COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

BULLETIN No. 79

Miocene and Pliocene Smaller Foraminifera from Papua and New Guinea

BY

D. J. BELFORD

Issued under the Authority of the Hon. David Fairbairn
Minister for National Development
1966

By Authority:
ALEX. B. DAVIES, Goverrnment Printer, Western Australia
(Printed in Australia)

95044/3/65—1,200

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.
SECRETARY: R. W. BOSWELL

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: J. M. RAYNER

THIS BULLETIN WAS PREPARED IN THE GEOLOGICAL BRANCH
ASSISTANT DIRECTOR: N. H. FISHER

M.S. completed: 31 October 1964
Issued: 15 April 1966

Published by the Bureau of Mineral Resources, Geology and Geophysics
Canberra, A.C.T.

CONTENTS

	Page
SUMMARY	1
INTRODUCTION	3
ACKNOWLEDGEMENTS	7
SYSTEMATIC DESCRIPTIONS	8
Introduction	8
SUPERFAMILY BULIMINACEA	
Genus *Buliminella*	15
Bolivinita	18
Bolivina	20
Brizalina	24
Laterostomella	44
Rectobolivina	45
Cassidulinoides	53
Bulimina	55
Globobulimina	66
Protoglobobulimina	67
Praeglobobulimina	73
Reussella	75
Euuvigerina	75
Rectuvigerina	84
Siphogenerina	85
Siphouvigerina	86
Trifarina	88
SUPERFAMILY DISCORBACEA	
Genus *Discorbinella*	89
Laticarinina	92
Parvicarinina	93
Rosalina	94
Baggina	96
Cancris	96
Valvulineria	98
Bueningia	99
Parrelloides	99
Asterigerina	104
SUPERFAMILY ROTALIACEA	
Genus *Ammonia*	108
Pseudorotalia	112

SUPERFAMILY ORBITOIDACEA

Genus *Neoeponides*	117
Planulina	119
Hyalinea	124
'*Eponides*'	125
Cibicides	131

SUPERFAMILY CASSIDULINACEA

Genus *Fursenkoina*	136
Sigmavirgulina	137
Cassidulina	138
Favocassidulina	145
Globocassidulina	146
Allomorphina	154
Quadrimorphina	155
Rotamorphina	156
Florilus	157
Nonionella	159
Alabamina	160
Gyroidina	161
Oridorsalis	170
Osangularia	175
Anomalina	177
Anomalinoides	177
Heterolepa	181
Melonis	183
Anomalinella	185

SUPERFAMILY ROBERTINACEA

Genus *Ceratobulimina*	186
Lamarckina	187
Hoeglundina	190
Geminospira	191
Robertinoides	194

BIBLIOGRAPHY	197
SAMPLE LOCALITIES	209
PLATES	225
INDEX OF ILLUSTRATED SPECIES	303

Corrections for Bulletin 79

Miocene and Pliocene Smaller Foraminifera from Papua and New Guinea

by

D.J. Belford (1966)

Page

21- Under heading BOLIVINA ROBUSTA, for text-fig. 4 read text-fig. 1.

33- Under heading 'Occurrence', Paratype B, C.P.C. 6115 should read C.P.C. 6185.

80- Under 'Occurrence' for Euuvigerina crassiostata, 'Yule' has been omitted before 'Island'. Under 'Occurrence' of Euuvigerina flinti, read 'Tubu Siltstone'.

82- (?) omitted after EUUVIGERINA and before NITIDULA.

91- Under text-fig. 8, first line, for 'text' read 'test'.

105- On text-fig. 10, after Amphistegina lessonii d'Orbigny add C.P.C. 6401.

117- Below 'Occurrence', after P.sp. insert 'A'.

123- Under PLANULINA RETIA sp. nov. delete text-fig. 32:4-5.

124- For 1951b Hyalina baltica (Schroeter) (sic), read 1951b Hyalinea baltica (Schroeter) (sic). Under text-fig. 13, for Schroeter, read Gmelin.

133- Insert 'C' in 'CIBICIDES'. After text-fig. 15:3-10, add 'text-fig. 14:3'.

161- Under 'Occurrence', delete 'loc. 31' and insert 'loc. 21'.

167- Text-fig. 21:4, C.P.C. 6500, should read C.P.C. 6600.

175- Text-fig. 22:5, for loc. 163 read 16g.

191- For 'Hofker (1951b) described Pacific specimens in H. elegans', read 'Hofker (1951b) described Pacific specimens as H. elegans'.

Plate 2, fig. 6 - 'D' omitted after paratype.

Plate 9, fig. 3 - For C.P.C. 6398, read C.P.C. 6348.

Plate 11, fig. 9 - For C.P.C. 6476, read C.P.C. 6470.

Plate 11, fig. 15 - Insert C.P.C. 6390.

Plate 12, fig. 6 - For C.P.C. 6396, read C.P.C. 6395.

Plate 12, figs 8-13 - Delete 'Holotype', 'paratype A', and 'paratype B'.

Plate 21, fig. 9 - Insert 'x' before 26.

Plate 28- Under Gyroidina acuta, figs 4-5 should read figs 4-6.

Plate 28 fig. 20 - For figure 10 read 19.

Plate 32 fig. 13 - C.P.C. 6656 should read C.P.C. 6655.

Plate 35 figs 4-5 omitted. Should read 4-5 C.P.C. 6644; 4, ventral view; 5, edge view; both x 75.

Plate 36 - Reference to figure 6 omitted; add '6, C.P.C. 6685, section access last chamber showing bilamellid structure; x 116.'

SUMMARY

One hundred and fifty-six species of Foraminifera, referred to 58 genera, are recorded and illustrated; 35 species have been described as new. Where possible, species have been given their attribution as recorded in the collection of the Australasian Petroleum Company, Port Moresby, and the known stratigraphical range within Papua and New Guinea is indicated.

The genera *Bolivinoides* and *Afrobolivina* are considered to be synonyms of *Bolivina*, based on a comparison of the internal structure of the type species. The generic name *Brizalina* is used for species having the biserial chamber arrangement of *Bolivina*, but lacking the basal chamber lobes. Species with a biserial to uniserial growth and lacking basal chamber lobes are referred to the genus *Rectobolivina*. In the genus *Bulimina* the 'second foramen' recorded in several species is considered to be formed by the toothplate 'cutting off' part of the septal foramen; it does not occur on the final chamber.

The dividing partition of the genus *Asterigerina* is shown by thin sections to have two layers of shell material, and it appears to be formed by a tight fold in the wall of the test. The synonymy of the genus *Nuttallides* with *Asterigerina* is not accepted; *Parvicarinina* and *Parrelloides* are recognized as valid genera.

The structure in the genus *Ammonia* which has been called the axial plate has not been observed. The internal structure is considered to be formed by a fold of the septal flap, which is secondarily doubled. Specimens of *A. beccarii* (Linn.) are radiate throughout. The genus *Pseudorotalia* has an internal structure similar to that of *Ammonia*. The apertural face of species of *Pseudorotalia* has a double layer of shell material.

The genus *Cibicides* is bilamellid, and the type species, *C. refulgens* Montfort, is considered to be granular in texture, although a radiate texture has also been recorded in published papers. Species such as *Rotalina ungeriana* d'Orbigny, usually referred to *Cibicides*, are here placed in the radiate bilamellid genus *Planulina*. The radiate genus *Hyalinea* has been found to have a bilamellid and not rotaliid structure.

All the species here referred to *Cassidulina* and *Cassidulinoides* are granular in texture. The genus *Favocassidulina* is here considered to have a radiate wall, although a granular texture has also been recorded in the type species, *F. favus* (Brady). The granular genera *Alabamina* and *Gyroidina* are shown to have a bilamellid structure. *Gyroidina* has an infundibulum similar to that of *Alabamina*, but less strongly developed; these two genera are closely related, and *Alabamina* is considered to be derived from *Gyroidina*. *Gyroidinoides* is placed in the synonymy of *Gyroidina*. The genus *Oridorsalis* is also bilamellid, and related to *Alabamina* and *Gyroidina*, but may be separated by its distinctive apertural characteristics. The genera *Anomalina*, *Anomalinella*, and *Anomalinoides* are bilamellid and granular in texture. The aperture of *Anomalinoides* is now considered to be dorsal and not ventral. The generic name *Melonis* is used for bilamellid species previously referred to *Nonion* or *Gavelinonion*; *Florilus* is used for species previously referred to *Nonion*. Both *Quadrimorphina* and *Rotamorphina* are recognised; the apertural difference is considered to be more important in distinguishing between these genera than the number of chambers per whorl.

The aragonitic genera *Ceratobulimina*, *Hoeglundina*, and *Robertinoides* are shown to have a bilamellid structure, and the toothplate is formed by folds in the wall of the test. The genera *Lamarckina* and *Geminospira* have also been examined, but no bilamellid structure has been observed; by analogy, it is reasonable to regard these genera as also bilamellid. The toothplate of *Lamarckina* forms the umbilical wall of all except the last chamber. It can be shown that when a new chamber is formed the ventral wall of the previous chamber is largely resorbed, exposing the previous toothplate.

The texture of the test wall has been investigated petrologically, and also by X-ray diffraction and Laue photographs. Perforation of the test has been studied, and the value of the pores as a specific feature is confirmed. Determination of the dorsal and ventral sides of the test is considered, and criteria suggested for distinguishing them. Correct homology of the dorsal and ventral sides is essential for accurate description of apertural characteristics and for comparison of the internal structure of different genera. The dorsal surface is taken to be that surface nearest to the proloculus, or the apex of the spire. The dorsal surface is often the only perforate surface, or is the more coarsely perforate.

95044—(2)

INTRODUCTION

Geological investigations in Papua and New Guinea have largely been carried out by, or on behalf of, companies engaged in the search for oil. Condon, Fisher, & Terpstra (1959) and the Bureau of Mineral Resources, Geology and Geophysics (BMR, 1960) have summarized the oil-search activities. The geology of different areas has been given in several publications, such as those of Stanley (1923), the Anglo-Persian Oil Company (1930), Glaessner, Osborne, & Montgomery (in David, 1950), Glaessner (1952), Rickwood (1955), Paterson & Kicinski (1956), McMillan & Malone (1960), and the Australasian Petroleum Company (APC, 1961). Biostratigraphical problems and correlation within the Indo-Pacific region were discussed by Glaessner (1943; 1959*a*, *b*), van Bemmelen (1949), Crespin (1950), and Cloud (1956). A paper by van der Vlerk (1955) also discussed the difficulties of inter-regional correlation. In these papers age determinations were made almost wholly by means of the Foraminifera, with the so-called 'larger' Foraminifera providing the basis for attempts at regional and inter-regional correlations.

Foraminifera have been studied in Papua and New Guinea more than any other fossil group, but most of the information gathered is unpublished, and very little descriptive work has been done. Crespin (1956) listed unpublished work carried out on samples from Papua and New Guinea; in addition to this work there are the unpublished reports of palaeontologists attached to the Australasian Petroleum Company Pty Ltd. Chapman (1914), Crespin (1938*a*, *b*; 1962), and Belford (1962) published papers illustrating Foraminifera from the Tertiary of Papua and New Guinea. The papers of Koch (1923; 1925; 1926), Cushman (1934), Boomgaart & Vroman (1936), Yabe & Asano (1937), LeRoy (1941*a*, *b*, *c*; 1944*a*, *b*; 1964), van der Sluis & de Vletter (1942), Boomgaart (1949), Kleinpell (1954), Daleon & Samaniego (1957), and Samaniego & Gonzales (1957) described faunas from the Indo-Pacific region which are similar to those known from Papua and New Guinea; other references to Indo-Pacific faunas may be found in these papers.

Although some species can be expected to be localized, assemblages of smaller Foraminifera from all parts of the Indo-Pacific region resemble each other, and enough species should be found in common to make possible long-distance correlation. Glaessner (1943, p. 65) stated that the Indo-Pacific smaller foraminifera 'will be found not less useful for stratigraphic purposes than larger foraminifera, when more detailed descriptive work is done'; and also (p. 69) 'Much further work on the stratigraphy of the Pacific Islands is required before the stratigraphic classification of the Tertiary sediments developed in the key areas of the East Indies can be extended over the whole Indo-Pacific region'. The necessity for detailed faunal description was again emphasized by Glaessner (1954*b*, p. 38): 'if properly collected, identified and described, and interpreted the fossils provide a framework of time data which is indispensible for the study of Tertiary geology. Much work on our own collections . . . remains to be done . . . .'; and also (1959*a*, p. 306) 'diese Arbeiten erfordern mikropaläontologische Studien, die hier frühzeitig begonnen wurden, aber mangels monographischer Faunenbeschreibungen, wie sie in Europa im vorigen Jahrhundert und in Amerika vor 30 Jahren ausgefuhrt wurden, noch nicht zu einer klären Zonengliederung geführt haben'.

