs.

White, M.P.

1928(a) Some index Foraminifera of the Tampico Embayment area of Mexico. pt.1, Jour. Paleont., vol.2, no.3, pp.177-215, pls.27-29.

1928(b) Some index Foraminifera of the Tampico Embayment area of Mexico. pt.2, Jour. Paleont., vol.2, no.4, p.280-317, pls.38-42.

1929 Some index Foraminifera of the Tampico Embayment area of Mexico. pt.3, Jour. Paleont., vol.3, no.1, pp.30-58, pls.4-5.

Wicher, C.A. and Bettenstaedt, F.

1957 Zur Oberkreide - Gliederung der bayerischen Innviertal - Bohrungen. Geol. Bavarica, no.30, pp.3-54, text-figs.1-3.

Wille-Janoschek, U.

1966 Stratigraphie und tektonik der schichten der Oberkreide und des Alttertiars im Raume von Gosau und Abtenau (Salzburg). Jb. Geol. Bund. Sond.109, pp.91-172, 3 figs., pls.1-11.

Williams-Mitchell, E.

1948 The zonal value of Foraminifera in the chalk of England. Geol. Assoc., Proc., vol.59, pt.2, pp.91-112, pls.8-10.

Witwicka, E.

1958 Micropaleontological stratigraphy of Upper Cretaceous of the Chelm Borehole (Lublin Upland). Inst. Geol. Biul. 121, Warszawa, vol.3, pp.117-267, pls.1-14.

Wood, A.

1949 The structure of the wall of the test in the Foraminifera; its value in classification. Quart. Geol. Soc., London, vol.104, pp.229-255, pls.13-15.

*Yakovlev, V.

1891 Description de quelques especes des Foraminiferes Cretaces. Kharkov, Univ., Trudy, (1890), vol.24, pp.341-364, pls.1-3.

Yoshida, S.

1967 Biostratigraphic significance of late Cretaceous to early Tertiary planktonic Foraminifera in Japan. First Plankt. Confr., Geneva, vol.2, pp.715-721, 3 figs., 3 tables.

Young, K.

1951 Foraminifera and stratigraphy of the Frontier formation. (Upper Cretaceous) southern Montana. Jour. Paleont., vol.25, no.1, pp.35-68, 6 figs., pls.11-14.

Zakharova - Atabekyan, L.V.

1961 Krevizii sistematik; Globotruncanids; predlozhenie novogo roda Planogyrina gen. nov. Armyanskov S.S.R., Akad. Nauk Doklady, vol.32, no.1, pp.49-53, (Russian with Armenian summary)

Ziegler, J.H.

1957 Die Fauna des Cardientones der Oberpfalz und die bedeutung der Foraminiferen fur seine Altersbestimmung (Coniac) Geol. Bavarica, no.30, pp.55-86, 3 tables, pl.1.

ZoBell, C.E.

1942 Changes produced by microorganisma in sediments after deposition. Jour. Sed. Petrology., vol.12, no.3, pp.127-136, 1 fig.

1946 Studies on redox potential of marine sediments. Amer. Assoc. Petrol. Geol. Bull., vol.30, no.4, pp.477-513, 5 figs.

* Taken directly from Ellis, F and Messina, R; "Catalogue of Foraminifera" 1940 et.seq.

- 0 -

PLATE 1

Fig. 1 — Guembelitria cretacea Cushman.(X135) Tayarat formation, R.W18

Fig. 2 — Guembelitria trilocula (Marie).(X210), Tanuma formation, Z.W8

Fig. 3 — Heterohelix cf. barnardi (Ansary).(X62), Tanuma formation,Z.W8

Fig. 4 — Heterohelix cf. globocarinata (Cushman).(X170), Sadi formation, Z.W8.

Figs.5,6 — Heterohelix moremani (Cushman).(X190), Khasib formation, Z.W8

Figs.7,8 — Heterohelix nakkadyi sp.nov., Holotype, Tanuma formation, Z.W8. Fig.7 (X370), Fig.8 (X157).

PLATE 2

Figs.1-3 — Heterohelix nakkadyi sp.nov. Paratypes, Tanuma formation, Z.W8, Fig.1 (X145), Fig.2 (X125), Fig.3 (X130).

Figs.4-8,9 — Heterohelix nuttalli (Voorwick) X Z.W8. Figs.4,7-8 (X135). From Qurna formation; Figs.5-6 (X215) and Figs.9 (X545) from Sadi formation.

PLATE 3

Figs.1,5 — Heterohelix planata (Cushman).(X180), Tanuma formation, R.W18

Fig.2 — Heterohelix pseudoguembeliniformis sp.nov.(X220), Holotype, Khasib formation, Z.W8

Figs.3-4 — Heterohelix pseudoguembeliniformis sp.nov. Paratypes, Khasib formation, Z.W8. Fig.3 (X225), Fig.4 (X130)

Figs.6-9 — Heterohelix pulchra (Brotzen).(X180), Khasib formation Z.W8.

PLATE 4

Figs.1-4 — Heterohelix pulchra (Brotzen). Tanuma formation R.W18. Figs.1-2(X200), Fig.3(X175), Fig.4(X260).

Fig. 5 — Heterohelix punctulata (Cushman).(X62) Qurna formation, Z.W8

Figs.6-8,9 — Heterohelix reussi (Cushman). Figs.6-9(X135), Sadi formation Z.W8. Figs.7-8(X240), a Juvenile form from Khasib formation.

PLATE 5

Fig. 1 — Heterohelix reussi (Cushman).(X150), Khasib formation, R.W18

Fig. 2 — Heterohelix robusta Stenestad.(X210), Tanuma formation, Z.W8

Fig. 3 — Heterohelix ? semicostata (Cushman).(X100), Sadi formation, Z.W8

Figs.4-7,9 — Heterohelix striata (Ehrenberg). Sadi formation, Z.W8, Figs.4-5(X215), Figs.6-7,9(X250).

Figs.8,10 — Heterohelix ultimatumida (White).(X143), Qurna formation, Z.W8

PLATE 6

Fig. 1 — Heterohelix striata aegyptiaca Ansary and Tewfik.(X130), Khasib formation, R.W18

Figs.2-3 — Heterohelix ultimatumida (White).(X110), Qurna formation, R.W18.

Figs.4-5 — Heterohelix sp. (X135), Sadi formation, Z.W8

Fig. 6 — Gublerina glaessneri Bronnimann and Brown.(X160), Sadi formation, Z.W8.

Fig. 7 — Gublerina ? reniformis (Marie).(X205), Tanuma formation, Z.W8

Fig. 8 — Gublerina cuvillieri Kikoine.(X100), Qurna formation, R.W18.

Fig. 9 — Gublerina sp.A. (X90), Tanuma formation, Z.W8.

Figs.10-12 — Pseudoguembelina palpebra Bronnimann and Brown. Qurna formation, Z.W8. Fig.10(X90), Figs.11-12(X100).

PLATE 7

Fig. 1 — Pseudoguembelina costulata (Cushman).(X580) From pl.8, fig.3

Fig. 2 — Gublerina ? reniformis (Marie).(X685). From pl.6, fig.7

PLATE 8

Fig. 1 — Pseudoguembelina excolata (Cushman).(X160), Tayarat formation R.W18

Figs.2-3,6-7 — Transitional stage between Pseudoguembelina costulata (Cushman) and Pseudoguembelina excolata uppermost Hartha formation, Z.W8, Figs.2-3(X125), Figs.6-7(X112).

Figs.4-5 Pseudoguembelina costulata (Cushman). Sadi formation, Z.W8 Fig.4(X110), Fig.5(X160).

Fig. 8 Pseudoguembelina zubairensis sp.nov. (X160), Holotype, Sadi formation, Z.W8

Figs.9-10 Pseudoguembelina zubairensis sp.nov. (X120), Paratypes, Sadi formation, Z.W8

Figs.11-13 Pseudoguembelina palpebra Bronnimann and Brown. (X100), Tayarat formation, R.W18.

P L A T E 9

Fig. 1 Pseudoguembelina pseudocarinata sp.nov. (X130) Holotype, Sadi formation, Z.W8.

Figs.2-3 Pseudoguembelina pseudocarinata sp.nov. (X175), Paratypes, Sadi formation, Z.W8.

Fig. 4 Pseudoguembelina sp. cf. Ps. pseudocarinata. (X170), Sadi formation, Z.W8.

Figs.5-6 Pseudotextularia plummeri (Loetterle).(X112), Sadi formation, Z.W8.

Figs.7-8 Sigalia deflaensis (Sigal). Fig.7(X150), from Khasib formation, Z.W8, Fig.8(X180) from Tanuma formation, R.W18.

Fig. 9 Genus Chilloguembelinella gen.nov. (X165), Sadi formation, Z.W8

Figs.10-11 Sigalia carpatica Salaj and Samuel.(X182), Z.W8, Fig.10, a juvenile form from Tanuma formation, Fig.11 from Sadi formation.

P L A T E 10

Figs.1,4 Sigalia carpatica Salaj and Samuel.(X165). Sadi formation,Z.W8

Figs.2-3 Sigalia carpatica var.1 var.nov.(X126), Sadi formation, Z.W8, Fig.2, Holotype, Fig.3, Paratype.

Fig. 5 Sigalia sp. cf. S. decoratissima (de Klasz).(X160) Sadi formation, Z.W8.

+ Fig.6 Sigalia sp.A.(X147), Tanuma formation, Z.W8.

Figs.7-9,11 Sigalia decoratissima (de Klasz) Sadi formation, Z.W8. Figs.7-9(X115), Fig.8(X150), Fig.11(X108)

Fig.10 Transitional with an as yet unknown, smooth "Sigalia decoratissima-type" form.(X120), Sadi formation, Z.W8.

P L A T E 11

Fig. 1 Sigalia deflaensis (Sigal).(X600) From pl.9, Fig.7.

Fig. 2 Sigalia carpatica Salaj and Samuel.(X500). From pl.9, Fig.10.

Fig. 3 Sigalia decoratissima (de Klasz).(X670), From pl.10, Fig.7.

Fig. 4 Sigalia carpatica Salaj and Samuel.(X520). From pl.9, Fig.11

P L A T E 12

Figs.1-4 Ventilabrella ornatissima Cushman and Church. Figs.2-3(X86), Sadi formation, R.W18; Figs.1,4 (X152), Tanuma formation, Z.W8.

Figs.5,7-8 Ventilabrella glabrata Cushman. Sadi formation, Z.W8, Fig.5 (X90), Figs.7-8(X80).

Fig. 6 Ventilabrella tricamerata sp.nov.(X146), Khasib formation Z.W8.

Fig. 9 Ventilabrella cf. eggeri Cushman.(X155), Tanuma formation,R.W18

Figs.10-11 Biglobigerinella sp.(X230), Sadi formation, Z.W8.

P L A T E 13

Fig. 1 Globigerinelloides bentonensis (Morrow).(X250), Khasib formation, Z.W8.

Figs.2-3 Globigerinelloides asperum (Ehrenberg). Khasib formation, R.W18, Fig.2(X150), Fig.3(X218).

Figs.4-6 Globigerinelloides turorensis (Bronnimann).(X216), Tanuma formation, Z.W8.

Figs.7-9 Planomalina sp.A. sp.nov. Tanuma formation, Z.W8. Fig.7(X250), Holotype; Figs.8-9(X210), Paratypes.

P L A T E 14

Fig. 1 Globigerinelloides sp.aff. Gl. japanica (Takajanagi).(X155), Tanuma formation, Z.W8.

Fig. 2 Globigerinelloides cushmani (Tappan).(X150), Khasib formation, Z.W8.

Fig. 3 Globigerinelloides prairiehillensis Pessagno.(X225), Sadi formation, Z.W8

Figs.4-6 Globigerinelloides sp.A. sp.nov. Tanuma formation, Z.W8. Fig.4(X165), Holotype; Figs.5(X260) and 6(X135), Paratypes.

Figs.7-9 Globigerinelloides pinguis (Herm).(X120), Sadi formation, Z.W8

Figs.10-11 Globigerinelloides messinae voluta (White).(X175), Sadi formation, Z.W8.

Fig.12 Globigerinelloides messinae messinae (Bronnimann).(X160), Sadi formation, R.W18.

P L A T E 15

Figs.1-3 Globigerinelloides sp.A. var.1. var.nov. Sadi formation,Z.W8. Fig.1(X210), Holotype; Fig.2 (X210) and Fig.3(X220) Paratypes.

Figs.4-5 Globigerinelloides sp.B sp.nov. Tanuma formation, R.W18. Fig.4(X195), Holotype; Fig.5(X200) Paratype.

Fig. 6 Biglobigerinella multispina Lalicker.(X225) Sadi formation, Z.W8.

Figs.7-8 Globigerinelloides sp., Sadi formation, Z.W8. Fig.7(X140), Fig.8(X165).

Figs.9-10 Biglobigerinella algeriana Ten Dam and Sigal.(X230) Sadi formation, Z.W8.

P L A T E 16

Figs.1-3 Biglobigerinella sp.1 sp.nov. Sadi formation, Z.W8. Fig.1 (X160) and Fig.3(X165) Paratypes; Fig.2(X150) Holotype.

Figs.4-5 Hedbergella brittonensis Loeblich and Tappan.(X120), Khasib formation, Z.W8.

Fig. 6 Hedbergella amabilis Loeblich and Tappan.(X105), Khasib formation, R.W18.

Figs.7-8 Hedbergella gautierensis (Bronnimann).(X165), Khasib formation, Z.W8.

Fig. 9 Clavihedbergella cf. simplex. (Morrow).(X125), Khasib formation, Z.W8.

Figs.10-12 Hedbergella planispira (Tappan).(X160), Tanuma formation, Z.W8.

PLATE 17

Figs.1-3 Hedbergella aff. paradubia (Sigal) Khasib formation, Z.W8. Figs.1-2(X150), Fig.3(X112).

Figs.4-7 Hedbergella planispira (Tappan). Figs.4-6(X150), Khasib formation, Z.W8; Fig.7(X160) Tanuma formation, R.W18.

Figs.8-10 Hedbergella delrioensis (Carsey).(X135) Sadi formation, R.W18.

Fig.11 Hedbergella hessi Bolli.(X112), Sadi formation, Z.W8

Fig.12 Hedbergella praehelvetica (Trujillo).(X90) Khasib formation, Z.W8.

PLATE 18

Figs.1-4 Praeglobotruncana inornata (Bolli). Figs.1-3(X165), Sadi formation, R.W18; Fig.4(X130), Sadi formation, Z.W8

Figs.5-6 Hedbergella crassa (Bolli).(X300) Sadi formation, Z.W8

Figs.7-9 Praeglobotruncana wilsoni (Bolli).(X145) Sadi formation, Z.W8.

PLATE 19

Figs.1-2 Praeglobotruncana coarctata Bolli.(X110) Khasib formation, Z.W8.

Fig. 3 Globotruncana obliqua Herm.(X110), Khasib formation, Z.W8

Figs.4-6 Globotruncana bulloides cf. austinensis Pessagno. Sadi formation, Z.W8. Figs.4-5(X115), Fig.6(X140).

Figs.7-9 Globotruncana aegyptiaca aegyptiaca Nakkady. Figs.7-8(X110, Harth formation, Z.W8; Fig.9(X105), Qurna formation, R.W18.

Figs.10-12 Globotruncana aegyptiaca duwi Nakkady. Qurna formation, Z.W8. Figs.10-11(X120), Fig.12(X115).

PLATE 20

Figs.1-2 Globotruncana coldreriensis Gandolfi.(X125), Khasib formation, Z.W8

Figs.3,6 Globotruncana cf. angusticarenata Gandolfi.(X110) Sadi formation, Z.W8.

Figs.4-5 Globotruncana bulloides bulloides Vogler.(X100), Khasib formation, Z.W8.

Figs.7-10 Globotruncana concavata primitiva Dalbiez. Figs.7-8(X145 Khasib formation, R.W18; Figs.9-10 (X150) Tanuma formation, Z.W8.

Figs.11-12 Globotruncana arca (Cushman).(X85), Harth formation, Z.W8.

PLATE 21

Figs.1-3 Globotruncana concavata dentata sp.nov.(X115) Sadi formation, Z.W8. Fig.1, Holotype; Figs.2-3 Paratypes.

Figs.4-6 Globotruncana concavata repanda Bolli. Sadi formation, Z.W8. Figs.4-5(X150); Fig.6(X138).

Figs.7-8 Globotruncana concavata carinata Dalbiez. Sadi formation Z.W8. Fig.7(X200); Fig.8(X170)

Fig. 9 Globotruncana marginata (Reuss).(X100) Sadi formation, R.W18

Figs.10-11 Globotruncana concavata concavata (Brotzen).(X130), Tanuma formation, Z.W8.

PLATE 22

Figs.1-3 Globotruncana coronata Bolli.(X100) Khasib formation, Z.W8

Figs.4-5 Globotruncana cretacea (d'Orbigny) Khasib formation, Z.W8. Fig.4(X210), Fig.5(X280).

Figs.6-8, 10-11 Globotruncana fornicata cesarensis Gandolfi. Figs.6-7(X112), Sadi formation, Z.W8; Fig.8(X180)and Figs.10-11(X130) Sadi formation,R.W18

Fig. 9 Globotruncana fornicata fornicata Plummer.(X100) Tanuma formation, Z.W8.

PLATE 23

Figs.1-4 Globotruncana renzi Gandolfi.(X125) Khasib formation, Z.W8.

Figs.5-6,9-10 Globotruncana fornicata fornicata Plummer. Figs.5-6(X100), Sadi formation, R.W18; Fig.9(X100)and Fig.10(X75) Hartha formation, R.W18.

Figs.11-12 Globotruncana marginata (Reuss).(X150) Sadi formation, Z.W8.

P L A T E 24

Figs.1-3 Globotruncana linneiana linneiana (d'Orbigny).(X150) Tanuma formation, Z.W8.

Figs.4-5 Globotruncana linneiana tricarinata (Quereau).(X105) Tanuma formation, Z.W8.

Figs.6-7 Globotruncana schneegansi Sigal.(X82), Khasib formation, Z.W8

Figs.10-12 Globotruncana gansseri pettersi Gandolfi. Tayarat formation, Z.W8. Figs.10,12(X110), Fig.11(X100).

P L A T E 25

Figs.1-2 Globotruncana ventricosa White.(X115), Tanuma formation,Z.W8

Figs.3-4 Transitional stage between Globotruncana stuarti stuarti (de Lapparent) and Globotruncana conica White. (X105), Qurna formation, Z.W8.

Figs.5-6 Rugoglobigerina bulbosa Belford. Sadi formation, R.W18. Fig.5(X90), fig.6(X110).

Figs.7-10 Rugoglobigerina macrocephala macrocephala Bronnimann. Sadi formation, Z.W8. Fig.7(X100), Fig.8 (X120), Fig.9(X140), Fig.10(X162).

Figs.11-12 Rugoglobigerina loetterli Nauss. Tanuma formation, Z.W8. Fig.11(X126), Fig.12(X130).

P L A T E 26

Figs.1-3 Rugoglobigerina macrocepha ornata Bronnimann. Fig.1(X160) and Fig.2(X165) Tanuma formation, Z.W8; Fig.3(X260) Qurna formation Z.W8.

Figs.4-7 Rugoglobigerina rugosa (Plummer). Sadi formation Z.W8. Fig.4 (X130), Fig.5(X290), Fig.6(X125), Fig.7(X135).

Fig. 8 Rugoglobigerina plana Belford.(X110) Sadi formation, Z.W8.

Figs.9-10 Rugoglobigerina tradinghousensis Pessagno.(X125) Tanuma formation, Z.W8.

PLATE 27

Figs.1-3 Globotruncana fornicata plana sp.nov.(X100) Holotype. Tanuma formation, Z.W8.

Figs.4-6 Globotruncana aegyptiaca var.1 Nakkady.(X105), Tayarat formation, Z.W8.

Figs.7-8 Globotruncana contusa Cushman.(X88) Qurna formation, Z.W8.

Fig. 9 Gublerina cuvillieri Kikoni.(X110) Qurna formation, R.W18.

Fig.10 Heterohelix cf. glabrans (Cushman).(X165) Qurna formation, Z.W8.

Fig.11 Pseudotextularia elegans Cushman.(X100) Qurna formation, Z.W8

Fig.12 Sigalia carpatica Salaj and Samuel.(X155) apertural view. Sadi formation, Z.W8.

PLATE 28

Figs.1-4 Globotruncana elevata (Brotzen).Figs.1-2(X100) Sadi formation Z.W8; Figs.3-4(X100) Hartha formation R.W18.

Figs.5-7 Globotruncana gansseri gansseri Bolli. Qurna formation, Z.W8. Figs.5-6(X100), Fig.7(X105).

Figs.8-10 Globotruncana gagnebini Tilev.(X100), Hartha formation, Z.W8.

Figs.11-12 Globotruncana imbricata Mornod.(X120) Tanuma formation, Z.W8

PLATE 29

Figs.1-2 Globotruncana leupoldi Bolli.(X100) Qurna formation Z.W8.

Figs.3-4 Rugoglobigerina pustulata Bronnimann.(X127) Tayarat formation Z.W8.

Figs.5-7 Globotruncana rosetta (Carsey). Figs.5-6(X120) Hartha formation, Z.W8; Fig.7(X110) Qurna formation, Z.W8.

Figs.8-10 Globotruncana mariei Banner and Blow.(X110) Sadi formation, Z.W8.

Figs.11-12 Globotruncana pseudolinneiana (Pessagno).(X100) Khasib formation, Z.W8.

PLATE 30

Figs.1-2 Globotruncana fareedi El-Naggar.(X100) Qurna formation; Z.W8

Figs.3-4 Globotruncana stuarti stuarti (de Lapparent).(X85), Hartha formation, R.W18

Figs.5-7 Globotruncana stuarti stuartiformis Dalbiez. Figs.5-6(X80); Sadi formation; Z.W8; Fig.7(X80) Qurna formation, R.W18.

Figs.8-9 Globotruncana subcircumnodifer Gandolfi.(X135) Sadi formation, Z.W8

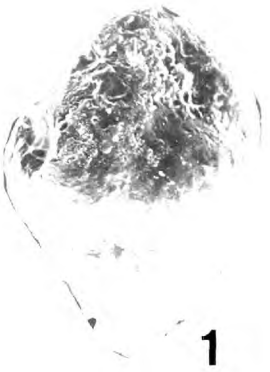
Fig.10 Globotruncana ? pura Hofker.(X150), Sadi formation, Z.W8

Figs.11-12 Trinitella scotti Bronnimann.(X125), Qurna formation, R.W18.