Although faunal description is essential, a knowledge of the faunas cannot in itself lead to detailed biostratigraphical conclusions. Concerning the Indo-Pacific region, Kleinpell (1954, p. 20) stated: 'an adequate stratigraphic control on species ranges for the province alone (teilzones) still remains to be established. Even within the province regional correlation on the basis of the smaller foraminifera alone is at this time possible only in the sense of a still very crude geologic time scale'. Additional stratigraphical information is available from some of the Pacific Islands, from the work of Todd & Post (1954), Cole (1954; 1957), Todd (1957), Todd & Low (1960), and LeRoy (1964). However, there is still no basis for relating this information to the stratigraphy of Papua and New Guinea.

Allan (1956) discussed the geological history of the Pacific region, including comments on the principles of inter-regional correlation and an outline of the application of several invertebrate groups to biostratigraphical problems. I agree with Allan that planktonic organisms are preferable to benthonic in establishing inter-regional correlations and that the value of the Tertiary benthonic smaller Foraminifera for such correlations is not yet demonstrated: but I do not agree that benthonic organisms should be rejected. In my opinion, the statement by Glaessner (1945, p. 224), quoted by Allan, is valid at the inter-regional level. Allan stated (pp. 337, 338) that the fallacy in this method lies in confusing teilchrons with biochrons (these terms are synonymous with the local range zone and range zone respectively of the American Code of Stratigraphic Nomenclature, 1961). As pointed out in this Code, since all local range zones can never be known, the true range zone cannot be determined; Allan (p. 335) noted that the teilchron is only a portion of the biochron. Although care is required in the use of overlapping ranges (concurrent range zone of the American Code), and it is essential to consider environmental factors, in my opinion the method is not invalid. The main precautions to be taken, at least in Papua and New Guinea, are that only sections free from structural complications should be used in establishing the range zones of any area, and that the possibility of a derived fauna, or of mixed faunas, should be considered.

The endemism of benthonic faunas referred to by Allan (pp. 336, 337) may, in the case of the Foraminifera at least, be more apparent than real, and due to the same species receiving different names in different areas from different workers (see Boltovstoy, 1958, 1963). Endemic faunas related to, and controlled in their distribution by, local environments are to be expected. An obvious example is the *Notorotalia* group, occurring in New Zealand and Victoria, but not known from the Indo-Pacific region. However, other species which have been given different names are in my opinion common to Papua-New Guinea and New Zealand. The species recorded in Papua-New Guinea as *Cibicides pseudoungerianus* Cushman is here considered to be synonymous with *Heterolepa mediocris* (Finlay), described from New Zealand; *Cassidulina cuneata* Finlay from New Zealand to be synonymous with *C. murrhyna* Schwager, occurring in Papua-New Guinea; and specimens identified in Papua-New Guinea as *Laticarinina pauperata* (Parker & Jones) as probably identical with those previously called *L. halophora* (Stache) in New Zealand. The species *Bulimina senta* Finlay is recorded for the first time from Papua-New Guinea, where it has probably been included in the records of *B. aculeata* d'Orbigny. Another aspect of this problem is shown by the specimens recorded by authors as *Cassidulina laevigata* d'Orbigny and *C. neocarinata* Thalmann. Following the observation of Nørvang (1958), I regard them as two forms of the same species, *C. laevigata*. These and other conflicting interpretations which obscure any potential inter-regional biostratigraphical value of the benthonic smaller Foraminifera must be considered and resolved.

This paper is intended primarily to begin the necessary task of describing the smaller Foraminifera of Papua and New Guinea, as a basis for future biostratigraphical work. The specimens are excellently preserved, and morphology has been studied in detail by dissection and thin sectioning; the perforation of the test has also been examined. New morphological information has been obtained for some genera.

The species described are only a small part of the total fauna recorded in the unpublished reports of the Australasian Petroleum Company Proprietary Limited, and incorporated in its collections. The samples in which the specimens have been found are generally isolated, and their relative stratigraphical position is not known. The sediments sampled lie within the structural units named by Glaessner (1950) the Northern Geosyncline, the Aure Trough, the Folded Sedimentary Zone, and the Finisterre Mountains. A list of the sample localities is given in Appendix A, and their position shown on maps 1 to 8. It is not possible at this time to attempt the recognition and formal definition of local or regional zones, or even to give an account of the stratigraphical distribution of the species in any one area. The most obvious, and in fact the only, source of detailed information is the Australasian Petroleum Company collection, at present in Port Moresby. This collection, together with the unpublished geological reports, would give a great deal of information, and would at least make available the complete recorded fauna, description of which must be the basis for any real progress in the Tertiary biostratigraphy of Papua-New Guinea. The Bureau of Mineral Resources has now been offered some of the Australasian Petroleum Company's early sample collections; it should be possible to obtain from them samples collected over measured sections, which will give information on the stratigraphical distribution of the species, and form the basis for detailed biostratigraphical studies. The collections made by the Australasian Petroleum Company are likely to remain the only source of detailed biostratigraphical work: the unpublished information was obtained over a long period at high cost, and it is unlikely that any future exploratory work will be carried out on this scale.

The vertical range given for each species recorded in this Bulletin is taken from unpublished reports of the Australasian Petroleum Company Pty Ltd. This information was accumulated throughout the period of the Company's operations in Papua and New Guinea and incorporated by the palaeontological staff into a card-index file, listing the samples in which each species was found, together with the age of each sample. In addition a comparison collection was built up for each species. Because of the pressure of routine examination of samples, and lack of literature, no descriptive work was undertaken by micropalaeontologists on the staff; new or unidentified species were distinguished only by a number. Wherever possible each new species described in this paper has also been given the species number under which it was recorded in the unpublished reports. It has not always been possible to do this, and some species are not known to have been recorded previously from Papua and New Guinea.

The Parr Collection of Foraminifera, now at the Bureau of Mineral Resources, Canberra, A.C.T., has been a valuable source of much comparative material. All specimens examined from other areas are, unless otherwise stated, taken from this collection.

The synonymies given are not exhaustive; for the original reference to many species reliance has been placed on the Catalogue of Foraminifera (Ellis & Messina, 1940 *et seq.*).

All figured specimens and thin sections are deposited in the Commonwealth Palaeontological Collection at the Bureau of Mineral Resources, Canberra, A.C.T.

ACKNOWLEDGEMENTS

This Bulletin is based on a thesis submitted to the Institute of Advanced Studies, Australian National University, for the award of the degree of Doctor of Philosophy. The work was carried out within the Department of Geology, School of General Studies, Australian National University, under the supervision of Professor D. A. Brown, and was made possible by the award of a Commonwealth Public Service Post-Graduate Scholarship in 1961 and of the Ampol Scholarship in Geology for 1962.

I wish to express my thanks to Professor D. A. Brown and Dr K. S. W. Campbell of the Department of Geology for their interest in the work, and for discussions on morphological problems and taxonomic procedure; to Dr A. J. R. White and Dr K. A. W. Crook of the Geology Department for advice on petrological problems connected with wall texture; to Mr K. L. Williams and Mr J. J. A. Taylor of the Geology Department for advice on photographic problems; to Mr B. W. Chappell of the Geology Department and Mr L. L. Hawes of the Chemistry Department for assistance with the Laue photographs of the test wall; to Professor M. F. Glaessner, Department of Geology, University of Adelaide, for comment and discussion; to Dr G. R. J. Terpstra and Mr A. R. Lloyd of the Bureau of Mineral Resources, and Dr N. de B. Hornibrook and Dr D. G. Jenkins of the New Zealand Geological Survey for supplying comparative material; to Professor J. J. Graham of Stanford University, California, for checking the identification of *Brizalina pseudobeyrichi* (Cushman); to Mr E. D. Gill, Assistant Director of the National Museum of Victoria, and Mr A. C. Collins of Geelong, Victoria, for assistance with enquiries concerning the holotype of *Brizalina subreticulata* (Parr); and to the Directors of Oil Search Ltd for permission to examine the smaller Foraminifera in the Australasian Petroleum Company's collection at Port Moresby, Papua.

Acknowledgement should also be made of the work on the late Tertiary smaller Foraminifera of Papua-New Guinea carried out for many years by Professor M. F. Glaessner, Dr F. M. Kicinski, and Mr L. W. Stach. These three workers discriminated between many of the species described in the present paper, distinguished them by a name or number, established their stratigraphic ranges, and assembled the comparative collection now held by Oil Search Limited at Port Moresby.

SYSTEMATIC DESCRIPTIONS

INTRODUCTION

Emphasis in classification has moved from the method of formation and the perforation of the foraminiferal test to its petrological and mineralogical nature, its lamination or non-lamination, and the nature of the septal wall (see, for example, Wood, 1949; Smout, 1954; Bandy, 1954; Troelsen, 1955*a*; Todd & Blackmon, 1956; Reiss, 1957, 1958, 1959, 1963*a*; Blackmon & Todd, 1959). These studies indicate that the composition, texture, and structure of the foraminiferal test wall are fundamental characters, subject to genetic control and not greatly affected by environment.

In recent years considerable progress has been made in knowledge of the finer morphological details of the foraminiferal test, but there is still much to be learned. Glaessner (1963) reviewed the progress of knowledge of major evolutionary trends in the Foraminifera. Several cases in which present knowledge is inadequate were pointed out, and it is clear that much more work is required, particularly on early representatives of the Order. In the absence of functional morphological studies the attainment of a stable taxonomy must depend solely on observational morphology. The development of soundly-based phylogenetic (or more properly phylomorphogenetic) theories also depends on accurate and detailed morphological studies. As Drooger (1954) said 'In itself, phylogenetic systematics is an ideal that may be achieved only when all morphological and other data concerning some group of fossils have been assembled, and even then its components must be expressed in morphologic terms'. Recently proposed classifications of the Foraminifera have emphasized one morphological feature in preference to others, and differing classifications have resulted. For instance, Hofker (1951*b*) emphasized the internal structure ('toothplate'), Loeblich & Tappan (1961; 1964*a*) the texture of the wall, and Reiss (1958; 1963*b*) the lamination of the test. The term 'texture' is used here as defined by Glaessner (1963), and as used by Reiss (1963*b*), for the granular and radiate divisions recognized by Wood (1949).

The emphasis to be given to wall texture and structure in the classification of the Foraminifera is a matter on which there is no agreement. Superfamilies have been proposed on these features, and they have been used down to the level of generic separation. Cifelli (1962) criticized the practice of referring species to different genera only on the basis of a radiate or a granular wall texture; Smout (1956, p. 337) stated 'In many instances it would be impractical to separate the granulate from the fibrous forms'. Hofker (1962) has criticized the observations on, and interpretation of, the test wall given by Smout (1954) and Reiss (1957; 1958). Reiss (1963*a*) has replied to this criticism, and I agree with all the comments he has made.

There are reports of species showing both radiate and granular areas of the wall in the same specimen, for example Cifelli (1962) in *Ammonia beccarii* (Linn.) and Glaessner (1963, p. 16) in species of *Cibicides* and *Anomalinoides*. If species of this type exist, wall texture would be of no value in classification; however, I do not believe that their existence has been conclusively demonstrated. On the other hand, the existence of two morphological groups, one showing a radiate and the other a granular wall texture, appears to be well established. Whether or not these are 'natural' groupings in that they developed along wholly separate lines of evolution, or whether members of each group evolved from the other at different times, is not known.

Conflicting reports on the wall texture of some species are to be found in the literature. Wood (1949) determined the wall of *Cibicides refulgens* Montfort to be granular, but later Wood & Haynes (1957) corrected this, and gave the texture as radiate in thin section, with the grains apparently larger than usual. Loeblich & Tappan (1962*c*) also recorded a radiate wall. I have examined Recent specimens of *C. refulgens* from 'Goldseeker' hauls, and consider that the wall should be regarded as granular. Thin sections suggest that some grains have a radiate arrangement, but that smaller grains with a random orientation occur between them. Wood (1949) recorded a radiate texture for *Favocassidulina favus* (Brady), but Loeblich & Tappan (1957*a*) considered that the wall is granular, from a re-examination of 'Challenger' specimens. All Papua-New Guinea specimens of *F. favus* are radiate, the texture being clearly shown by both fragments of the shell wall and by thin sections.