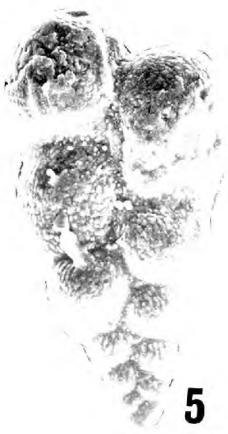
- 0 -

3

2

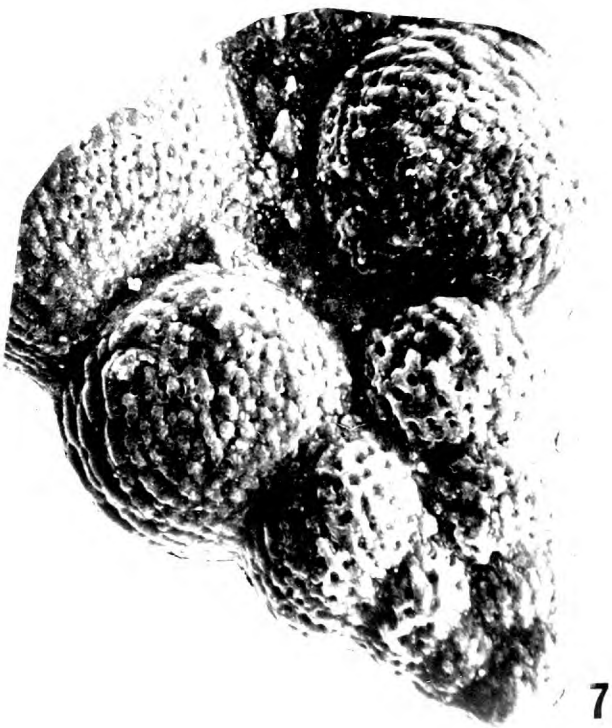

1

6


5

4

8


7

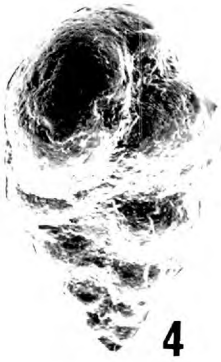
3

2

1

6

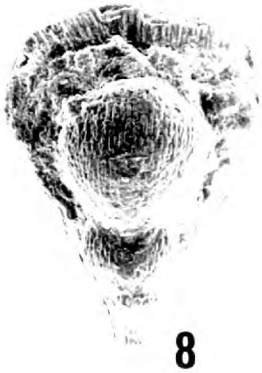
5



4

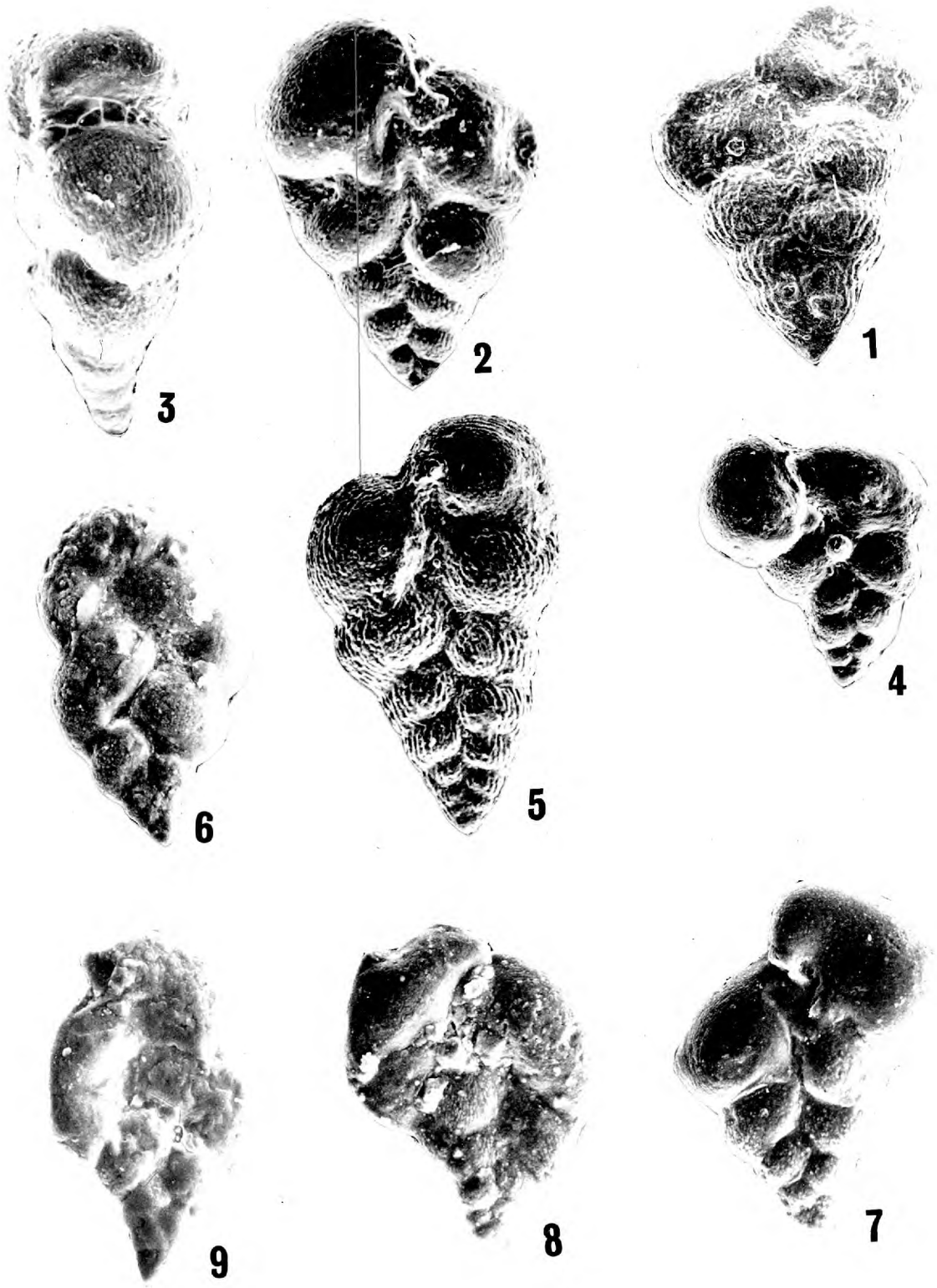
9

7



8

PLATE 3

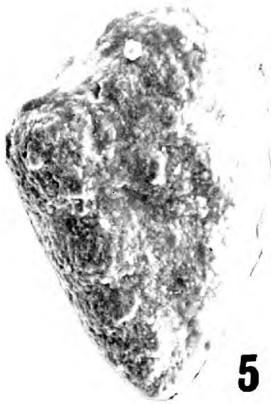


3

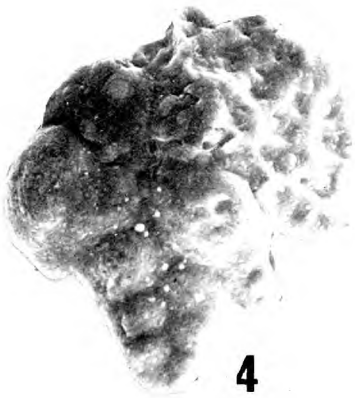
2

1

6

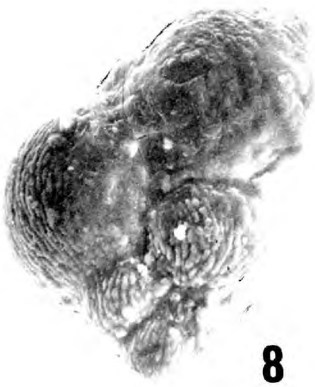


5



4

9

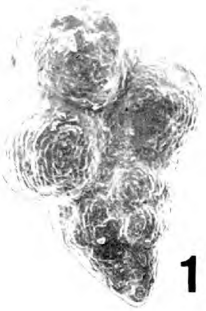


8

7

3

2

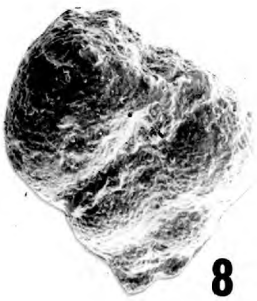

1

6

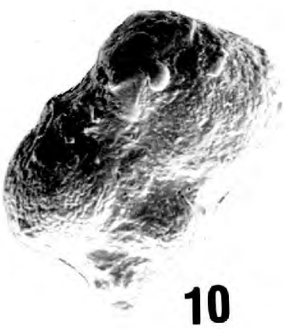
5

4

9

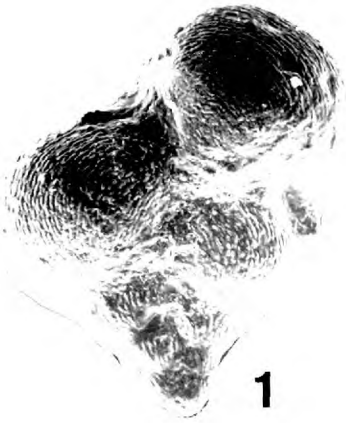

8

7


10

3

2



1

6

5

4

9

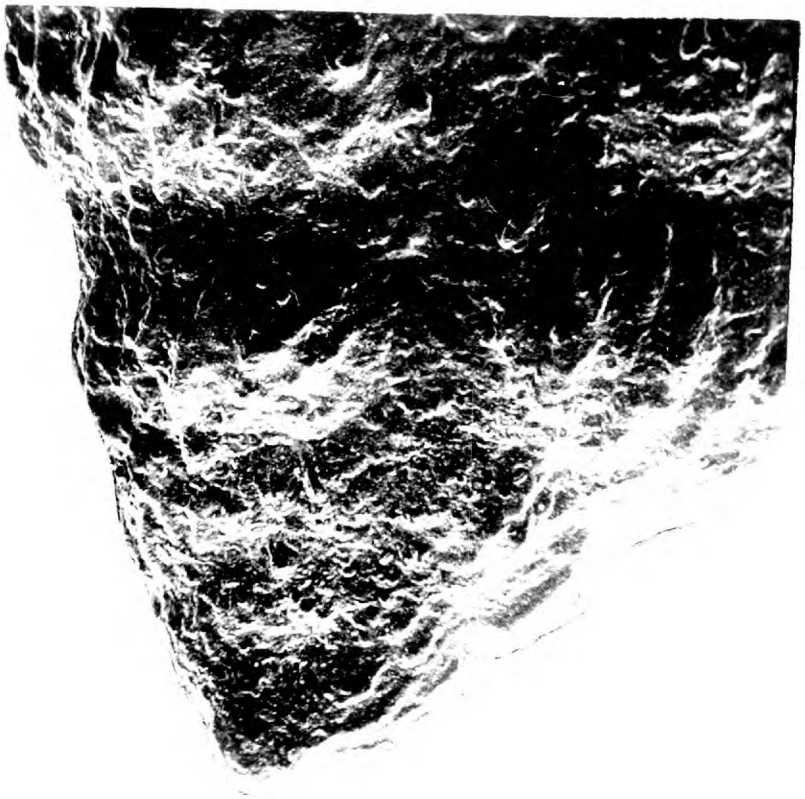
8

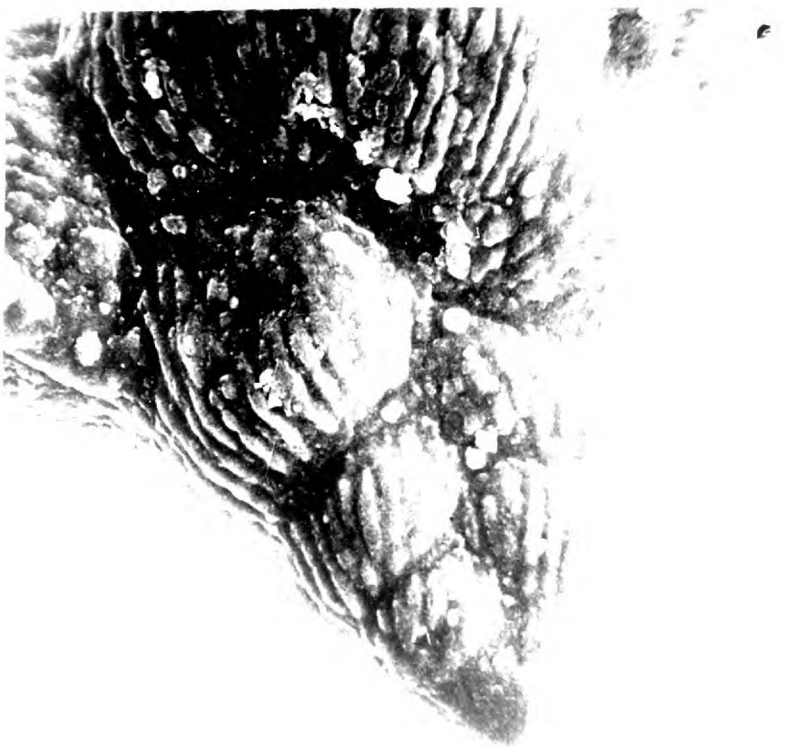
7

12

11

10





3

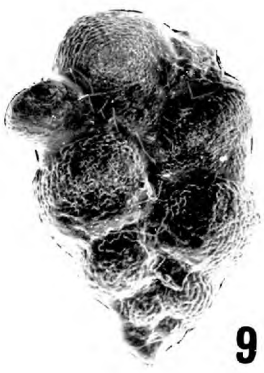
2

1

6

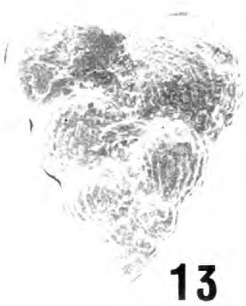
5

4


9

8

7

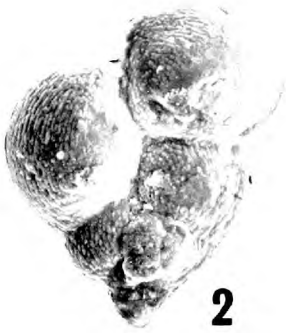

13

12

11

10

3

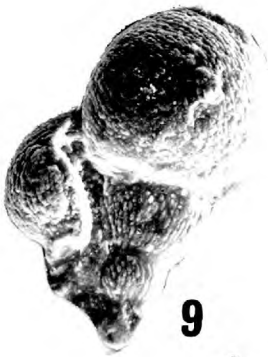

2

1

6

5

4


9

8

7

11

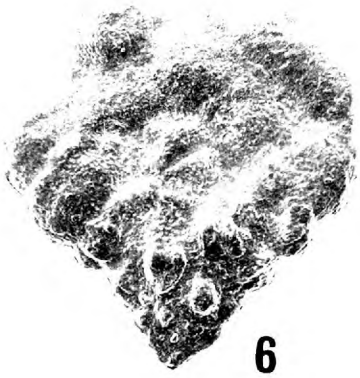
10

PLATE 10

3

2

1



6

5

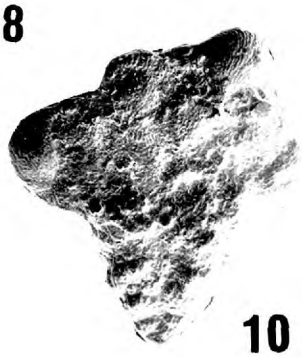
4

9

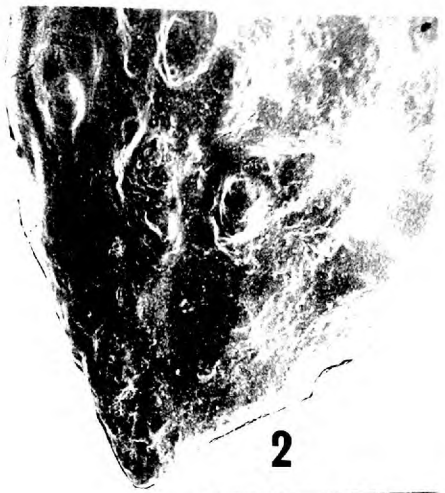
8

7

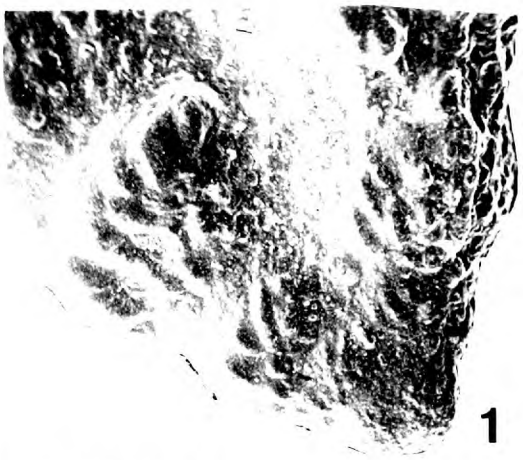
11



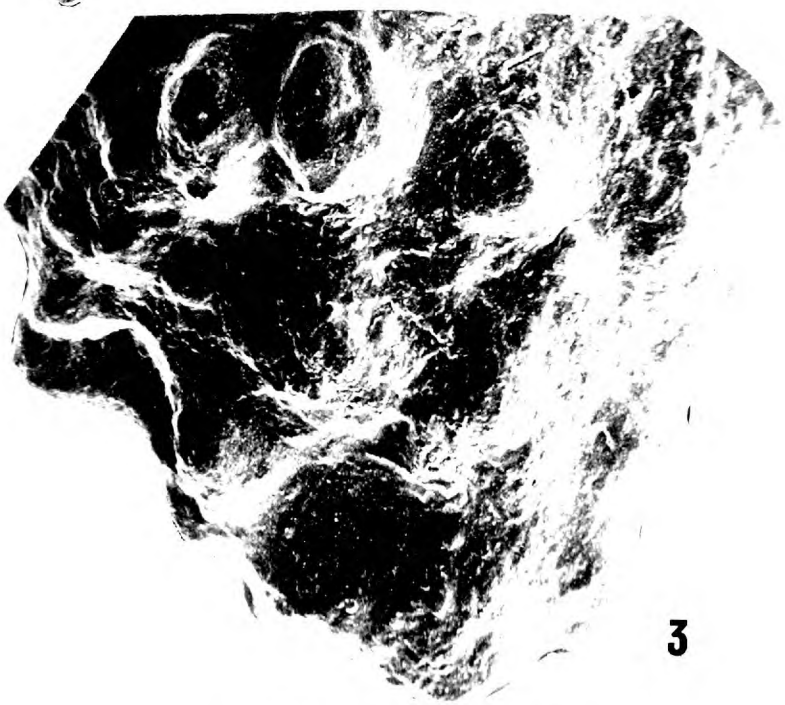
10



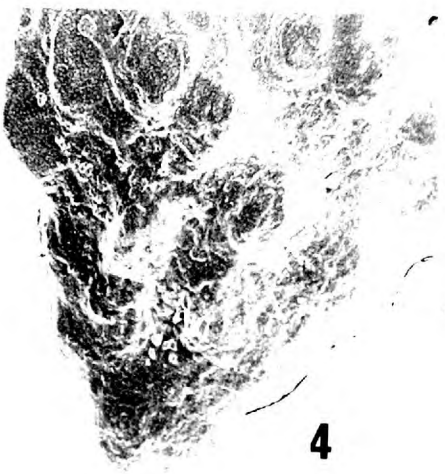
2



1



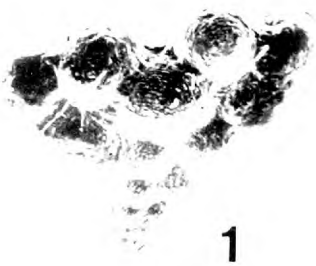
3



4

3

2



1

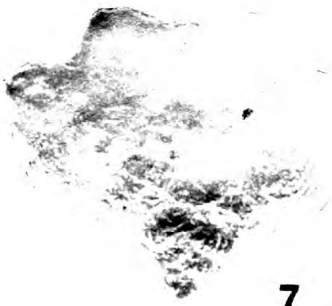
6

5

4

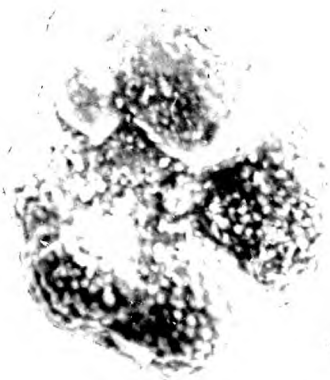
9

8



7

11



10

3

2

1

6

5

4

9

8

7

3

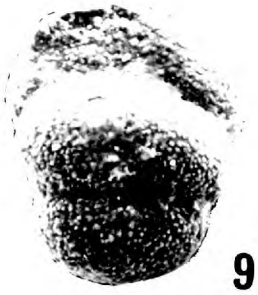
2

1

6

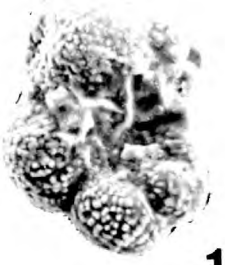
5

4

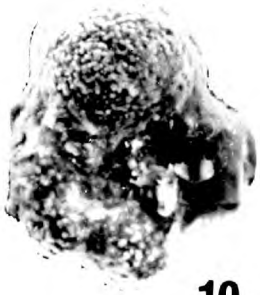

9

8

7


12

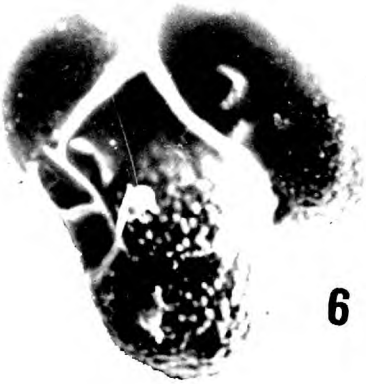
11


10

3

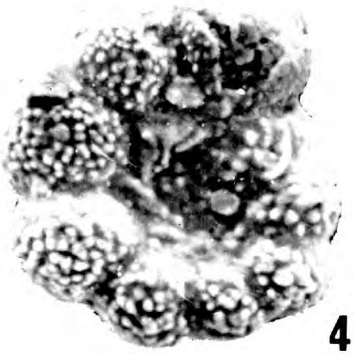
2

1



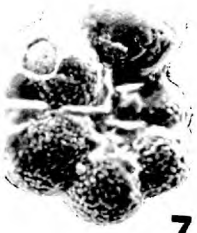
6

5



4

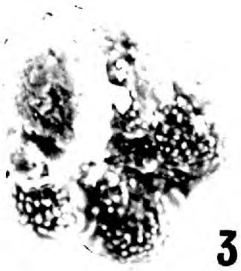
10



7

8

9


3

2

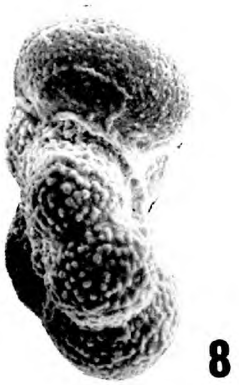
1

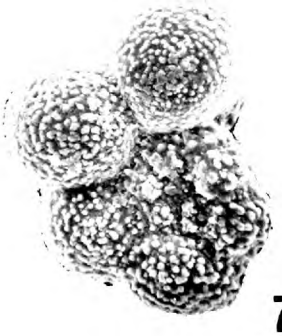
6

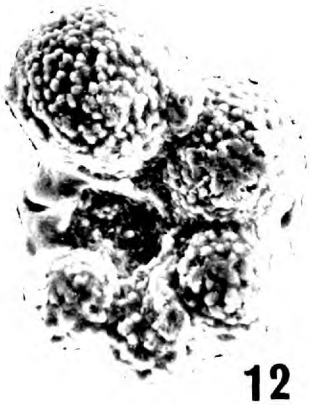
5

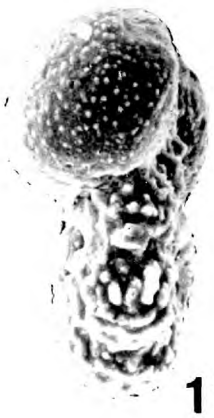
4

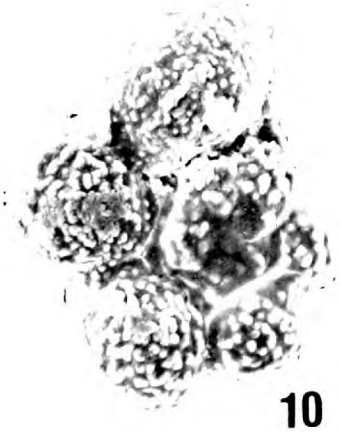
9

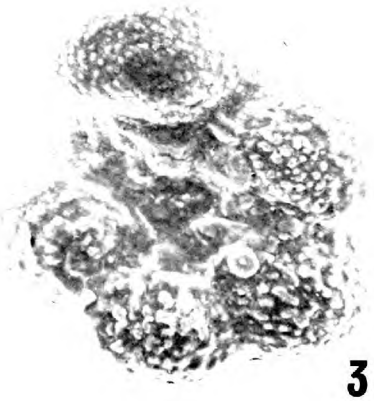

8


7

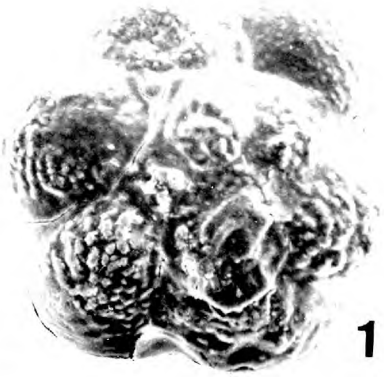

12

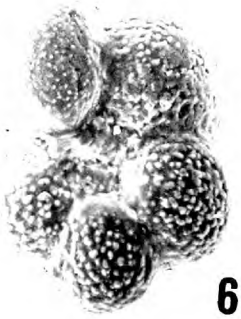

11


10


3

2


1


6

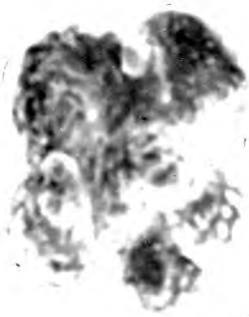
5

4

9

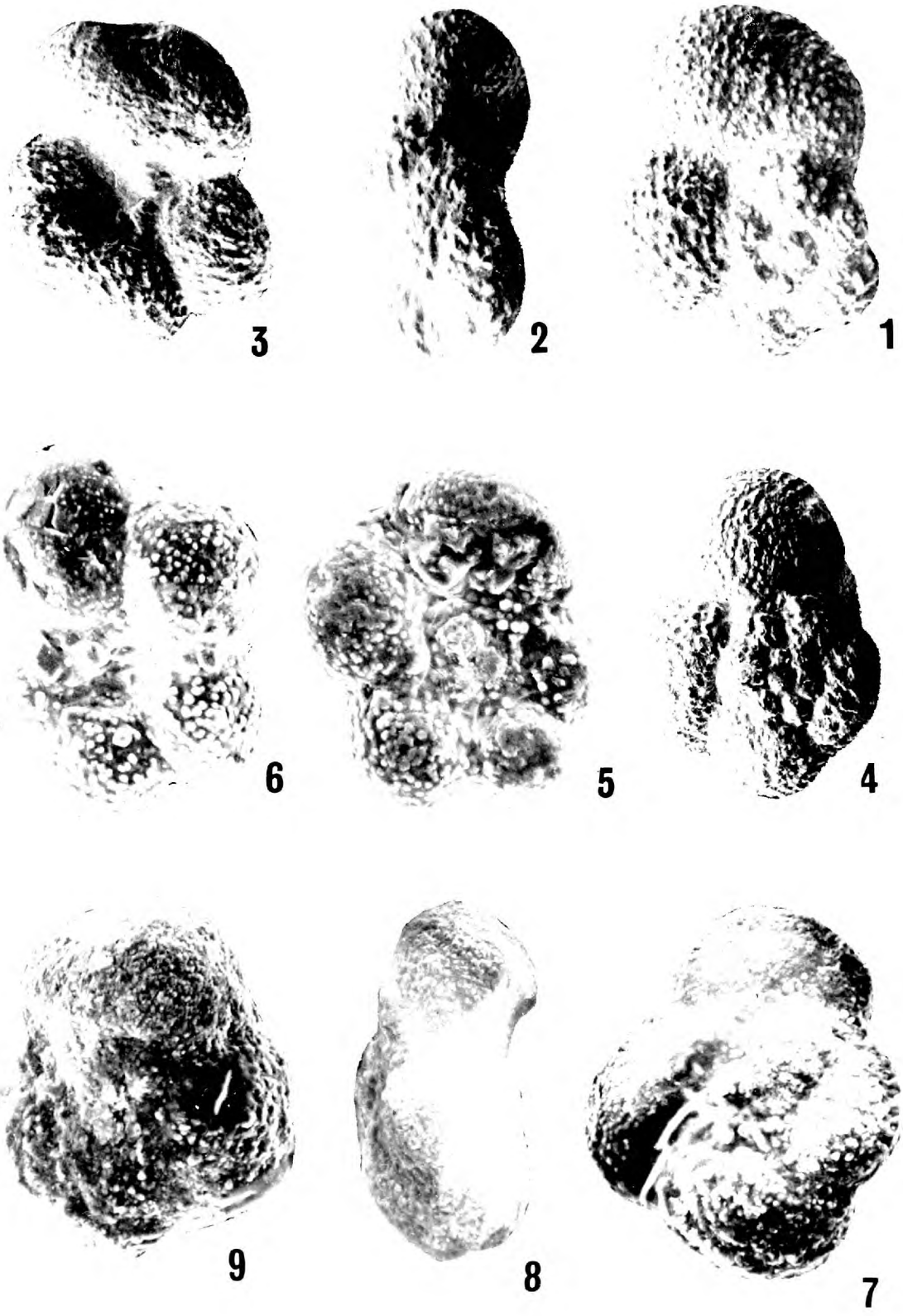
8

7

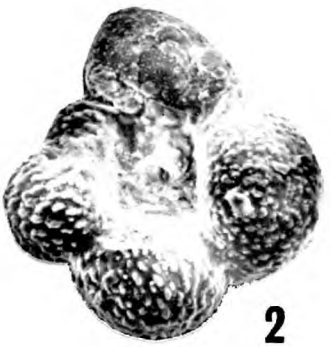

12

11

10


3
2
1
6
5
4
9
8
7

3

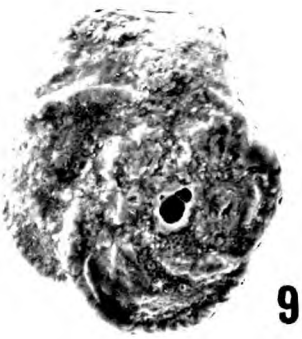

2

1

6

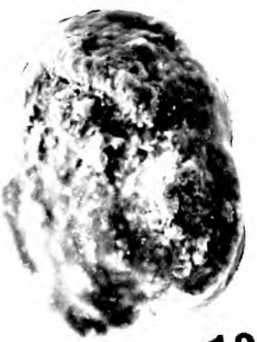
5

4

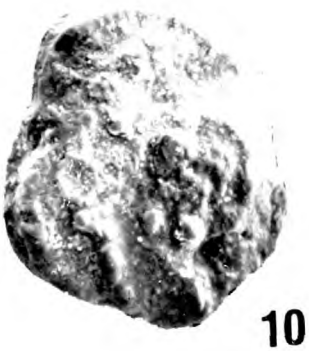

9

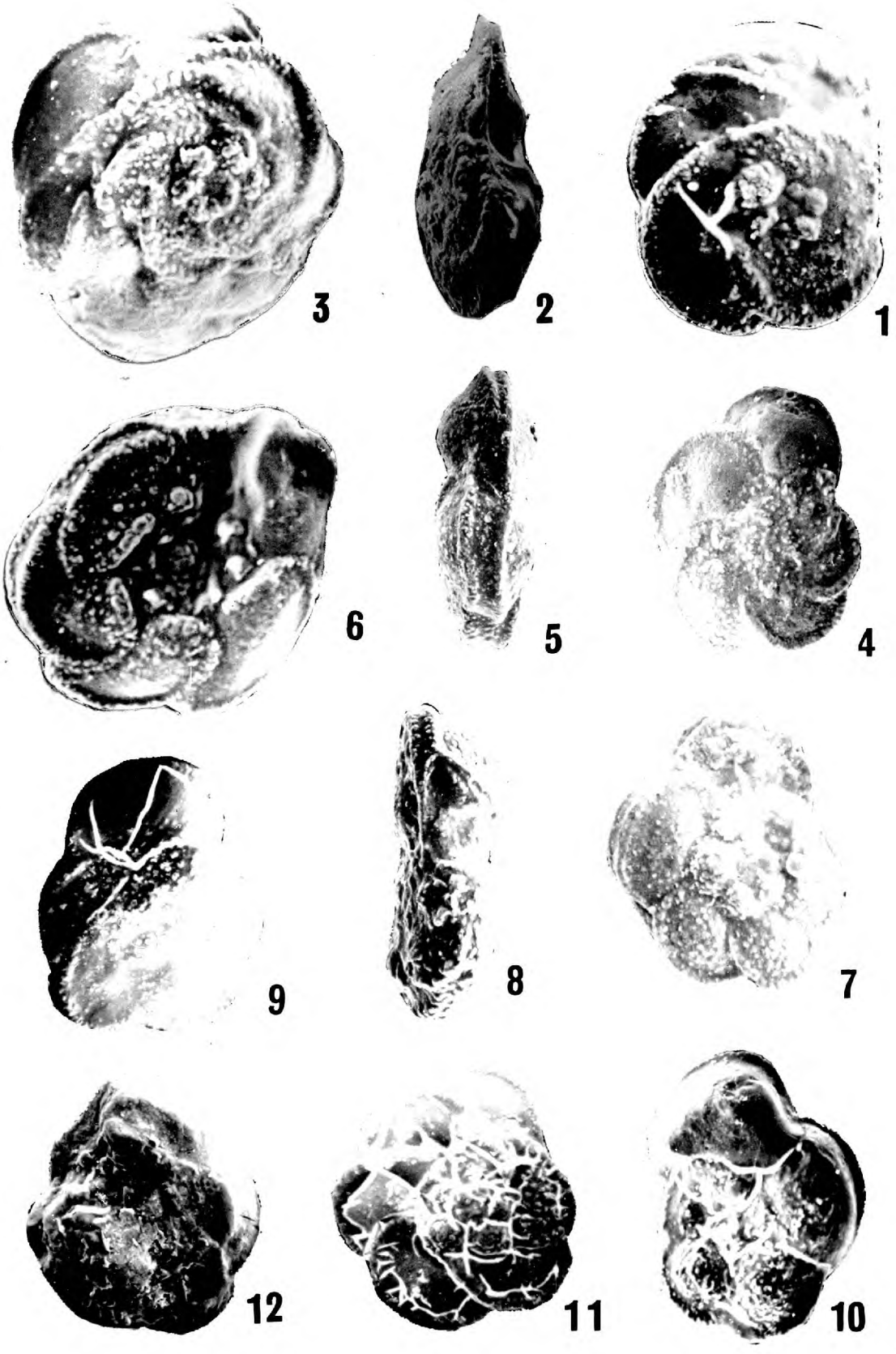
8

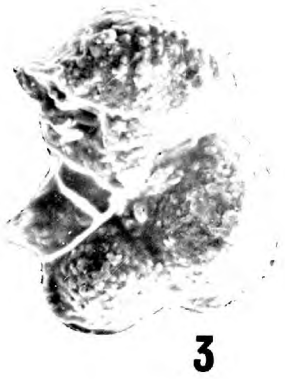
7


12

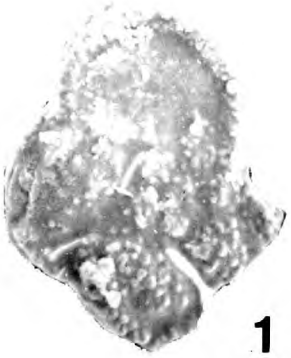
11

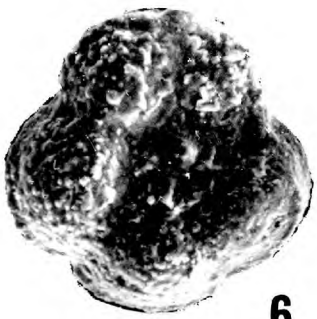

10

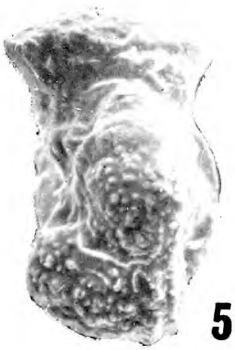

3
2
1
6
5
4
9
8
7
12
11
10


3

2

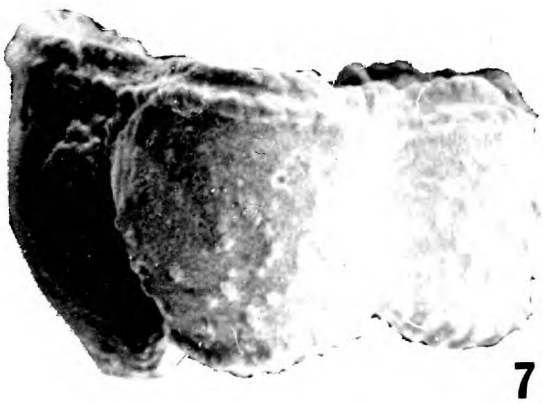

1


6

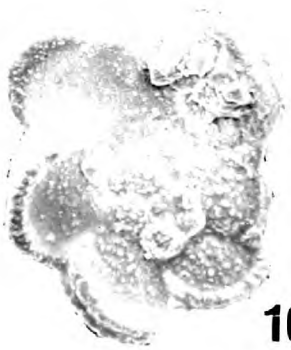

5

4

8


7

11

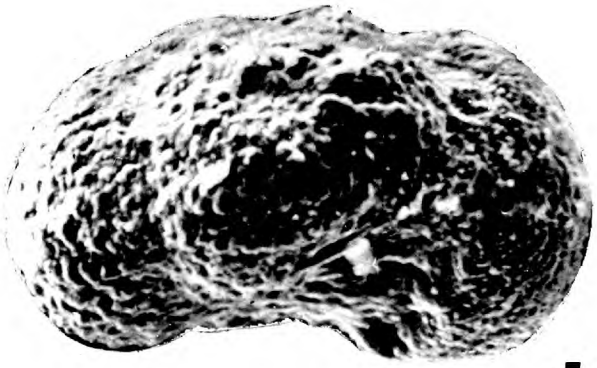

10

9

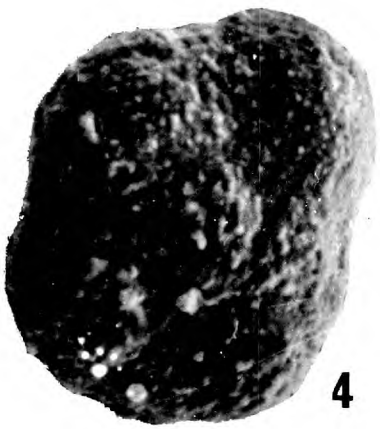
3

2

1



5



4

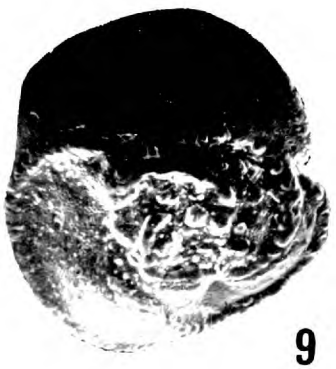
8

7

6

11

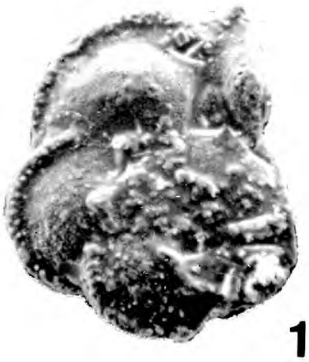
10



9

3

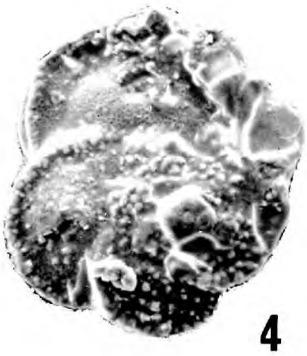
2



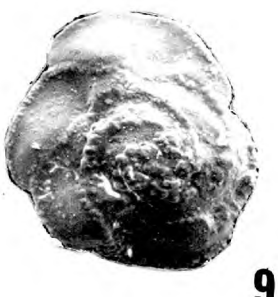
1

6

5

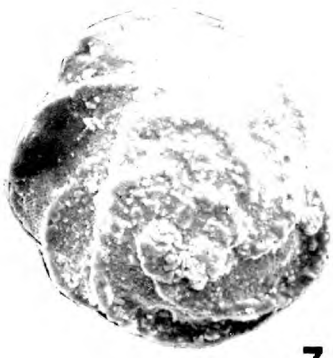


4



9

8



7

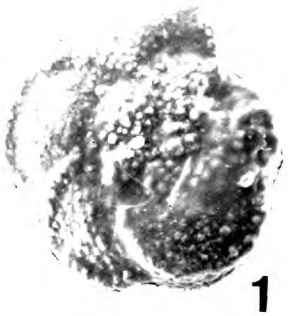
12

11

10

3

2

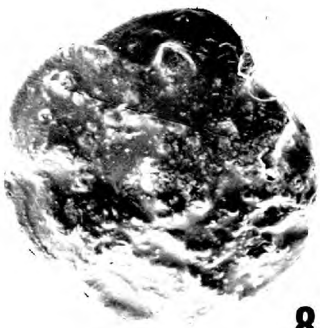

1

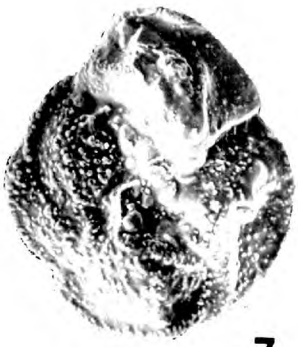
6

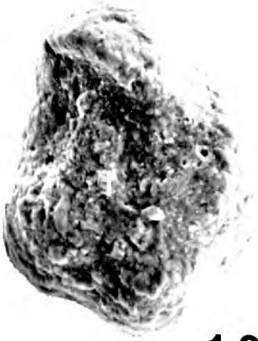
5

4

9

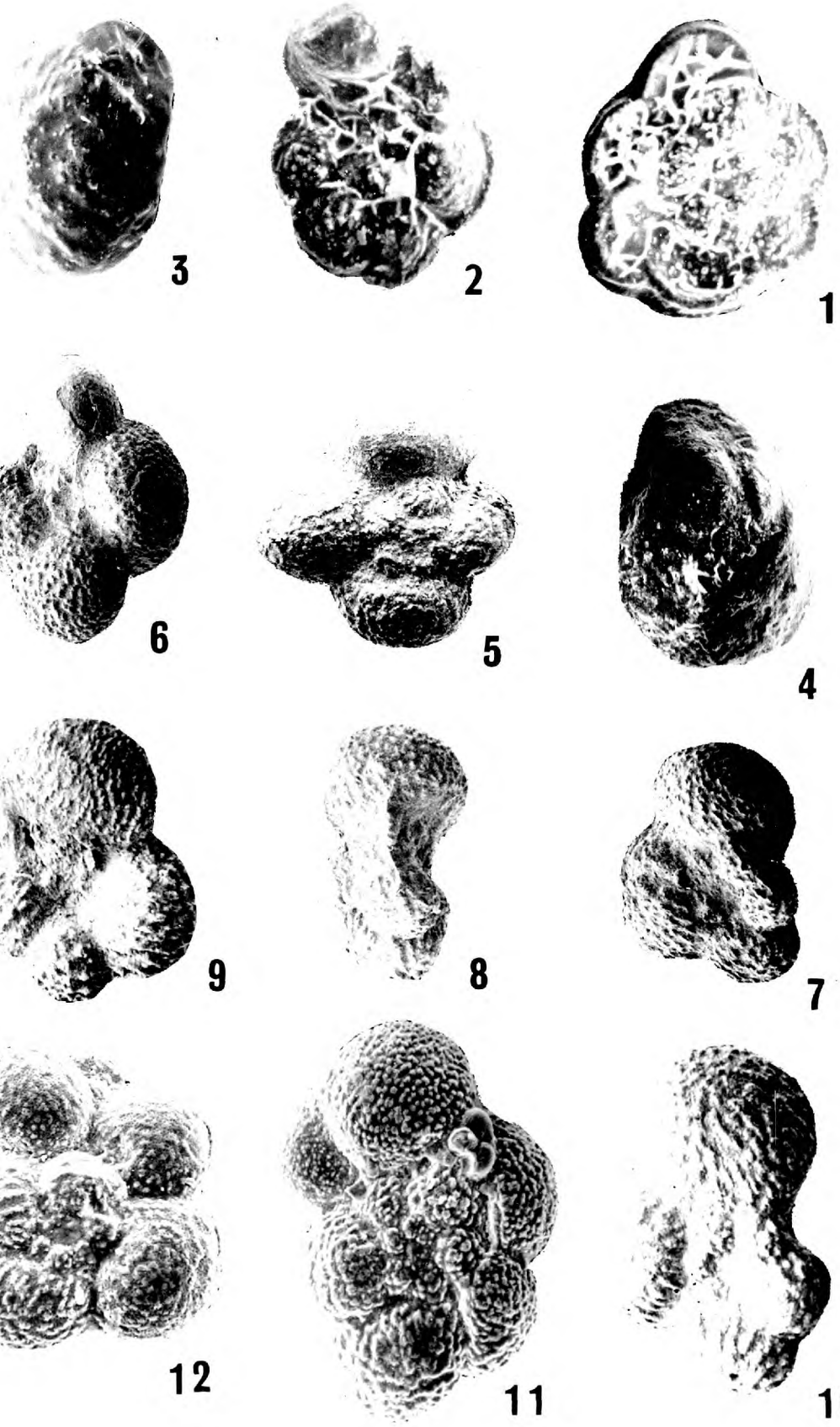

8


7


12

11

10


3
2
1
6
5
4
9
8
7
12
11
10

3

2

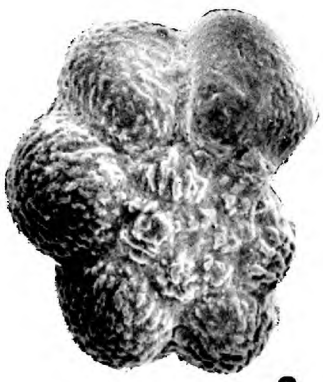
1

6

5

4

9

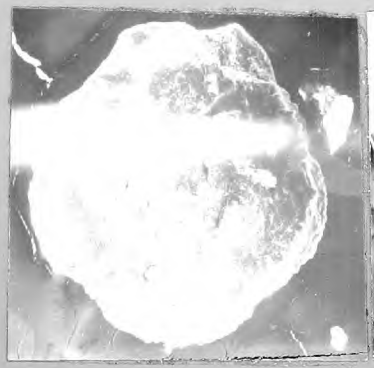


8

7

10

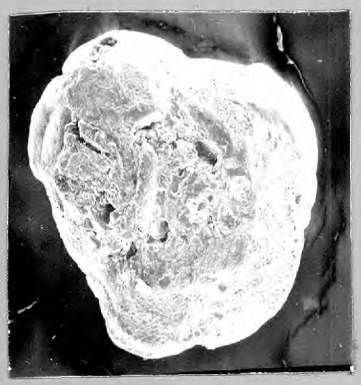
PLATE 27



3

2

1

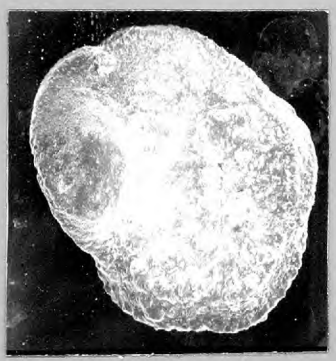


6

5

4

9



8

7

12

11

10

PLATE 28

3

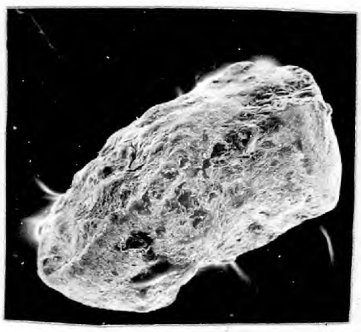
2

1

6

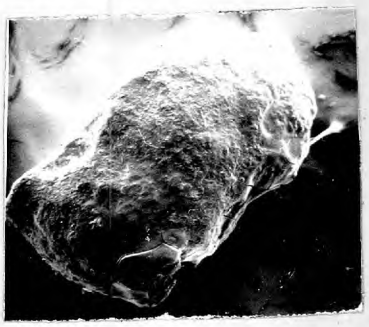
5

4

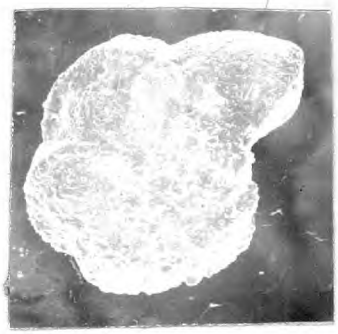


9

8

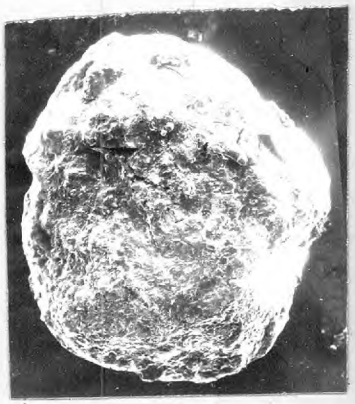


7



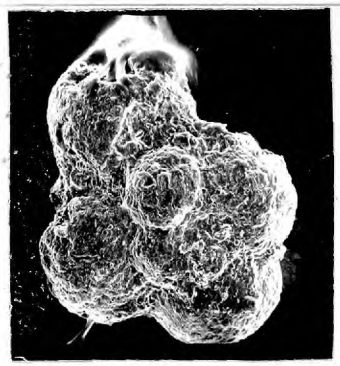
12

11



10

PLATE 29

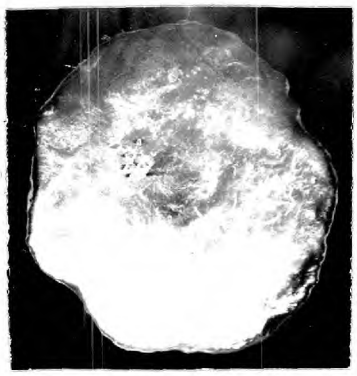


3

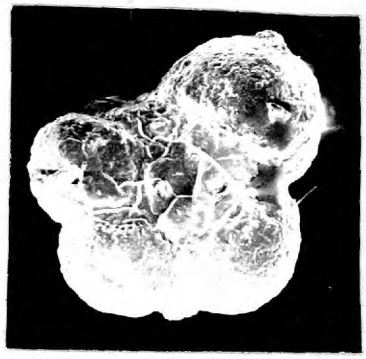
2

1

6



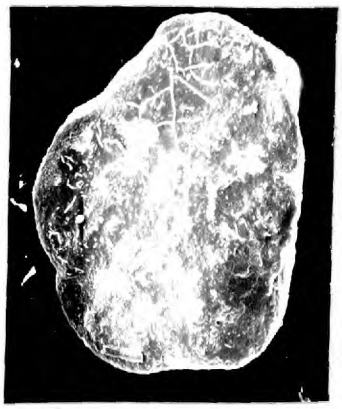
5



4

9

8



7

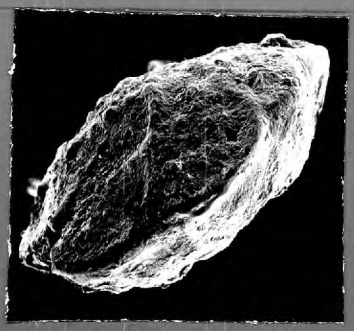
12

11

10

PLATE 30

3



2

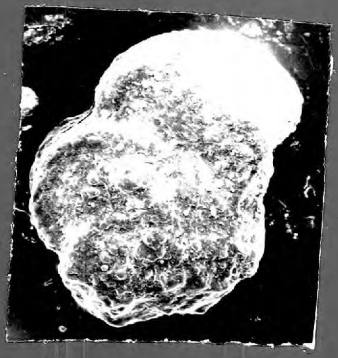
1

6

5

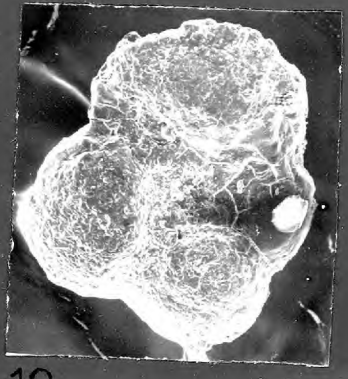
4

9

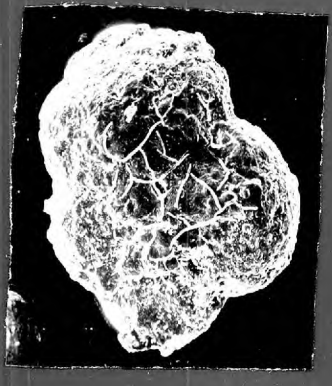