These conflicting determinations of a feature regarded as a diagnostic character of the foraminiferal test wall cannot but reduce confidence in its taxonomic value. It seems that some agreement must be reached on the petrological characteristics of radiate and granular wall texture. The original distinction was established mainly on fragments of the wall, with radiate species giving a pseudo-uniaxial interference figure under crossed nicols. Provided that a truly radiate texture exists, irrespective of grain size, an interference figure should be obtained, if necessary with conoscopic light, although Wood (1963) has warned against the use of convergent light. A comparison between the appearance of a fragment of the wall of *Cibicides refulgens*, and of an undoubted radiate species, indicates that they have different petrological characteristics. It seems that although some grains in the wall of *C. refulgens* have a radiate arrangement, smaller grains with a random orientation prevent the observation of any interference figure.

In addition to petrological examination of the test wall, its characteristics have been investigated by X-ray diffraction (see Chart 1). Undoubted radiate species such as *Orbulina universa* d'Orbigny and *Globorotalia cultrata* d'Orbigny have been examined, and also granular species such as *Oridorsalis variapertura* sp.nov. and *Globocassidulina subglobosa* (Brady), and a porcellaneous species, *Marginopora vertebralis* Blainville. A characteristic X-ray diffraction chart has been obtained for each of these three types of wall texture. Wall thickness and grain size have no effect on the relative intensity of the main peaks recorded, at least for the species investigated: the thin-walled and fine-grained radiate species *Globorotalia cultrata* and *Pulleniatina obliquiloculata* (Parker & Jones) give the same type of chart as the thick-walled *Neoeponides subornatus* (Cushman); the thick-walled, coarse-grained granular species *Oridorsalis variapertura* sp.nov. gives the same chart as *Globocassidulina subglobosa*. It can be seen from Chart 1 that entire tests of *Orbulina universa* give a chart similar to that of granular species; this is to be expected, as the entire spherical test contains grains occupying all orientations with respect to

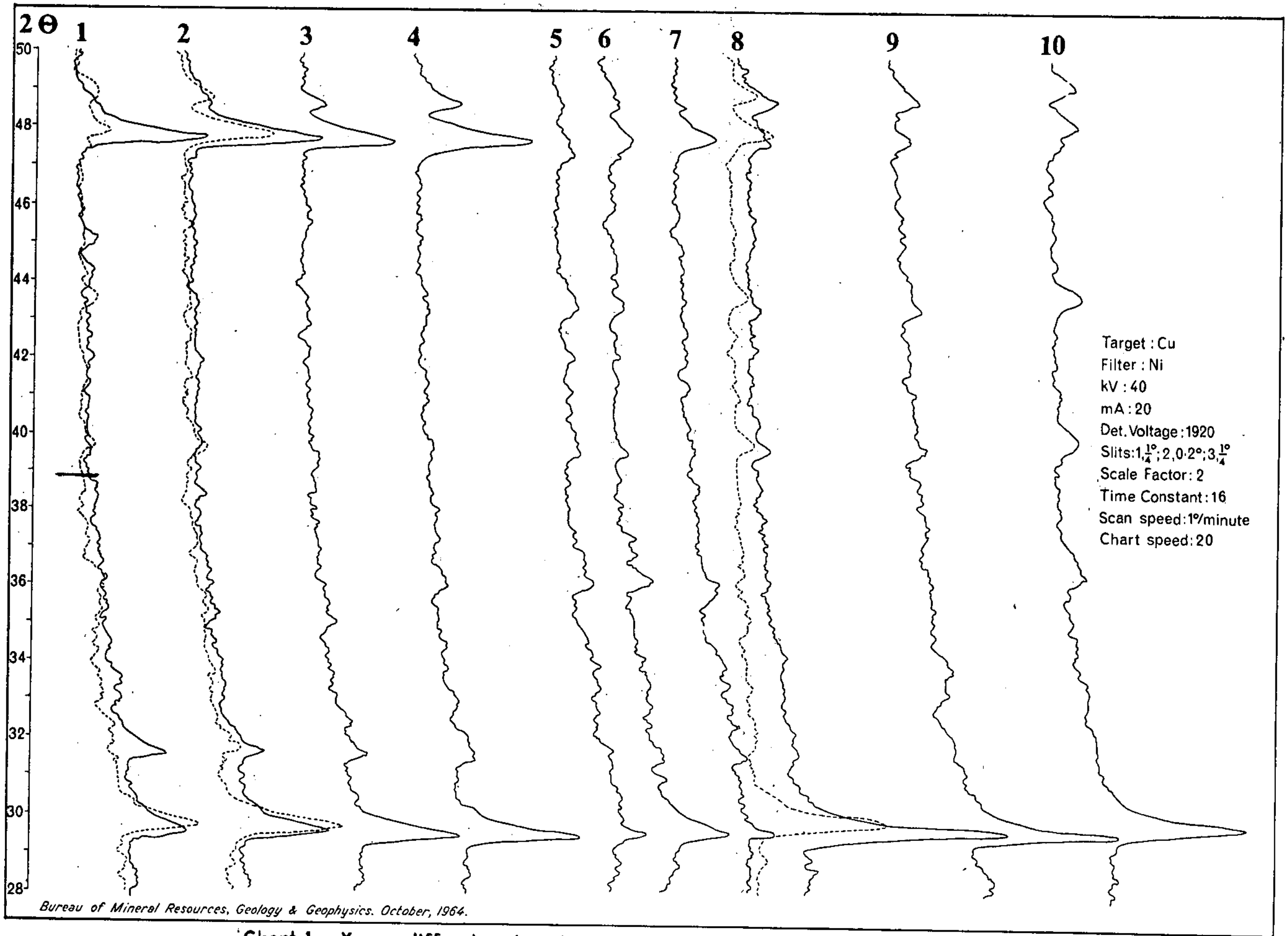


Chart 1 X-ray diffractometer charts obtained from foraminiferal tests

P/A/64

the X-ray beam. The effect is not as noticeable with complete tests of *Globorotalia cultrata*, and this may be explained by the compressed shape of the test, resulting in a smaller range of random grain orientation. For granular species, the charts from both fragments and complete tests are the same. The porcellaneous species *Marginopora vertebralis* gives a chart similar to that of a granular species, but with more clearly defined smaller peaks in the middle of the chart. This species appears to have a preferred orientation of the crystals parallel to the surface of the chambers; an identical chart was obtained from a species of the genus *Peneroplis*.

The chart obtained from fragments of *Cibicides refulgens* shows differences from those of both radiate and granular species. *C.* sp.cf. *C. refulgens* from the Wreck Island Bore, Queensland, and *Gyroidina torulus* sp.nov. give a chart similar to that of *refulgens*. These three species may also show indistinct smaller peaks in the middle of the chart, as do the granular and porcellaneous species.

The difference between the charts given by *Cibicides refulgens* and by true radiate species at least supports the observed petrological difference in their wall texture. The conclusion reached here is that *Cibicides refulgens* does not have a radiate wall; its wall texture also seems to differ from that of a wholly random granular species.

Laue photographs of the test wall (see Plate 38) also support the view that the wall texture of *Cibicides refulgens* differs from that of a true radiate species. A photograph of a fragment of the wall of *Orbulina universa* from 'Goldseeker' haul 211 shows less strongly developed lines than that of a fragment of *Cibicides refulgens* from the same locality. The Laue photographs were taken only to support the petrological and diffractometer results. The present work suggests that if a clear indication of the wall texture cannot be obtained by petrological examination, a diffractometer chart will settle the question; these charts are more easily and quickly produced than is a Laue photograph.

A disadvantage in carrying out X-ray diffraction work on Foraminifera is that it is impossible to obtain a large continuous surface of the wall; nor is it possible to compare exactly the same surface area of different species. These factors may influence the relative intensity of the peaks recorded. However, it does appear

---

CHART 1: X-ray diffractometer charts obtained from foraminiferal tests

1 *Orbulina universa* **d'Orbigny, locality 9c; heavy line, fragments of the test; dotted line, whole tests.**
2 *Globorotalia cultrata* **d'Orbigny, locality 21; heavy line, fragments of the test; dotted line, whole tests.**
3 *Pulleniatina obliquiloculata* **(Parker & Jones), locality 21.**
4 *Neoeponides subornatus* **(Cushman), locality 41.**
5 *Cibicides refulgens* **Montfort, 'Goldseeker' haul 135, 61° 34′ N., 02° 04′ E., at 370 metres.**
6 *Cibicides* **sp.cf.** *C. refulgens* **Montfort, Wreck Island Bore, Queensland, at 614-625 feet.**
7 *Gyroidina torulus*, **sp.nov., locality 21.**
8 *Oridorsalis variapertura*, **sp.nov., locality 39; heavy line, fragments of the test; dotted line, whole tests.**
9 *Globocassidulina subglobosa* **(Brady), locality 21.**
10 *Marginopora vertebralis* **Blainville, Recent, from the lagoon, Lord Howe Island.**

to be a suitable technique for the examination of wall texture. Fragments of the wall should be used, rather than whole tests, which in the case of a radiate species may give a chart characteristic of a granular species.

The internal structure of the foraminiferal test, now generally referred to as a toothplate, was first described by Höglund (1947), who used the terms diaphragm, tongue, internal tube, or internal trough. Brotzen (1948) referred to the internal structure as a partition, septum inferior, or infundibulum, according to the genus in which it occurred. Hofker (1951*a*) introduced the term toothplate, defining it as a 'more or less developed, often contorted plate, running from a former, now septal foramen to the next one, through a chamber'. This term has come to be used for internal structures formed in a number of ways, and is obviously applied in a much wider sense than originally defined. Thus the peripheral keel of *Laticarinina*, incompletely dividing the following chamber, the umbilical wall dividing the chambers of *Pseudorotalia* into two parts, and the dividing partition of *Asterigerina*, are all called toothplates. The broad application of the term toothplate obscures possible generic relationships in that structural similarities which may enable homologous features to be recognized in different genera are not considered. Glaessner (1954*a*) stated that a new descriptive term is needed for the internal structure. With the recognition of the finer details of the test as important morphological features it seems to me necessary to distinguish between features formed in different ways, or differently situated, and to give them different names. In my opinion, the term 'infundibulum' defined by Brotzen (1948) for *Alabamina* should be retained. Reiss (1960) proposed the term 'murus reflectus' for a structure formed in essentially the same way as the infundibulum, by infolding of the chamber wall, but situated at the umbilical apertural margin. The internal structure of several genera, such as *Bulimina*, *Globobulimina*, *Cassidulina* (s. 1), *Virgulina*, *Ceratobulimina*, *Hoeglundina*, and *Robertinoides*, is also formed by infolding of the apertural face, but is connected with the septal foramen. The infundibulum does not reach to the septal foramen, and although there are genera (for example *Osangularis*) in which the murus reflectus reaches to the previous apertural face, at least in geologically younger species, it is not closely connected with the septal foramen. The internal structure of *Ceratobulimina*, *Hoeglundina*, and *Robertinoides*, and probably of all aragonitic genera, is bilamellid; the term 'partition' as used by Höglund (1947) is available for this structure, although it does not in all cases completely divide the chambers. *Asterigerina* is a calcitic genus which has a bilamellar partition, but it is clear from thin sections that it is a structurally different feature from the partition in the aragonitic genera; it is here referred to as the 'dividing septum'. In *Ceratobulimina* the bilamellid structure is caused by an inner lining to the chamber wall, and in *Robertinoides* the partition may be wholly formed by the inner lining, although this is not certain. In *Asterigerina* both layers of the dividing partition are formed by the chamber wall, the partition resulting from a tight fold in the wall. Another type of internal structure is shown by *Cassidulina laevigata* d'Orbigny and some other species referred to *Cassidulina*. This takes the form of a small internal ledge above the aperture, also resulting from inward folding of the apertural face; this ledge has no connexion with the septal foramen. In species such as

C. murrhyna Schwager it is very strongly developed. This type of internal structure can be distinguished from the infundibulum and murus reflectus in that it is not attached to the previous whorl, and from the toothplate in that it does not reach to the septal foramen.

Hofker has in several papers suggested that apertural lips are structures homologous with toothplates, or that part of the apertural face is formed by the toothplate. Many genera have both a toothplate and an apertural lip; I do not believe that a good case has been made for the homology of these structures. In the genus *Bulimina*, for example, the apertural collar is continuous with one margin of the toothplate; although both are connected, each is merely a different expression of the one feature, namely the outer chamber wall.