8

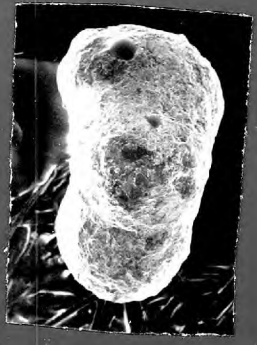
7



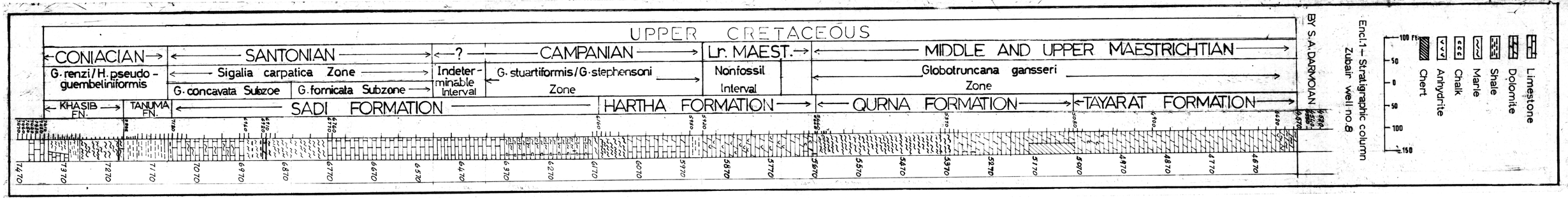
12

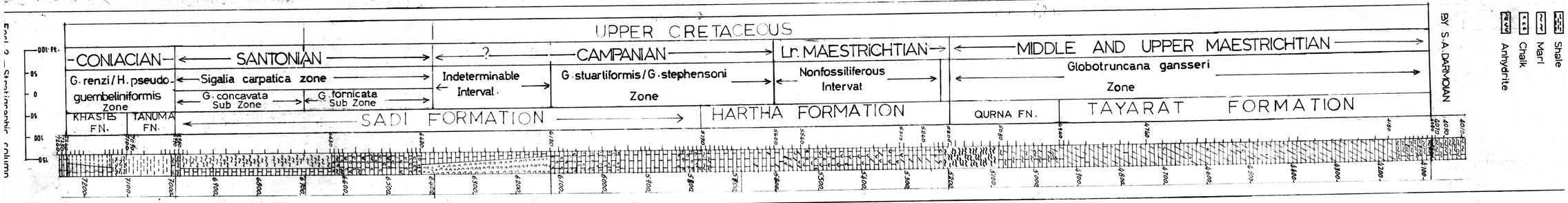


11



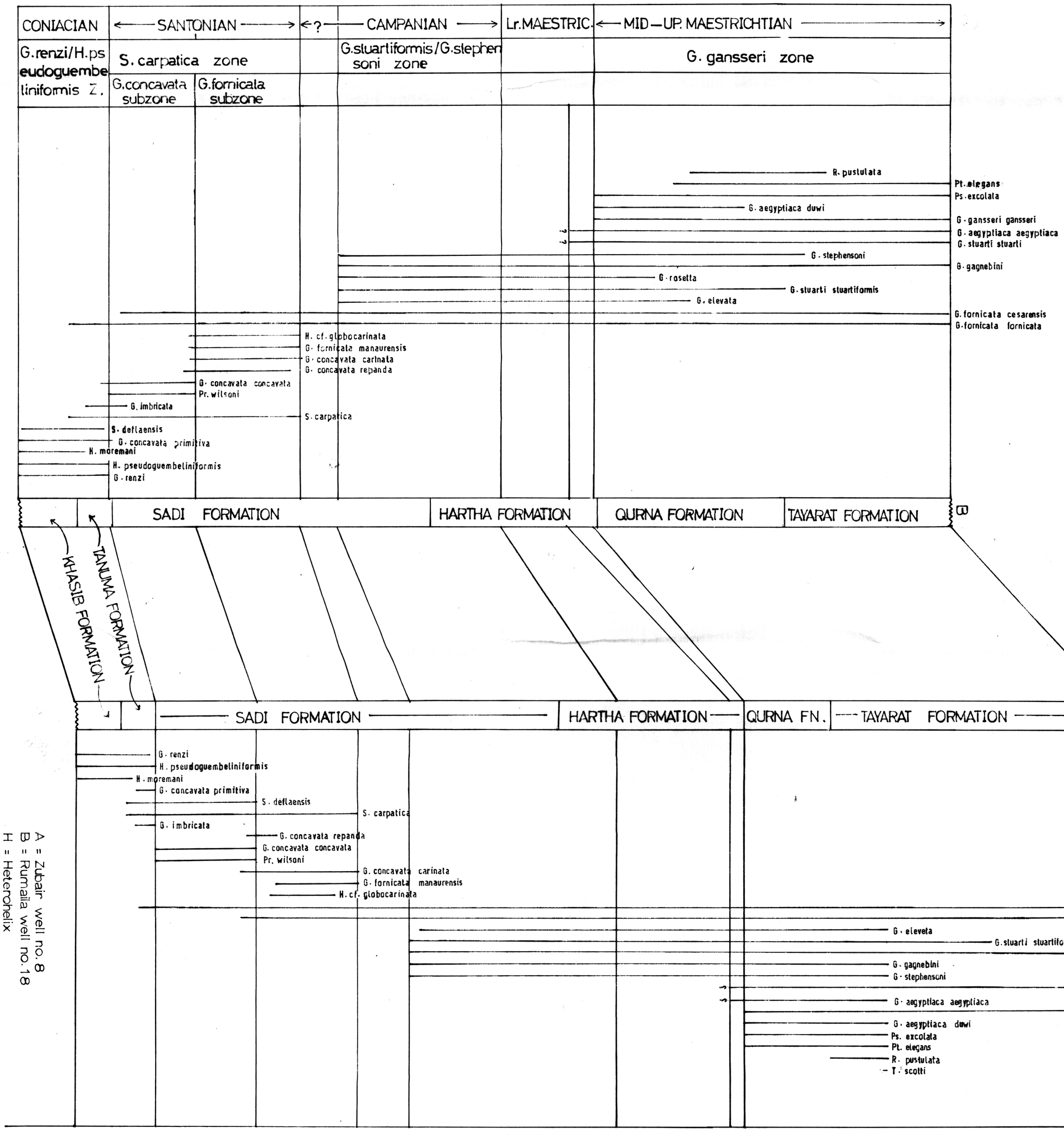
10


UPPER CRETACEOUS
CONIACIAN
SANTONIAN
? CAMPANIAN
Lr. MAEST.
MIDDLE AND UPPER MAESTRICHTIAN
G. renzi / H. pseudo - guembeliniformis
Sigalia carpatica Zone
G. concavata Subzoe
G. fornicata Subzone
Indeter-minable Interval
G. stuartiformis / G. stephensoni Zone
Nonfossil Interval
Globotruncana gansseri Zone
KHASIB FM.
TANUMA FM.
SADI FORMATION
HARTHA FORMATION
QURNA FORMATION
TAYARAT FORMATION
BY S.A. DARMOIAN
Encl.1 – Stratigraphic column
Zubair well no.8
100 Ft.
50
0
50
100
150
Limestone
Dolomite
Shale
Marle
Chalk
Anhydrite
Chert


UPPER CRETACEOUS
CONIACIAN
SANTONIAN
?
CAMPANIAN
Lr. MAESTRICHTIAN
MIDDLE AND UPPER MAESTRICHTIAN
G. renzi / H. pseudo-guembeliniformis Zone
Sigalia carpatica zone
G. concavata Sub Zone
G. fornicata Sub Zone
Indeterminable Interval
G. stuartiformis / G. stephensoni Zone
Nonfossiliferous Interval
Globotruncana gansseri Zone
KHASIB FN.
TANUMA FN.
SADI FORMATION
HARTHA FORMATION
QURNA FN.
TAYARAT FORMATION
BY S.A. DARWISH
Shale
Marl
Chalk
Anhydrite

BY S.A. DARMOIAN

Encl. 3 — Biostratigraphic correlation in Zudair–Rumaila Fields.



A = Zubair well no. 8
B = Rumaila well no. 18
H = Heterohelix
Ps = Pseudoguembelina
Pt = Pseudotextularia
S = Sigalia
Pr = Praeglobotruncana
G = Globotruncana
T = Trinitella

Encl. 6 — Distribution of planktonic Foraminifera in Zubair well no. 8.

BY: S. A. DARMOJAN

EUROPEAN STAGES			CONIACIAN	LR. SANTONIAN	UP. SANTONIAN	?	CAMPANIAN	LR. MAESTRICHTIAN	MID.–UP. MAESTRICHTIAN		
THICKNESS			1270	1170	1070	970	870	770	670	570	470
FORMATION			KHASIB F.N.	TANUMA F.N.	SADI FORMATION			HARTHA FORMATION	QURNA FORMATION		TAYARAT FORMATION
SAMPLE	SPECIES										
1	Guembelitria	cretacia CUSHMAN									
2		aff. harrisi TAPPAN									
3		trilocula (MARIE)									
4	Heterohelix	aff. barnardi (ANSARY)									
5		cf. glabrans (CUSHMAN)									
6		cf. globocarinata (CUSHMAN)									
7		moremani (CUSHMAN)									
8		nakkadyi sp. nov.									
9		nottalli (VOORWICK)									
10		planata (CUSHMAN)									
11		pseudoguembeliniformis sp. nov.									
12		petchra (BROTZEN)									
13		punctulata (CUSHMAN)									
14		reussi (CUSHMAN)									
15		robusta STENESTAD									
16		? semicostata (CUSHMAN)									
17		striata (EHRENBERG)									
18		ultimatumida (WHITE)									
19	Gublerina	cuvillieri KIKOINE									
20		glaessneri BRONNIMANN AND BROWN									
21		?reniformis (MARIE)									
22		sp. A									
23	Pseudoguembelina	costulata (CUSHMAN)									
24		excolata (CUSHMAN)									
25		palpebra BRONNIMANN AND BROWN									
26		pseudocarinata sp. nov.									
27		zubairensis sp. nov.									
28	Pseudotextularia	elegans (RZEHAK)									
29		plummerae (LOETTERLE)									
30	Sigalia	carpatica SALAJ AND SAMUEL									
31		carpatica var.1 var. nov.									
32		decoratissima (deKLASZ)									
33		deltaensis (SIGAL)									
34		sp. A									
35	Ventilabrella	cf. eggeri CUSHMAN									
36		gladrata CUSHMAN									
37		ornatissima CUSHMAN AND CHURCH									
38		tricamerata sp. nov.									
39	Planomalina	sp. A. sp. nov.									
40	Biglobigerinella	algeriana TEN DAM AND SIGAL									
41		multispina LALICKER									
42		sp. 1 sp. nov.									
43		sp.									
44	Globigerinelloides	asperum (EHRENBERG)									
45		bentonensis (MORROW)									
46		cushmani (TAPPAN)									
47		sp. aff. Globigerinelloides lapanica TAKAYANAGI									
48		messinae messinae (BRONNIMANN)									
49		messinae voluta (WHITE)									
50		pinguis HERM									
51		prairiehillensis PESSAGNO									
52		tururensis (BRONNIMANN)									
53		sp. A. sp. nov.									
54		sp. A. var.1 var. nov.									
55		sp. B sp. nov.									
56	Clavihedbergella	cf. simplex (MORROW)									
57	Hedbergella	amabilis LOEBLICH AND TAPPAN									
58		brittonensis LOEBLICH AND TAPPAN									
59		crassa (BOLLI)									
60		delrioensis (CARSEY)									
61		gautierensis (BRONNIMANN)									
62		hessi (PESSAGNO)									
63		holmdelensis (OLSSON)									
64		aff. paradubia (SIGAL)									
65		planispira (TAPPAN)									
66		praehelvetica (TRUJILLO)									
67	Praeglobotruncana	coarctata BOLLI									
68		inornata (BOLLI)									
69		wilsoni (BOLLI)									
70	Globotruncana	aegyptiaca aegyptiaca NAKKADY									
71		aegyptiaca duwi NAKKADY									
72		aegyptiaca var.1 NAKKADY									
73		cf. angusticarenata GANDOLFI									