Hofker's claim that part of the apertural face is formed by the toothplate seems to be based to some extent on such genera as *Lamarckina* and *Asterigerina*. I do not agree with Hofker that the umbilical plate of *Lamarckina*, or the perforate face of *Asterigerina*, are in fact the toothplates of the succeeding chamber; this is discussed more fully under the genera concerned. The only genus I have observed in which the internal division of the chamber is formed before the chamber is built is *Laticarinina*, and here the structure is not a toothplate as originally defined. Hofker considers the fact that part of the apertural face is imperforate as indicative of its formation by the toothplate; this is demonstrated in a paper (Hofker, 1956*a*) with regard to the genus *Buliminella*. In this genus, the toothplate is again a continuation of the lamina forming the chamber, and it is not possible to distinguish structurally between the toothplate and the apertural face. Texturally, there is a difference: the toothplate and the upper part of the apertural face are imperforate, and the remainder of the chamber wall finely perforate. The fact that the toothplate is imperforate is the basis of attempts by Hofker to recognize other imperforate parts of the test as homologous with the toothplate. In my opinion, this has not yet been satisfactorily demonstrated in any genus; one objection, already pointed out by other workers, is that all ornamentation of the foraminiferal test, whether striae, costae, or keels, is also imperforate.

Although I consider that the internal structure is an important morphological character, to be considered in foraminiferal classification, it must be emphasized that it alone does not necessarily indicate generic relationships. For instance, an infundibulum occurs in the granular genera *Gyroidina* and *Alabamina*, but also in *Neoeponides*, which has a radiate wall. The function of the internal structure is not known, and its development has not been observed; these are fundamental gaps in knowledge which must be filled before the significance of the different features distinguished on a structural basis can be accurately assessed.

Correct homology of the dorsal and ventral sides of the foraminiferal test is essential for comparison of apertural characteristics, and also for the comparison of the internal structure of different genera and consideration of their possible phylogenetic derivation. Published papers make it clear that there is no general agreement on the features characterizing dorsal and ventral sides. Brown & Bronnimann (1957) stated that Palmer (1934) confused the dorsal and ventral sides of her *Camerina? dickersoni*, the type species of the genus *Sulcoperculina*: they did not indicate any method to be used in determining the dorsal and ventral side. Hofker

(1955) stated that Bermudez (1952) had confused the dorsal and ventral sides of *Hanzawaia*. Earlier (1951*b*, p. 343), discussing the genus *Cibicidoides*, Hofker stated that only transverse sections would indicate the ventral side, but did not give any criteria to be applied.

Glaessner (1945, p. 69) gave two criteria for distinguishing between the dorsal and ventral side of trochospiral tests. Often there is no difficulty in deciding on the correct orientation of the test; the most difficult cases are low-spired tests, and wholly or strongly involute, only slightly asymmetric tests, such as those of species of *Anomalinoides*. As either side of the test may be evolute or involute, and this feature has a large intra-specific variability, the convention given by Glaessner of regarding the evolute side of low-spired tests as dorsal is not wholly satisfactory. Bolli, Loeblich, & Tappan (1957) have outlined the different criteria used and indicated some of the inconsistencies in determining dorsal and ventral sides; they used the terms 'spiral' and 'umbilical', which were introduced by Brotzen (1942), rather than dorsal and ventral. Previously (1960) I also used these terms, but would now agree with Drooger (1960, p. 319), who considered that spiral and umbilical were scarcely better terms than dorsal and ventral. The main objection to these terms is that as either side of the test may be involute or evolute they describe the appearance of the test rather than determine the dorsal and ventral sides.

Drooger (1960, p. 319) gave, as one possible method of distinguishing the ventral side, of the Rotaliidea at least, '. . . the preference of the intercameral foramen to be situated at this side'. This is true of the Rotaliidea, but does not necessarily apply to all groups and may give incorrect results. I consider that the second criterion given by Glaessner, that of regarding the apical surface as dorsal, is the most useful. For involute slightly asymmetric species vertical sections are essential, and they are also desirable in the case of low-spired species. In this paper, the surface nearest to the proloculus is regarded as dorsal, and the greater part of the test therefore lies on the ventral side of the plane passing through the periphery and the centre of the proloculus. Reiss (1963*b*, p. 43) also used this method, but retained the terms 'spiral' and 'umbilical' rather than 'dorsal' and 'ventral'. The application of this criterion is shown later in the discussion of *Discorbinella bertheloti* (d'Orbigny). Comments given in an earlier paper (Belford, 1960, p. 101 ff.) are now regarded as incorrect: the flatter side of specimens in vertical section was regarded as the base of the spire and called ventral; by analogy, the flat surface of species such as *Cibicides voltziana* d'Orbigny was also regarded as ventral. This comparison should have been made the opposite way, from species such as *C. voltziana* to thin sections, and would have given a dorsal aperture for *Anomalinoides*. The criterion of regarding the surface nearest the proloculus as dorsal gives the same result. This correction also applies to the species of *Anomalinoides* described from the Upper Cretaceous of Western Australia.

Another feature which is of assistance in indicating the dorsal and ventral sides is the perforation of the test. It is notable that in many trochospiral species the preference is for the dorsal side to be perforate, or at least to be more coarsely perforate than the ventral side. Examples of species in which the perforation is usually confined to the dorsal side are *Planulina ariminensis* d'Orbigny, *Parrelloides bradyi* (Trauth), and *Heterolepa mediocris* (Finlay). *Cibicides refulgens* Montfort is one species which has pores on the ventral side, but they are much finer than the dorsal pores. There are also species in which no apparent difference in pore size on the dorsal and ventral sides can be detected, such as *Asterigerina carinata* d'Orbigny, or species of *Neoeponides*. However, in these cases there is no difficulty in determining the dorsal and ventral sides by other methods. In the case of a species for which determination of dorsal and ventral sides is difficult I believe that the perforation of the test is a feature worthy of consideration.

Bolli, Loeblich, & Tappan (1957, pp. 9–10) have outlined the different interpretations of the dorsal and ventral sides of attached forms depending on the feature used. This group constitutes a special case, as an attached form would assume different positions depending on the position of the material to which it is attached. In the fossil state specimens are only rarely found still adhering to other material. I consider that in this case it is necessary to agree on a convention for recognizing the dorsal and ventral sides. It is suggested that the criterion of regarding the surface nearest the proloculus as dorsal be applied, although this may be the attached side, and from this point of view considered as ventral. McKnight (1962) apparently used this criterion for species of *Cibicides*. Such a convention if adopted would avoid the confusion resulting from the use of several different methods, not all of which give the same result. It may be noted that in the case of *Cibicides refulgens* the attached flattened surface, here regarded as dorsal, is the more coarsely perforate, as in free-living forms.

The suprageneric classification used in this paper is that of Loeblich & Tappan (1964*a*) but some genera are interpreted differently.

Subphylum SARCODINA Schmarda, 1871

Class RHIZOPODEA von Siebold, 1845

Subclass GRANULORETICULOSIA de Saedeleer, 1934

Order FORAMINIFERIDA Eichwald, 1830

Suborder ROTALIINA Delage & Hérouard, 1896

Superfamily BULIMINACEA Jones, 1875

Family TURRILINIDAE Cushman, 1927

Subfamily TURRILININAE Cushman, 1927

Genus BULIMINELLA Cushman, 1911

The toothplate of *Buliminella* is similar to that of the genus *Stainforthia* Hofker, and the close relationship of these two genera has been noted by Hofker (1956*b*). In *Buliminella* the toothplate extends to the septal foramen, but in *Stainforthia* is attached to the upper part of the apertural depression.

Höglund (1947) described the aperture and toothplate of '*Bulimina fusiformis*' Williamson. From his own work and an examination of the literature, Höglund believed the aperture of the young stage of this species to be without parallel. I have examined specimens of *fusiformis* from 'Goldseeker' hauls 125 and 135, and have found that the aperture of the young stages is a rounded interiomarginal opening behind a small lip, lying in a deep apertural depression, as in *Buliminella* *elegantissima*. The wall of *fusiformis* is radiate in texture. The toothplate of *fusiformis* is similar to that of *B. elegantissima*, but is attached to the upper surface of the previous chamber and does not reach to the septal foramen.

Höglund stated that obviously '*B.*' *fusiformis* could hardly belong to *Bulimina*, and suggested a relationship with *Virgulina* (= *Fursenkoina* (Loeblich & Tappan)). Cushman & Parker (1947) also referred *fusiformis* to *Virgulina*. However, *Fursenkoina* is a granular genus with quite different apertural characteristics. It is here suggested that *fusiformis* is developed from or related to the genus *Buliminella*, possibly through species such as *B. exilis* and *B. tenuata*. In these species the number of chambers in each whorl is reduced to three, and a further reduction could result in the twisted biserial test of *fusiformis*. Species referable to the genus *Stainforthia* resemble *fusiformis* in that the toothplate does not reach to the septal foramen, and in the twisted biserial younger chambers, but the apertural characteristics of *Stainforthia* are different. '*Bulimina*' *fusiformis* may be referable to the genus *Buliminellita*. However, Hofker (1956*a*, p. 924) stated that the toothplate of *Buliminellita* indicates a close relationship to *Uvigerina*, although the coiling of the test shows a resemblance to *Buliminella*.

BULIMINELLA sp.cf. B. TENUATA Cushman, 1927

(Pl. 6, figs 22–24; text-fig. 6: 9–10)

cf. 1927*d* *Buliminella subfusiformis* Cushman var. *tenuata* Cushman, p. 149, pl. 2, fig. 9.

Material examined: 96 specimens.

Abundant specimens from several samples in the Papua-New Guinea material are tentatively referred to *B. tenuata*. They resemble *tenuata* in lacking a spine on the proloculus, but are not as slender and elongate as the specimen figured by Cushman & Parker (1947) and identified as *Bulimina exilis* Brady var. *tenuata* (Cushman); the range of variation shown by *tenuata* is not known. Walton (1955) referred *tenuata* to the genus *Bulimina* as a subspecies of *B. exilis*, but Bandy (1953) raised it to specific level and placed it in the genus *Buliminella*.

I have examined specimens of *Buliminella exilis* (Brady) from 'Albatross' station 2262, 39° 54′ 45″ N., 69° 29′ 45″ W., from a depth of 250 fathoms; most of these specimens are elongate, but some shorter specimens have an outline similar to that of specimens from Papua-New Guinea. All the specimens have an initial spine, but Cushman & Parker (1947) noted that the spine is sometimes absent from megalospheric forms. The aperture of *B. exilis* (Brady) was described by Cushman & Parker as 'broad, loop-shaped, placed at the apex of the test, pointing directly downwards to meet the junction of the second and third chambers'. Specimens from 'Albatross' Station 2262 have a broad apertural hollow, formed by infolding of the apertural face; the aperture is a small rounded to oval interiomarginal opening under a thin semicircular lip. The inner part of the apertural face forms a narrowly folded toothplate in each chamber, extending into the previous apertural hollow and reaching to the margin of the septal foramen. The same aperture and toothplate are shown by Papua-New Guinea specimens.

All specimens observed have three chambers to a whorl, the chamber series following regularly on each other, or the whole test twisted, the twisting being against the direction of coiling. The test is very finely perforate, the pore pattern of the Papua-New Guinea specimens and Recent specimens of *Buliminella exilis* being very similar; both groups have a pore diameter of 0·4 to 0·6 microns, and the wall is radiate in texture.

The two species *B. exilis* (Brady) and *B. tenuata* Cushman may be separated on the presence or absence of an initial spine; on this feature the present specimens are closer to *B. tenuata* than to *B. exilis*. However, the similarity of Papua-New Guinea specimens to *B. exilis* in apertural characters, toothplate pores, and wall texture suggests that the initial spine is a feature due to geographic subspeciation. The Papua-New Guinea populations apparently include a much greater proportion of short broad individuals than do Recent populations of *B. exilis* and *B. tenuata*, and subspecific distinction may be justified. At present, lack of information on the full variation of both *exilis* and *tenuata* prevents this.

*Dimensions of figured specimens:**	Length	Maximum Width
CPC 6149	0·56	0·18
CPC 6150	0·47	0·16
CPC 6151	0·56	0·18

Occurrence: Figured specimens (CPC 6149 and 6150) from below the cliff at Maprik, Screw River, Sepik district, New Guinea (upper Miocene); figured specimen (CPC 6151) from Pagansop village, north-north-east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 23, 27, 30, 35.

Buliminella exilis (Brady) has been recorded as *Bulimina exilis*, occurring only in the Pliocene. It has been noted that specimens comparable to *B. exilis* occur in older beds and these may be specimens of the type here compared to *Buliminella tenuata*.