74		arca (CUSHMAN)									
75		bulloides cf. austinensis PESSAGNO [not GANDOLF									
76		bulloides bulloides VOGLER									
77		coldreriensis GANDOLFI									
78		concavata concavata (BROTZEN)									
79		concavata carinata DALBIEZ									
80		concavata dentata var. nov.									
81		concavata primitiva DALBIEZ									
82		concavata repanda BOLLI									
83		contusa (CUSHMAN)									
84		conveza SANDIDGE									
85		coronata BOLLI									
86		cretacea (d'ORBIGNY)									
87		elevata (BROTZEN)									
88		fareedi EL–NAGGAR									
89		fornicata cesarensis GANDOLFI									
90		fornicata fornicata PLUMMER									
91		fornicata manaurensis GANDOLFI									
92		fornicata plana var. nov.									
93		gagnebini TILEY									
94		gansseri gansseri BOLLI									
95		gansseri pattersi GANDOLFI									
96		hilli PESSAGNO									
97		imbricata MORNOD									
98		leupoldi BOLLI									
99		linneiana linneiana (d'ORBIGNY)									
100		linneiana tricarinata (QUEREAU)									
101		marginata (REUSS)									
102		mariei BANNER AND BLOW									
103		obliqua HERM									
104		pseudolinneiana (PESSAGNO)									
105		? pura HOFKER									
106		renzi GANDOLFI									
107		rosetta (CARSEY)									
108		schneegansi SIGAL									
109		stephensoni PESSAGNO									
110		stuarti stuarti (de LAPPARENT)									
111		stuarti stuartiformis DALBIEZ									
112		subcircumnodifer GANDOLFI									
113		ventricosa WHITE									
114	Rugoglobigerina	bulboza BELFORD									
115		loetterli (NAUSS)									
116		macrocephala macrocephala BRONNIMANN									
117		macrocephala ornata BRONNIMANN									
118		plana BELFORD									
119		pustulata BRONNIMANN									
120		rugosa (PLUMMER)									
121		tradinghousensis PESSAGNO									

0	
50	
100	
150	
200	
250	
300	
330	

Barren interval.

BY S.A. DARMOIAN

P.B. LOWER PLANKTONIC OPEN SEA BIOFACIES → ← CALCAREOUS BENTHONIC CLOSED SEA BIOFACIES → BIOFACIES NON-FOSSILIFEROUS UPPER PLANKTONIC OPEN SEA BIOFACIES → — BIOFACIES

← KHASIB FN. → TANUMA FN ← SADI FORMATION → ← HARTHA FORMATION → ← QURNA FORMATION — FORMATION

THICKNESS

7410 7395 7205 7185 7110 6980 6760 6730 6657 6550 6410 6370 5920 5540 5550 5650 5340 5550

P.B. — PORCELLANEOUS BIOFACIES.