Remarks: The apertural characters and toothplate of *B. tenuata* and *B. exilis* indicate that they cannot be referred to the genus *Bulimina*. The description of the toothplate of *Buliminella elegantissima* (d'Orbigny) given by Hofker (1951*b*) suggested that it may be of the same form as that of *B. tenuata* and *B. exilis*, particularly description of the shape of the toothplate as a 'cornet'. This was confirmed by examination of a specimen of *B. elegantissima* from 'Challenger' station 219A, Nares Harbour, Admiralty Islands, at a depth of 17 fathoms; the aperture was also found to be the same. The toothplate of *B. elegantissima* is broader at the base, where it is attached to the margin of the septal foramen.

Specimens from the Pico Formation, Los Angeles Basin, California, very similar to *Buliminella curta* Cushman, have the same type of aperture and toothplate as *elegantissima*; the toothplate is narrow, and similar in shape to that of *tenuata* and *exilis*. The two species *tenuata* and *exilis* differ from *elegantissima* only in having fewer chambers to each whorl, a difference which is not considered to be of generic significance. For this reason the present specimens, which are compared to *tenuata*, are referred to the genus *Buliminella*.

* Dimensions throughout this Bulletin are in millimetres unless otherwise stated.

Family BOLIVINITIDAE Cushman, 1927

Genus BOLIVINITA Cushman, 1927

BOLIVINITA QUADRILATERA (Schwager, 1866)
(Pl. 4, figs 4–7; text-fig. 1: 4)

1866 *Textilaria quadrilatera* Schwager, p. 253, pl. 7, fig. 103.
1884 *Textilaria quadrilatera* Schwager; Brady, p. 358, pl. 42, figs. 8a–b, 9–12.
1911 *Textilaria quadrilatera* Schwager; Cushman, p. 24, text-fig. 42a–c, 43–44.
1921 *Textilaria quadrilatera* Schwager; Cushman, p. 125, pl. 23, figs. 2a–b.
1927*a* *Bolivinita quadrilatera* (Schwager); Cushman, p. 90.
1941*a* *Bolivinita quadrilatera* (Schwager); LeRoy, p. 31, pl. 1, figs 99–101; pt. 2, p. 79, pl. 2, figs 3–4.
1941*b* *Bolivinita quadrilatera* (Schwager); LeRoy, p. 79, pl. 2, figs 3–4.
1942 *Bolivinita quadrilatera* (Schwager); Cushman, p. 2, pl. 1, figs 1, 2a–c, 3a–b, 4a–c. (Synonymy).
1944*b* *Bolivinita quadrilatera* (Schwager); LeRoy, p. 83, pl. 2, figs 13–14.
1949 *Bolivinita quadrilatera* (Schwager); Boomgaart, p. 95, pl. 8, figs 3a–b.
1951*b* *Bolivina quadrilatera* (Schwager); Hofker, p. 102, figs 59, 60a–e, 61a, b, d, e, 62.
1952 *Bolivinita quadrilatera* (Schwager); Asano, p. 14, figs 76–77.
1957 *Bolivinita quadrilatera* (Schwager); Montanaro Gallitelli, p. 146, pl. 33, figs 17a–b, 18a–b, 19–20.
1957 *Bolivinita quadrilatera* (Schwager); Samaniego & Gonzales, p. 199, pl. 22, fig. 9.
1957 *Bolivinita quadrilatera* (Schwager); Daleon & Samaniego, p. 40, pl. 1, fig. 32.
1960 *Bolivinita quadrilatera* (Schwager); Barker, p. 86, pl. 42, figs 8a–b, 9–12.
1963 *Bolivinita quadrilatera* (Schwager); Decima, p. 88, pl. 1, figs 11a–b.
1964 *Bolivinita quadrilatera* (Schwager); Huang, tab. 1, pl. 2, fig. 23.
1964 *Bolivinita quadrilatera* (Schwager); LeRoy, p. 29, pl. 2, figs 37–38.

Material examined: 59 specimens.

B. quadrilatera occurs abundantly in a number of samples. The tests are usually narrow and elongate, but some relatively broader specimens occur, with concave chamber surfaces, closely resembling the specimens described by Asano (1938) as *Bolivinita quadrilatera cuneata* and by LeRoy (1944*a*) as *Bolivinita quadrilatera* var. *sumatrensis*. These specimens are here considered to represent only normal intra-specific variation (see also Montanaro Gallitelli, 1957, pl. 33, figs 17a–b). The specimens figured by Vella (1957) as *Bolivinita* cf. *grant-taylori* also seem to be referable to *B. quadrilatera*.

The test wall of *Bolivinita quadrilatera* is finely and densely perforate over the entire chamber surface, the pore diameter being 2–3 microns, and is radiate in texture. Each chamber has a well developed toothplate with a broad flaring base, the folded portion confined to the upper part and forming a narrow tooth in the aperture.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6153	0·82	0·31	0·20
CPC 6154	0·76	0·35	0·22

Occurrence: Figured specimen (CPC 6153) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); figured specimen (CPC 6154) from the road cutting south of Moab, Bogia district, New Guinea (upper Miocene); other localities: 3, 13a, 18, 25, 27, 38, 39.

Bolivinita quadrilatera is recorded from the lower Miocene (Burdigalian) to the Pliocene. It also occurs in Recent deposits.

BOLIVINITA COMPRESSA Finlay, 1939

(Pl. 4, figs 1–3; text-fig. 1: 3)

1939 *Bolivinita compressa* Finlay, p. 319, pl. 27, figs 101–102.

Material examined: 11 specimens.

The description of *B. compressa* published by Finlay (1939) is very brief, but gives the characteristic feature of the species, namely the longitudinal keel in the centre of the test. This appearance is caused by the rhomboid and not rectangular outline in end-view. The two outer keels are strongly developed, but those towards the centre of the test are not always distinct, particularly on the later chambers. The test wall is finely perforate, the pore diameter being 2–3 microns, and is radiate in texture. Each chamber has a well developed toothplate with a broad flaring base and a broadly folded upper part, the free edge forming a narrow tooth in the aperture.

Dimensions of figured specimens:	Length	Maximum Width (incl. keel)	Thickness
CPC 6156	0·98	0·45	0·18
CPC 6157	0·70	0·35	0·16

Occurrence: Figured specimens (CPC 6156 and 6157) from a sample east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); other locality: 7b.

This species has been recorded both as *Bolivina compressa* (Finlay) and as *B.* sp. 10, occurring in the middle and upper Miocene.

BOLIVINITA SUBANGULARIS (Brady, 1881)

(Pl. 3, figs 8–11)

1881 *Bolivina subangularis* Brady, p. 59.
1884 *Bolivina subangularis* Brady; Brady, p. 427, pl. 53, figs 32–33.
1937 *Bolivina subangularis* Brady; Cushman, p. 133, pl. 17, figs 5a–b, 6–8, 9a–b, 10. (Synonymy).
1942 *Bolivina subangularis* Brady; Cushman, p. 19, pl. 6, figs 3a–c, 4.
1957 *Bolivina subangularis* Brady; Samaniego & Gonzales, pl. 22, fig. 11.
1957 *Bolivina subangularis* Brady; Daleon & Samaniego, p. 45, pl. 1, fig. 44.
1959 *Bolivina subangularis* Brady; Graham & Militante, p. 79, pl. 12, figs 15a–b. (Synonymy).
1960 *Bolivinita subangularis* (Brady); Barker, p. 109, pl. 53, figs 32–33.

Material examined: 6 specimens.

This distinctive species has been found only rarely in the present material. The deep wide longitudinal central depression bordered by thin keels gives an appearance similar to that of *B. quadrilatera.* Cushman (1933*a*) referred *angularis* to *Bolivinita* when he described a new variety as *Bolivinita subangularis* (Brady) var. *lineata.* The test wall of *B. subangularis* is finely and densely perforate, the pore diameter being 2 to 3 microns, and is radiate in texture. All specimens found have the chambers infilled and the toothplate has not been observed.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6159	0·84	0·41	0·36
CPC 6160	0·79	0·40	0·34

Occurrence: Figured specimens (CPC 6159 and 6160) from a sample below the cliff at Maprik, Screw River, Sepik district, New Guinea (upper Miocene); other localities: 30, 32.

B. subangularis is recorded from the upper Miocene and the Pliocene, and occurs also in Recent deposits.

Genus BOLIVINA d'Orbigny, 1839

Loeblich & Tappan (1964*a*) restricted the genus *Bolivina* to include only those species characterized by retral processes and overlapping chamber margins, species without retral processes being placed in the genus *Brizalina* Costa. The retral processes were observed in specimens of *Bolivina robusta* Brady from Papua--New Guinea, and led to an investigation of other species of *Bolivina*, and also species referred to the genera *Bolivinoides* Cushman and *Afrobolivina* Reyment. I agree with Loeblich & Tappan in placing *Afrobolivina* in the synonymy of *Bolivina*; however, I also regard *Bolivinoides* as a synonym of *Bolivina*. Hofker has in a number of papers (1952*a*, 1956*a*, 1957) stressed the close relationship between *Bolivina* and *Bolivinoides*, and Reyment (1959) also regarded *Bolivinoides* as a synonym of *Bolivina*.

B. robusta has short limbate projections at right angles to the sutures, which were described by Brady (1884) as 'crenulate'. Cushman (1937) also used this term, and considered the appearance to result from 'the basal margin of the chamber having a series of alternating lobes and reentrants'. Dissection of the chambers shows that the limbate projections are the external indications of low narrow triangular internal ridges at the base of each chamber. The surface of the chambers is usually slightly depressed above the pillars, and it seems that they are first formed by an infolding of the chamber wall, later developing into solid pillars through secondary deposition of shell material. Hofker (1951*b*) referred to the internal structure of *B. robusta* as 'retral processes', stating that they were formed by '. . . outgrowths of the chambers and not only by a thickening of the walls'. This is taken to mean that the internal structure is in fact part of the chamber wall, and my observations support this interpretation. The type species of *Bolivina*, *B. plicata* d'Orbigny, has a lobate suture with overlaps of the lower chamber margins. Specimens of *B. plicata*, of the type figured by Cushman (1937), from a sample of the Pico Formation (upper Pliocene), Los Angeles Basin, California, have been examined; they have, at least in the later chambers, rounded internal ridges on the lower part of the chamber wall. The ridges are broader than those in *B. robusta*, but this difference is due only to a tighter fold of the wall forming the ridges in *B. robusta*. *B. sinuata* Galloway & Wissler, from a sample of the Repetto Formation (lower Pliocene), Malaga Cove, Los Angeles Basin, California, also has similar internal ridges. Both *B. plicata* and *B. sinuata* were, together with other species, referred by Hofker (1952*a*) to the genus *Bolivinoides*; later (1956*a*), Hofker referred *robusta* to *Bolivinoides*. Glaessner (1945, p. 139) stated that *Bolivinoides* was distinguished only by the heavily costate surface, and regarded this as a feature of hardly more than subgeneric significance. Hiltermann & Koch (1950) discussed *Bolivinoides* in some detail and observed the bolivinid toothplate, but retained a generic distinction between *Bolivinoides* and *Bolivina* on the basis of difference in structure and ornament. Montanaro Gallitelli (1957) also recognized *Bolivinoides* as a valid genus.

Specimens of *Bolivinoides draco draco* (Marsson) from upper Maestrichtian beds, Starzmuhl, Teisendorf, Bavaria, have internal ridges of the type shown by *Bolivina plicata, B. sinuata,* and *B. robusta.* Montanaro Gallitelli (1957) regarded the septal surface as flat and stated that 'the marginal undulation is simulated by the septa encountering an internally tuberculate wall'. My observations indicate that the internal ridges of *Bolivinoides draco draco* result from a lobate chamber margin, the lobations also being continuous with the characteristic raised ornament at right angles to the sutures. The species *Bolivinoides miocenicus* Gianotti, described from the type area of the Tortonian stage in Italy, has very distinct lobations along the base of each chamber, almost as strongly developed as those of *B. draco draco.*

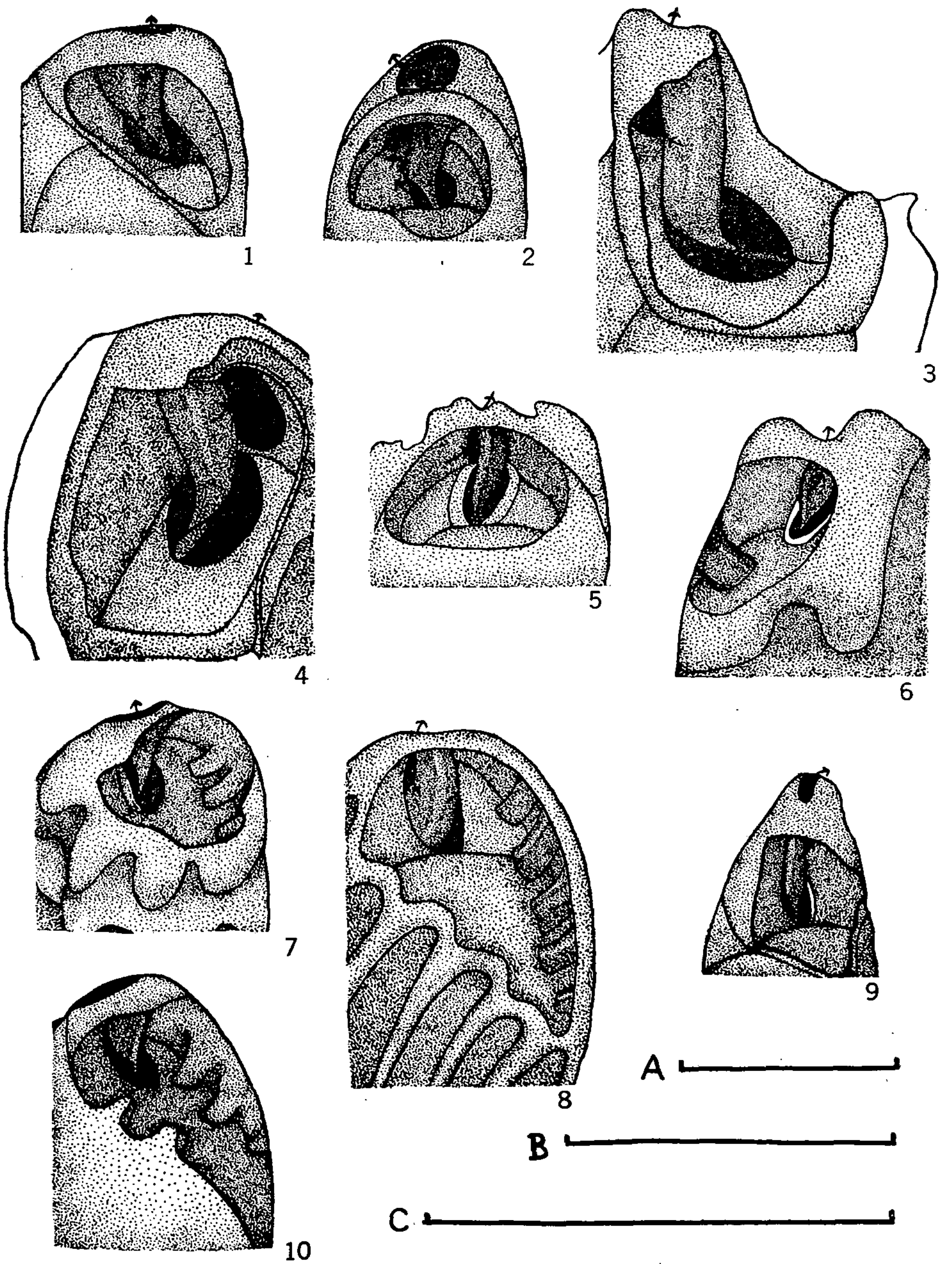
Reyment (1959) also erected a new genus *Afrobolivina,* with type species *A. afra* Reyment; a feature of this genus is a series of internal partitions, termed by Reyment 'subsepta', which are formed in the lower part of the chamber. In appearance, these are the same as the internal ridges of some species referred to *Bolivina,* but they are regarded by Reyment as being formed by outgrowths of the toothplate, which is typically bolivinid. Reyment did not observe vertical partitions in *Bolivinoides draco draco* and considered that the tuberculated wall seen by Montanaro Gallitelli was derived from the overlaps, also stating 'besides the overlaps, other tubercular formations do occur that appear as bulges on the inner wall'. The 'bulges' in *B. draco draco* are caused by the lobate lower margin of the chambers, and are here regarded as similar to those in *Afrobolivina.* They are broad and low in *B. draco draco,* and in *Afrobolivina afra* narrow and relatively higher, resembling those of *Bolivina robusta.*

Through the courtesy of Dr G. R. J. Terpstra of the Bureau of Mineral Resources I have been able to examine specimens of *Afrobolivina afra*; none of the specimens examined have any indication of a roof over the internal partitions. I have not been able to observe any connexion between the partitions and the toothplate; each partition is below a narrow depression between successive overlaps and an alternative suggestion is that they are formed by a fold of the chamber wall. There is no essential difference between the structure of *A. afra* and that of *Bolivina plicata,* and I consider that *Afrobolivina* is also a synonym of *Bolivina.*

BOLIVINA ROBUSTA Brady, 1881

(Pl. 1, figs 5–7; text-fig. 4: 10)

1881 *Bolivina robusta* Brady, p. 57.
1884 *Bolivina robusta* Brady; Brady, p. 421, pl. 53, figs 7–9.
1937 *Bolivina robusta* Brady part; Cushman, p. 131, pl. 17, figs 1?3, (not fig. 4).
1941*a* *Bolivina robusta* Brady; LeRoy, p. 33, pl. 1, figs 75–76.
1941*b* *Bolivina robusta* Brady (non-spinose var.); LeRoy, p. 80, pl. 1, fig. 2; pl. 2, figs 9–10.
1949 *Bolivina robusta* Brady; Boomgaart, p. 111, pl. 12, fig. 1 (not fig. 2).
1951*b* *Bolivina robusta* Brady; Hofker, p. 76, figs 41a–g, 42a–c.
1957 *Bolivina robusta* Brady; Samaniego & Gonzales, p. 201, pl. 23, figs 1a–b.
1963 *Bolivina robusta* Brady; Pezzani, p. 626, pl. 37, fig. 11.
1964 *Bolivina robusta* Brady; Huang, tab. 1, pl. 2, fig. 10.
1964 *Bolivina robusta* (Brady); LeRoy, p. 31, pl. 2, fig. 13.


1
2
3
4
5
6
7
8
9
10
A
B
C

Material examined: 55 specimens.

B. robusta occurs commonly in a number of samples. Two forms of this species are known, one with a distinct basal spine and one without; both forms have the same chamber shape, the same outline in side and top views, the same type of toothplate, and the same characteristic lobate appearance of the sutures in external view. In the present study, non-spinose specimens have been found in only one sample, from the Tubu area, Papua. The compressed non-spinose specimens figured by Cushman (1937, pl. 17, figs 4a–b; 1942, pl. 6, figs 2a–b) are considered to be referable to *B. robusta* var. *pacifica* Boomgaart (renamed *B. robusta* var. *indonesiensis* by Boomgaart in Thalmann, 1950). The specimen figured by Boomgaart (1949, pl. 12, fig. 2) as *B. robusta* is also thought to be closer to this variety than to the typical form of the species as originally figured by Brady.

Comments on the internal ridges of *B. robusta* have already been given. Each chamber also has a well developed toothplate attached at the base of the full width of the septal foramen, with a small folded free edge extending throughout its length and forming a small tooth in the aperture. The test is perforate, the pores in the later chambers at least extending over more of the chamber wall than in the specimens figured by Hofker (1951*b*), and continuing to the apertural margin; the pore diameter has not been determined. The wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6161	0·95	0·52	0·19
CPC 6162	0·87	0·48	0·19

Occurrence: Figured specimens (CPC 6161 and 6162) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 1d, 18, 21, 23, 25, 31, 36.

B. robusta is recorded from the lower Miocene (Burdigalian) to the Pliocene, and occurs also in Recent deposits.

TEXT-FIGURE 1

1	**CPC 6170**	*Brizalina plicatella* **(Cushman), locality 27. Toothplate.**
2	**CPC 6218**	*Laterostomella voluta* **sp.nov., locality 12c. Toothplate.**
3	**CPC 6158**	*Bolivinita compressa* **Finlay, locality 7b. Toothplate.**
4	**CPC 6155**	*Bolivinita quadrilatera* **(Schwager), locality 27. Toothplate.**
5–6	**CPC 6213**	*Bolivina plicata* **d'Orbigny, Pico Formation, Los Angeles Basin, California. Two views of the toothplate, figure 6 also showing a small ridge in the chamber wall.**
7	**CPC 6214**	*Bolivina sinuata* **Galloway & Wissler, Repetto Formation, Los Angeles Basin, California. Showing the toothplate and internal ridges in the chamber wall.**
8	**CPC 6215**	*Bolivina draco draco* **Marsson, Upper Maestrichtian, Starzmuhl, Bavaria. Showing toothplate and ridges in the chamber wall associated with external lobations.**
9	**CPC 6518**	*Sigmavirgulina tortuosa* **(Brady), locality 12c. Toothplate.**
10	**CPC 6163**	*Bolivina robusta* **(Brady), locality 21, showing toothplate and internal ridges.**

Each scale represents 0·25 mm.

Figures 3–4, 7 to scale A.
Figures 5–6, 8–10 to scale B.
Figures 1–2 to scale C.

Genus BRIZALINA Costa, 1856

Loeblich & Tappan (1964*a*) defined the genus *Brizalina* as including species 'commonly compressed and laterally carinate', but it is used here for biserial radiate species, neither compressed nor carinate, which lack the basal chamber lobes of *Bolivina*.

BRIZALINA ALATA (Seguenza, 1862)

(Pl. 1, figs 1–2; text-fig. 2: 1–3)

1862 *Vulvulina alata* Seguenza, p. 115, pl. 2, figs 5, 5a.
1884 *Bolivina beyrichi* var. *alata* Seguenza; Brady, p. 442, pl. 53, figs 2–4.
1937 *Bolivina alata* (Seguenza); Cushman, p. 106, pl. 13, figs 3–11.
1941*a* *Bolivina alata* (Seguenza); LeRoy, p. 34, pl. 2, figs 45–46.
1944*a* *Bolivina alata* (Seguenza); LeRoy, p. 28, pl. 1, fig. 33.
1945 *Bolivina alata* (Seguenza); Cushman & Todd, p. 42, pl. 6, fig. 25. (Synonymy).
1949 *Bolivina alata* (Seguenza); Bermudez, p. 187, pl. 12, fig. 25.
1951*b* *Bolivina alata* Seguenza; Hofker, p. 96, figs 54a–b.
1957 *Bolivina alata* (Seguenza); Samaniego & Gonzales, p. 200, pl. 22, fig. 10.
1959 *Loxostomum alatum* (Seguenza); Parker, p. 262, pl. 2, figs 30–32.
1959 *Bolivina alata* (Seguenza); Dieci, p. 66, pl. 5, fig. 25.
1964 *Bolivina alata* (Seguenza); LeRoy, p. 31, pl. 2, fig. 12.

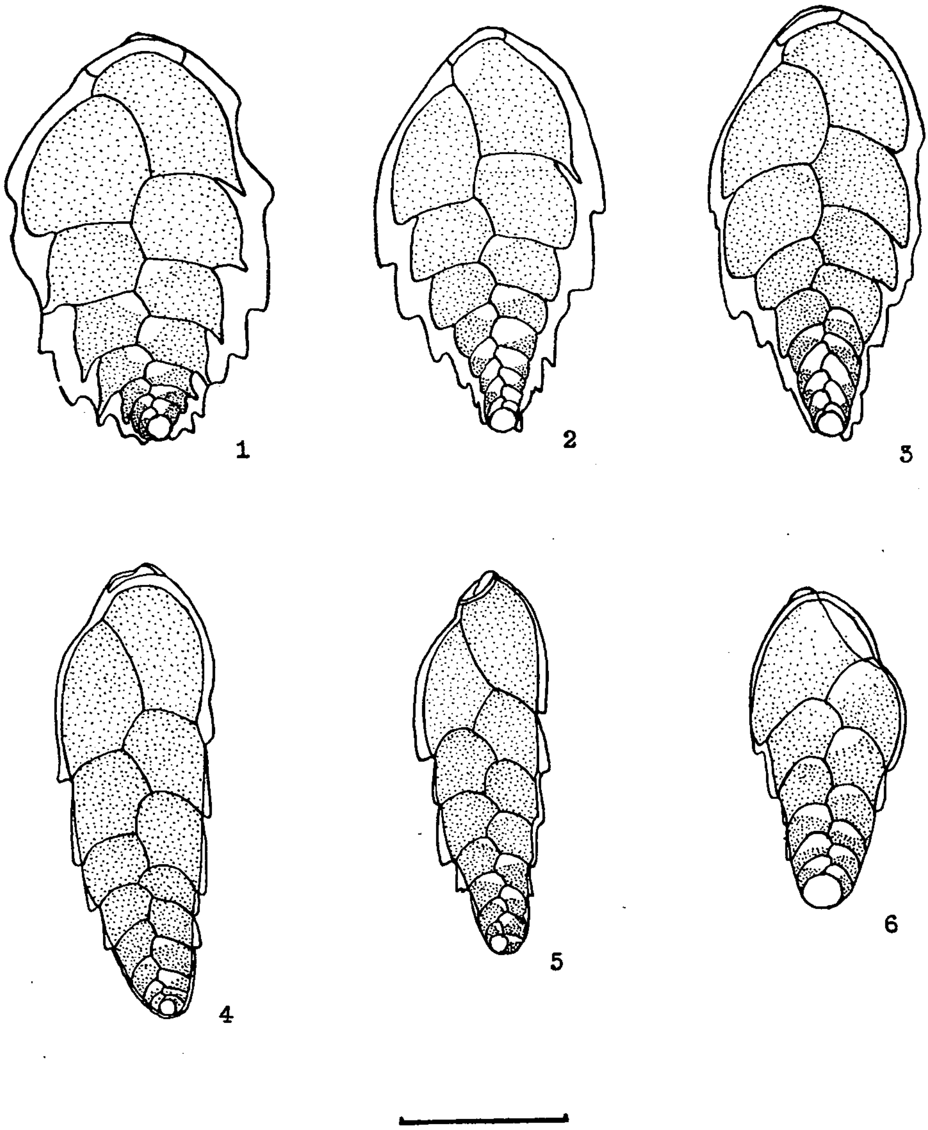
Material examined: 31 specimens.