Relative frequency of specimens

Arenaceous (incl. Porcellaneous)
Calcareous Benthonic
Planktonic

0% 10 20 30 40 50 60 70 80 90 100%

Foraminiferal number

6550 6510 6420 6550

Reduced to half

250 Ft. 200 175 150 100 50 0

Total number of species

Planktonic
Calcareous Benthonic
Arenaceous (incl. Porcellaneous)

No. of species No. of genera

0 2 4 6 8 0 2 4 6 8

Encl. 4 — Paleoecologic curves of Zubair well no. 8.

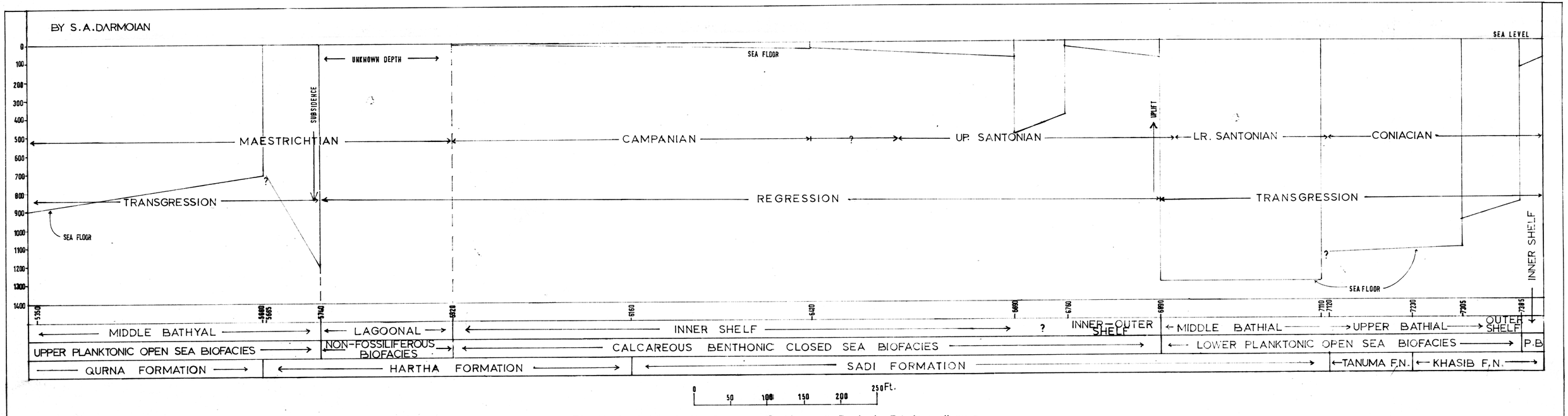
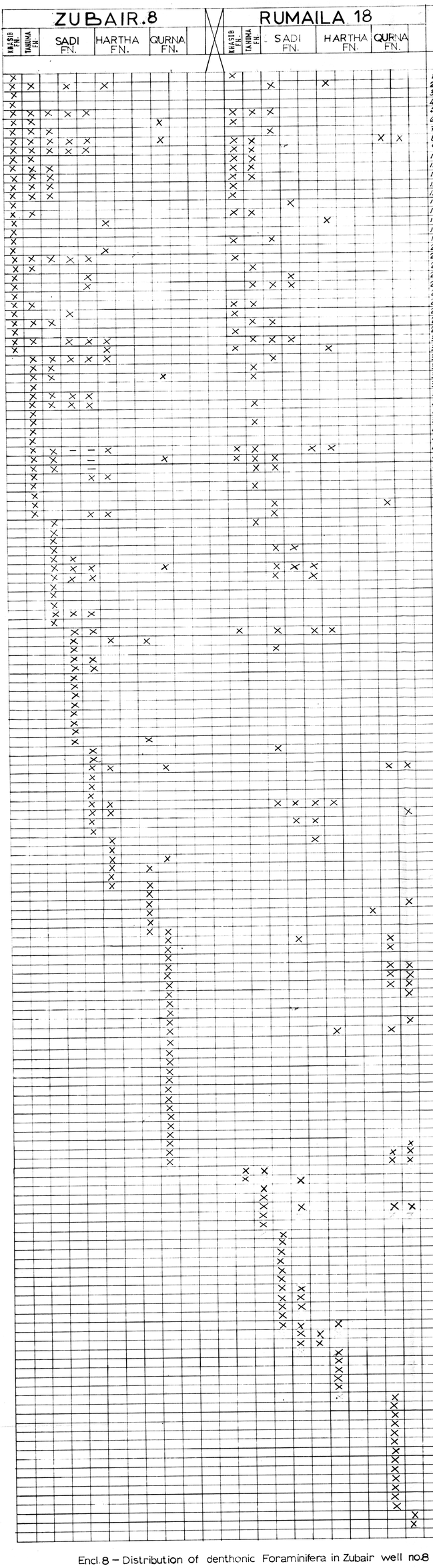


Fig. 5 — Probable depth of Upper Cretaceous Basin in Zubair well no. 8

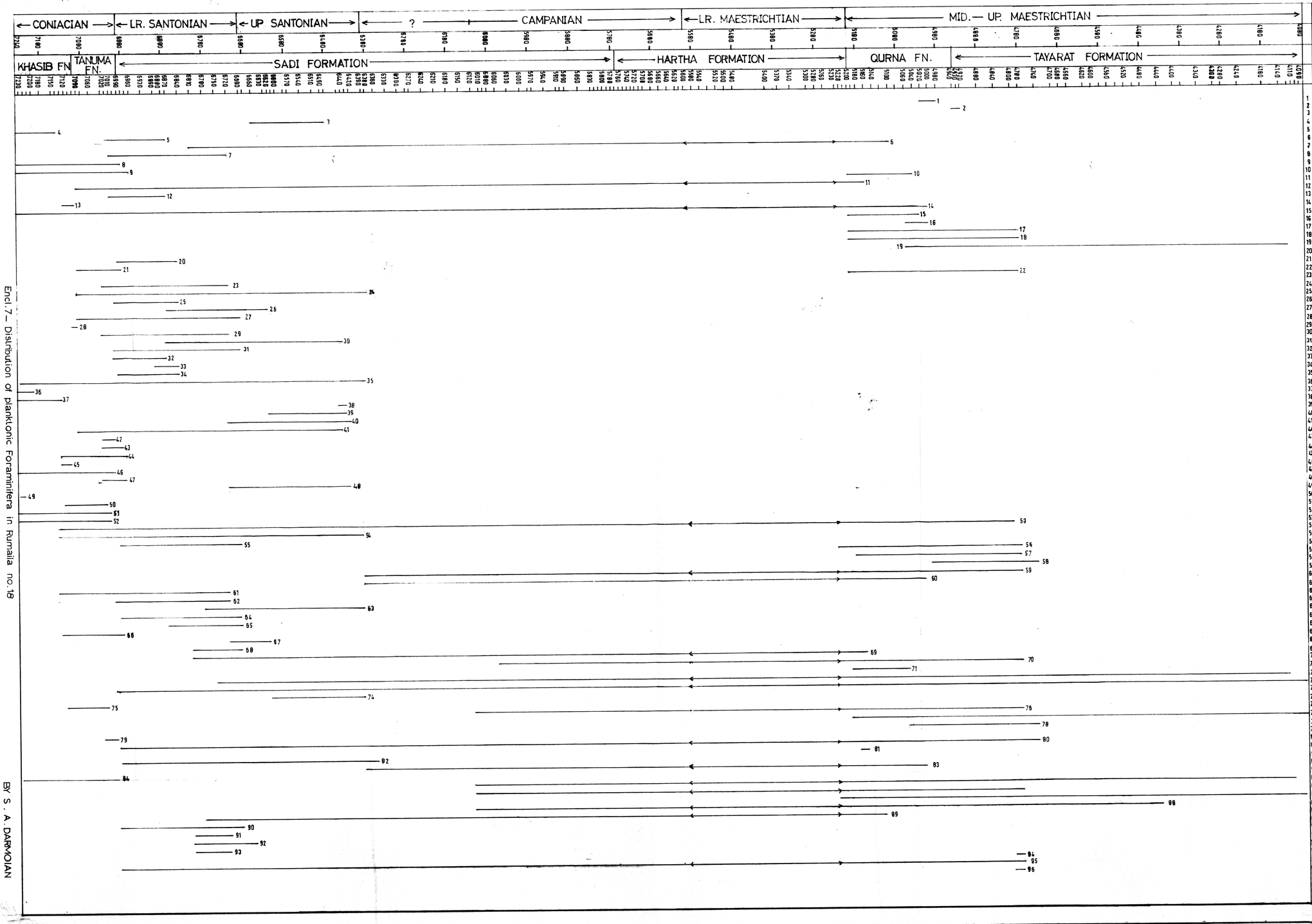


Encl.8 – Distribution of denthonic Foraminifera in Zubair well no.8 and Rumaila well no.18

BY S.A.DARMOIAN

Encl.7 — Distribution of planktonic Foraminifera in Rumaila no.18

BY S. A. DARMOIAN



	EUROPEAN STAGES	
	THICKNESS	
	FORMATION	
	SAMPLE	SPECIES
1		Guembelitria cretacea CUSHMAN
2		Heterohelix cf. glabrans (CUSHMAN)
3		cf. globocarinata (CUSHMAN)
4		moremani (CUSHMAN)
5		nakkadyi sp. nov.
6		nuttalli (VOORWICK)
7		Planata (CUSHMAN)
8		pseudoguembeliniformis sp. nov.
9		pulchra (BROTZEN)
10		punctulata (CUSHMAN)
11		reussi (CUSHMAN)
12		robusta STENESTAD
13		? semicostata (CUSHMAN)
14		striata (EHRENBERG)
15		ultimatumida (WHITE)
16		Gublerina curvilleri KTKOINE
17		Pseudoguembelina costulata (CUSHMAN)
18		excolata (CUSHMAN)
19		palpebra BRONNIMANN AND BROWN
20		zubairensi sp. nov.
21		pseudocarinata sp. nov.
22		Pseudotextularia elegans (RZEHAK)
23		plummerae (LOETTERLE)
24		Sigalia carpatica SALAJ AND SAMUEL
25		carpatica var.1 var.nov.
26		decoratissima de KLASZ
27		deflaensis (SIGAL)
28		Ventilabrella cf. eggeri CUSHMAN
29		glabrata CUSHMAN
30		ornatissima CUSHMAN AND CHURCH
31		tricamerata sp. nov.
32		Biglobigerinella algeriana TEN DAM AND SIGAL
33		multispina LALICKER
34		sp.1 sp. nov.
35		Globigerinelloides asperum (EHRENBERG)
36		bentonensis (MORROW)
37		cushmani (TAPPAN)
38		messinae messinae (BRONNIMANN)
39		messina voluta (WHITE)
40		pinguis (HERM)
41		prairiehillensis PESSAGNO
44		turonensis (BRONNIMANN)
43		sp. A. var.1 var. nov.
44		sp. B. sp. nov.
45		Hedbergella anabilis LOEBLICH AND TAPPAN
46		brittonensis LOEBLICH AND TAPPAN
47		crassa (BOLLI)
48		delriensis (CARSEY)
49		gautierensis (BRONNIMANN)
50		hessi (PESSAGNO)
51		planispira (TAPPAN)
52		praehelvetica (TROJILLO)
53		Praeglobotruncana coarctata BOLLI
54		inornata (BOLLI)
55		witsoni (BOLLI)
56		Globotruncana aegyptiaca aegyptiaca NAKKADY
57		aegyptiaca duwi NAKKADY
58		aegyptiaca var. 1. NAKKADY
59		arca (CUSHMAN)
60		bulloides cf austinensis PESSAGNO
61		bulloides bulloides VOGLER
62		coldreriensis GANDOLFI
63		concavata carinata DALBIEZ
64		concavata concavata (BROTZEN)
65		concavata dentata var. nov.
66		concavata primitiva DALBIEZ
67		concavata repanda (BOLLI)
68		coronata BOLLI
69		crelacea (d'ORBIGNY)
70		elevata (BROTZEN)
71		fareedi EL-NAGGAR
72		fornicata cesarensis GANDOLFI
73		fornicata fornicata PLUMMER
74		fornicata manaurensis GANDOLFI
75		fornicata plana var. nov.
76		gagnebini TILEY
77		gansseri gansseri BOLLI
78		gansseri pettersi GANDOLFI
79		imbricata MORNOD
80		lineiana lineiana (d'ORBIGNY)
81		lineiana tricarinata (QUEREAU)
82		marginata (REUSS)
83		marlei BANNER AND BLOW
84		renzi GANDOLFI
85		rosetta (CARSEY)
86		stephensoni PESSAGNO
87		stuarti stuarti (de LAPPARENT)
88		stuarti stuartiformis DALBIEZ
89		ventricosa WHITE
90		Rugoglobigerina bulbosa BELFORD
91		loetterli (NAUSS)
92		macrocephala macrocephala BRONNIMANN
93		macrocephala ornata BRONNIMANN
94		pustulata BRONNIMANN
95		rugosa (PLUMMER)
96		Trinitella scotti BRONNIMANN