Specimens of *B. alata* from the present material are not as slender and elongate as is the holotype; they are of the type figured by Brady (1884, pl. 53, fig. 4) and fall within the range of variation illustrated by Cushman (1937, pl. 13, figs 4–7, 9, 10).

Only megalospheric specimens of *B. alata* have been found; the proloculus ranges in diameter from 25 to 35 microns, and is imperforate. Some specimens also lack pores on the first pair of biserial chambers, but pores are usually present on the basal part of the chambers, often in only one row. The perforate area of the chamber wall then gradually increases, but most specimens have a small imperforate area near the aperture. The wall of the last pair of biserial chambers is wholly perforate in some specimens, and one with 8 pairs of biserial chambers has a completely perforate wall after the third pair of chambers; the pore diameter ranges from 3 to 4 microns, the pores being oval in outline; the wall is radiate in texture.

The peripheral margin of some chambers is drawn out as an elongate tube extending into the imperforate keel, at times reaching the outer margin of the keel; this is not a constant feature, even on the one specimen. Each chamber has a well developed toothplate beginning within the septal foramen, but not extending the full width of the foramen. The free edge is narrowly folded; the fold begins some distance above the base of the toothplate, and forms a narrow tooth in the aperture. There is no indication of the serrated edge on the free part of the toothplate observed by Hofker (1951*b*).

Dimensions of figured specimens:	Length	Maximum Width (incl. keel)	Thickness
CPC 6164	0·86	0·53	0·10
CPC 6165	0·67	0·45	0·09



TEXT-FIGURE 2

1–3 *Brizalina alata* (Seguenza), locality 1d.

4–6 *Brizalina pseudobeyrichi* (Cushman), locality 1d. Showing difference in outline of the test and in the development of the peripheral keel.

The scale represents 0·25 mm.

Occurrence: Figured specimens (CPC 6164 and 6165) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene), locality 1d); other localities: 7a, 14b, 30, 31.

B. alata is recorded from the lower Miocene (Burdigalian) to the top of the Miocene; it is also known from Recent deposits.

BRIZALINA CAPITATA (Cushman, 1933)

(Pl. 1, figs 3–4)

1933*a* *Bolivina capitata* Cushman, p. 80, pl. 8, figs 12a–b.
1937 *Bolivina capitata* Cushman; Cushman, p. 146, pl. 19, figs 29a–b.
1942*a* *Bolivina capitata* Cushman; Cushman, p. 28, pl. 8, figs 1a–b, 2, 3a–b.
1959 *Bolivina capitata* Cushman; Graham & Militante, p. 79, pl. 12, figs 13a–b.
1964 *Bolivina capitata* Cushman; LeRoy, p. 31, pl. 2, fig. 9.

Material examined: 21 specimens.

Papua-New Guinea specimens of *B. capitata* are identical in all respects with specimens in slides from 'Challenger' stations 218A and 219A, Nares Harbour, Admiralty Islands, and from a dredged sample, Peper Bay, west coast of Java, at a depth of 31 metres, except that they have secondary deposits of shell material which on the early chambers in particular form a reticulate or sometimes slightly striate ornament. Some Recent specimens have thickened sutures and shell wall on the early chambers, but not to the extent shown by the fossil forms.

Specimens of this kind were not figured by Brady (1884), but they agree well with the description of *B. capitata* given by Cushman (1933*a*). They are identical with the specimen figured by Graham & Militante (1959), which shows the large curved oval aperture and also faint striations on the early chambers. The tooth-plate of both Recent and fossil specimens is broad, extending at the base across the septal foramen; the free edge has only a small fold, which forms a narrow tooth in the aperture. The pore diameter ranges from 4 to 6 microns for both Recent and fossil specimens, the pores being irregularly circular in outline; the early chambers on some specimens are more coarsely perforate than the later chambers. The wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width	Thickness
CPC 6166	0·61	0·20	0·13
CPC 6167	0·60	0·19	0·12

Occurrence: Figured specimens (CPC 6166 and 6167) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

B. capitata has not been recorded previously from Papua-New Guinea; it has previously been known only from Recent deposits.

BRIZALINA PLICATELLA (Cushman, 1930)

(Pl. 1, figs 8–9; text-fig. 1: 1)

1930 *Bolivina plicatella* Cushman; p. 46, pl. 8, figs 10a–b.
1933 *Bolivina plicatella* Cushman; Cushman, p. 89, pl. 11, figs 3a–b, 4. (Synonymy).
1963 *Bolivina plicatella* Cushman; Pezzani, p. 625, pl. 37, fig. 8.

Material examined: 7 specimens.

B. plicatella occurs only rarely, in one sample. The specimens have a longitudinal central depression with the early chambers and sutures largely obscured by an irregular raised ornament. Small re-entrants occur along the sutures, but no associated internal ridges, as in *B. robusta,* have been observed. The largest specimen found (pl. 1, fig. 8) has three distinct pairs of smooth biserial chambers, with deeply depressed sutures; the early chambers of this specimen are identical with those of more typical specimens, and it is obviously to be referred to *B. plicatella.* The outline of the specimens in end view ranges from rounded to angulate. The entire wall of the test is coarsely perforate, but as specimens are rare none have been broken to determine the pore diameter. Each chamber has a well developed broadly rounded toothplate, beginning within and extending the full width of the septal foramen; the free edge is smooth and forms a small tooth in the aperture.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6168	0·70	0·28	0·10
CPC 6169	0·48	0·27	0·10

Occurrence: Figured specimens (CPC 6168 and 6169) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

B. plicatella is recorded from the lower Miocene (Burdigalian) to the Pliocene, and is also known from Recent deposits.

BRIZALINA sp.cf. B. VARIABILIS (Williamson, 1858)

(Pl. 1, figs 10–12)

cf. 1858 *Textularia variabilis* Williamson, p. 76, pl. 6, figs 162–163.

Material examined: 54 specimens.

Specimens occurring commonly at one locality in Papua show no marked external difference in chamber shape or outline of test from specimens of *B. variabilis* from the area of the Shetland Islands; the last chambers of the Papuan specimens are slightly more inflated. The original figure of *B. variabilis* given by Williamson (1858) shows a very low aperture, but Cushman (1937) figured other specimens with a narrow and elongate aperture, as in the Papuan specimens. Cushman (1942) figured a carinate form under this name, but no specimens of this type have been found in the present samples. Insufficient Recent specimens are available to permit a comparison with the internal structure and the pore pattern of the Papuan specimens. These features may permit some differentiation, but specimens from the two areas are obviously closely related.

In the Papuan specimens the entire surface of the chambers is perforate, but the pore diameter has not been determined; the wall is radiate in texture. The toothplate is small, with a narrowly folded free edge forming a small tooth in the aperture.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6171	0·33	0·12	0·08
CPC 6172	0·33	0·13	0·09

Occurrence: Figured specimens (CPC 6171 and 6172) from the south-eastern flank of the Wira Anticline, Puri-Purari River area, Papua (upper Miocene, locality 14d); also found in other samples from this area.

Specimens of the type here compared to *B. variabilis* have been included in the records of *B. seminuda* (Cushman); their range in Papua-New Guinea is not known.

BRIZALINA PSEUDOBEYRICHI (Cushman, 1926)

(Pl. 1, figs 13–16; text-figs 2: 4–6)

1926*a* *Bolivina pseudobeyrichi* Cushman, p. 45. (Synonymy).
1937 *Bolivina pseudobeyrichi* Cushman; Cushman, p. 139, pl. 19, figs 4, 5a–b. (Synonymy).
1953 *Bolivina pseudobeyrichi* Cushman; Drooger, p. 131, pl. 21, figs 9–10.
1955 *Loxostoma pseudobeyrichi* (Cushman); Walton, p. 1010, pl. 102, fig. 20.
1961 *Loxostomum pseudobeyrichi* (Cushman); Bandy, p. 21, pl. 4, figs 13a–b.
1963 *Bolivina* (*Bolivina*) *pseudobeyrichi* Cushman; Smith, p. 22, pl. 31, figs 3–8.
1964 *Bolivina pseudobeyrichi* Cushman; Ishiwada, pl. 4, fig. 62.

Material examined: 16 specimens.

Several specific names have been proposed for slender elongate species characterized by narrow peripheral keels or sharp backwardly projecting chamber margins. These include *B. beyrichi* Reuss from the Oligocene of Germany, *B. bramletti* Kleinpell from the Miocene of California, *B. pseudobeyrichi* from the Pliocene of California and the Recent of the eastern Pacific, and *B. bradyi* Asano from the Recent of the eastern Pacific. All these species should be referred to the genus *Brizalina*. Cushman (1911) included the specimen figured by Brady (1884, pl. 53, fig. 1) in the synonymy of *Bolivina beyrichi*, but did not refer to it in later papers. Asano (1938) named this specimen *Bolivina bradyi*; it differs from the holotype of *Brizalina pseudobeyrichi* mainly in its greater length/breadth ratio. Smith (1963) considered that *bradyi* is probably an ecologic variant of *pseudobeyrichi*, but did not find enough specimens to confirm this relationship. Martin (1952) recorded *Bolivina beyrichi* from the Pliocene of the Los Angeles Basin, and retained Brady's specimen in this species.

Specimens occurring in samples from the Tubu area, Papua, are indistinguishable from specimens occurring in the upper Pliocene of the Los Angeles Basin, California. Cushman (1926*a*, 1937) noted that *Brizalina pseudobeyrichi* occurs in the Californian upper Pliocene. In the description of this species it was stated that the length was 1½ to 2 times the breadth. The present specimens are 2½ to 3 times as long as broad and in this respect are closer to *B. bramletti* and *B. bradyi*; the Californian upper Pliocene specimens observed are also about 3 times as long as broad. Professor J. J. Graham examined the specimens from the Tubu area, and agrees that they are *B. pseudobeyrichi*; it therefore seems that Cushman did not observe the full variations shown by *pseudobeyrichi*.

In some samples from the Tubu area, Papua, *B. alata* and *B. pseudobeyrichi* occur together. The possibility that the two forms represent different generations of the same species is not supported by measurements of the proloculus. The toothplate of specimens referred to *B. pseudobeyrichi* is similar to that of *B. alata*, not extending the full width of the septal foramen, and with a narrowly folded free edge. Apart from the narrower keel, specimens of *B. pseudobeyrichi* differ from *B. alata* in having coarser pores, oval in outline, the pore diameter being 6 to 7 microns. The entire wall of the later chambers of all observed specimens of *B. pseudobeyrichi* is perforate, but some specimens have on the early chambers a small imperforate area near the aperture. The same feature is shown by the Californian specimens observed, and is another difference from *B. alata*, in which the imperforate upper part of the chambers is a normal feature. The wall of *B. pseudobeyrichi* is radiate in texture. Outline drawings of specimens referred to *B. alata* and *B. pseudobeyrichi* are given in text-figure 1, to show the difference in the length/breadth ratio and in the development of the peripheral keel.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6173	0·72	0·23	0·11
CPC 6174	0·62	0·21	0·12
CPC 6175	0·66	0·30	0·10

Occurrence:—Figured specimens (CPC 6173 and 6175) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); figured specimen (CPC 6174) from east of Yekimbolje village, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localities: 23, 28.

B. pseudobeyrichi has not been recorded previously from Papua-New Guinea; it is possible that records of *B. alata* may include specimens here referred to *B. pseudobeyrichi*.

BRIZALINA SUBRETICULATA (Parr, 1932)

(Pl. 1, figs 17–18; text-figs 3: 1–3)

1884 *Bolivina reticulata* Brady, p. 426, pl. 53, figs 30–31 (not of Hantken).
1932 *Bolivina subreticulata* Parr, p. 12, pl. 1, figs 21a–b.
1937 *Bolivina subreticulata* Parr; Cushman, p. 148, pl. 19, figs 24a–b, 25–26. (Synonymy).
1942*a* *Bolivina subreticulata* Parr; Cushman, p. 31, pl. 9, fig. 2. (Synonymy).
1944*a* *Bolivina subreticulata* Parr; LeRoy, p. 29, pl. 8, figs 21–22.
1964 *Bolivina subreticulata* Parr; Huang, tab. 1, pl. 2, fig. 14.
1964 *Bolivina subreticulata* Parr; LeRoy, p. 31, pl. 2, fig. 16.

Material examined: 17 specimens.

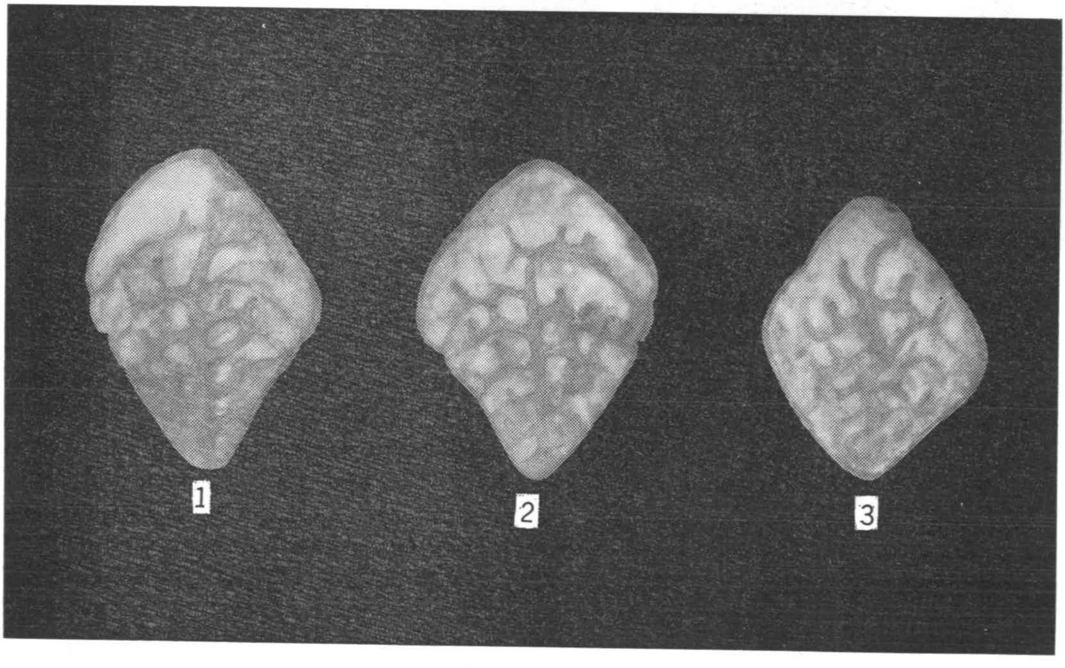
The ornament of our specimens of *B. subreticulata* varies considerably, but in all specimens observed the last pair of biserial chambers is smooth. On some specimens the irregular reticulate ornament covers the remainder of the test, obscuring the sutures; on others the reticulation is restricted to the central part of the test, with the peripheral areas smooth or with only short irregular projections from the sutures across the lower part of the chambers. The pores are difficult to observe, but where they have been seen they are confined to a row at the base of the chamber and an irregular scattering at the outer peripheral margin. The wall of the test is radiate in texture; the toothplate has not been clearly observed.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6176	0·39	0·25	0·12
CPC 6177	0·33	0·24	0·11

Occurrence: Figured specimens (CPC 6176 and 6177) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); other localities: 3, 27, 32, 36.

B. subreticulata is recorded from the lower Miocene (Burdigalian) to the Pliocene; it occurs also in Recent deposits.

Remarks: Parr did not figure the holotype of *B. subreticulata*, which is from 'Challenger' station 185, off Raine Island, Torres Strait, at a depth of 155 fathoms, and it seems that no specimen was designated as the holotype. The National Museum of Victoria has the types of only the fossil species of Foraminifera erected by Parr, and it is thought that types of Recent species were in that part of the Parr Collection forwarded to the Bureau of Mineral Resources (E. D. Gill, *pers comm.*, 9th October, 1964). No specimen designated as the holotype of *subreticulata* is in the Bureau collection; seven specimens have been found in a slide from 'Challenger' Station 185, and are here regarded as syntypes. A lectotype has been selected and is illustrated in Text-figure 3, together with a paralectotype.



TEXT-FIGURE 3

Brizalina subreticulata **(Parr), 'Challenger' station 185. 1–2, Lectotype, CPC 6178, opposite sides; 3, paralectotype, CPC 6179, side view; all X 135.**

BRIZALINA sp.cf. B. PYGMAEA (Brady, 1881)

(Pl. 1, figs 19–22)

cf. 1881 *Bolivina pygmaea* Brady, p. 57.
1884 *Bolivina pygmaea* Brady; Brady, p. 421, pl. 53, figs 5–6.

Material examined: 7 specimens.

Rare very small specimens resembling *B. pygmaea* Brady, but not as strongly compressed, have been found in two samples. The test of the Papua-New Guinea specimens is also more elongate than those figured by Brady (1884). A specific distinction may be possible, but more specimens are required before this is done, and a comparison with specimens of *B. pygmaea* would be desirable. Cushman & Moyer (1930) figured a specimen referred to *B. pygmaea* from Recent deposits near San Pedro, California; the Papua-New Guinea specimens are very similar to this.

Because of the scarcity of specimens in the present material, the pores and toothplate have not been investigated.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6180	0·36	0·15	0·09
CPC 6181	0·18	0·12	0·08
CPC 6182	0·18	0·11	0·06

Occurrence: Figured specimen (CPC 6180) from near the culmination of the Popo Anticline, 3½ miles south-south-east of Popo village, Papua (upper Miocene); figured specimens (CPC 6181 and 6182) from the south-east flank of the Wira Anticline, Puri-Purari River area, Papua, at top of section (upper Miocene, locality 14d).

Specimens recorded as *Bolivina* sp. 14, ranging from the lower Miocene (Burdigalian) to the Pliocene, are very similar to the specimens here compared with *B. pygmaea.*

BRIZALINA MULTILINEATA sp.nov.

(Pl. 2, figs 1–6)

Material examined: 75 specimens.

Three forms of *B. multilineata* may be recognized on external appearance; the grouping is related to the size of the proloculus and on available information the groups are limited to their lateral extent.

The three groups are:

(a) Abundant specimens occurring in the Tubu area, Papua, with some very rare specimens from samples on the Wira Anticline, Papua. The test is broadly triangular in outline with a wide peripheral keel; the proloculus usually ranges in diameter from 50 to 64 microns, one specimen having a proloculus about 70 microns in diameter.

(b) Small, more slender and elongate specimens with a narrow peripheral keel, occurring only in the Tubu area, in association with specimens from group (a). The proloculus ranges in diameter from 20 to 26 microns.

(c) Specimens similar to those in group (a), but not as broad, and with only a narrow peripheral keel; known only in samples from the Wira Anticline, Papua. The proloculus ranges in diameter from 38 to 50 microns.

Diagnosis: A compressed species ranging from broadly triangular with wide peripheral keel to slender and elongate with very narrow keel; ornamented by fine continuous striations, on some specimens replaced by thin short ridges on proloculus and early biserial chambers; sutures oblique; aperture large, oval, toothplate large with broad flaring base.

Description: (a) Test compressed, broadly triangular in outline, broadening gradually from proloculus to greatest width at last pair of chambers. Length/breadth ratio usually between 1·4 to 1·5, with one specimen having ratio of 1·7. Periphery with wide, thin, fragile imperforate keel, sometimes spinose on early chambers. Proloculus globular, followed by 4 to 5 pairs of biserial chambers, broader than high, increasing slowly in size as added. Proloculus and peripheral margin of early biserial chambers ornamented by strong backwardly directed spines. Surface of test ornamented by low fine costae, continuous across sutures, 12 to 20 on last chambers, with shorter costae confined to one chamber, on lower or upper part of test. Sutures narrow, distinct, straight or slightly curved, at first smooth, depressed on later chambers; strongly oblique, forming angle of 30 to 35 degrees with horizontal, meeting at centre of test in thickened and raised areas of clear shell material. Test wall radiate in texture, very finely and densely perforate, pore diameter 2 microns. Aperture large, oval, with raised imperforate rim, reaching to basal suture of chamber. Each chamber with well-developed toothplate extending across septal foramen, base broad and flaring, upper part narrowly folded, with smooth free edge forming narrow tooth in aperture.

(b) Test small, slender, elongate, relatively less compressed than specimens in groups (a) and (c), periphery with very narrow keel, scarcely developed on some specimens. Length/breadth ratio ranging from 1·7 to 2·2. Proloculus small, globular, followed by 4 to 6 pairs of biserial chambers, increasing slowly in size as added. Proloculus and early biserial chambers ornamented by thin short ridges passing into fine continuous striations on later chambers, 6 to 10 in number. Sutures narrow, distinct, strongly oblique, at first smooth, later depressed, meeting at centre of test in small imperforate raised areas of shell material. Aperture, perforation of test, and toothplate as for specimens in group (a).

(c) Test more slender than that of specimens in group (a), length/breadth ratio ranging from 1·7 to 2·2; peripheral keel narrow. Proloculus globular, followed by 5 to 6 pairs of biserial chambers. Ornament of test similar to that of specimens in group (a), but heavier on proloculus and early biserial chambers, striations replaced by thin short ridges. Sutures narrow, straight or slightly curved, at first smooth, later depressed, on early chambers sometimes obscured by ornament. Aperture, perforation of test, and toothplate as for specimens in group (a).

Dimensions:	Length	Maximum Width (incl. keel)	Maximum Thickness
Holotype (Group a)	0·79	0·50	0·18
Paratype A (Group a)	0·72	0·48	0·18
Paratype B (Group c)	0·70	0·31	0·13
Paratype C (Group b)	0·43	0·20	0·12
Paratype D (Group b)	0·48	0·21	0·12

Occurrence: Holotype (CPC 6183) and paratypes A, C, and D (CPC 6184, 6186, 6187) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene); holotype and paratype A from locality 1d, paratypes C and D from locality 1g. Paratype B (CPC 6115) from the north-west flank of the Wira Anticline, Puri-Purari River area, Papua (upper Miocene, locality 13a); other localities: 1f, 13b.

B. multilineata sp.nov. has been recorded as *B.* sp. 15, ranging from the lower Miocene (Burdigalian) to the upper Miocene.

Remarks: A superficial examination would suggest that specimens in group (b) are sufficiently different from specimens in groups (a) and (c) to warrant their being recognized as a distinct species. However, the differences are of degree only, and, as specimens of groups (a) and (b) occur in the same samples from the Tubu area, are more probably due to normal intra-specific variation.

It is not possible in this species to recognize the normal trimorphic forms, that is, two megalospheric generations and one microspheric. The smallest observed range in the size of the proloculus, 20 to 26 microns, is considerably larger than that usually found in the microspheric generation. Groups (a) and (c) may represent one megalospheric generation and group (b) another, but this is not borne out by the difference in outline and degree of development of ornament between groups (a) and (c).

B. multilineata is distinct from other described species. The specific name refers to the ornament of the test.

Brizalina macella sp.nov.

(Pl. 2, figs 7–10)

Material examined: 30 specimens.

Diagnosis: A slender elongate species with rounded periphery; usually smooth, rare specimens with faint striae on the lower part; sutures oblique, slightly depressed; aperture broad oval, toothplate well developed.

Description: Test slender, elongate, gradually broadening from initial end to greatest width at last pair of biserial chambers, very rare specimens slightly twisted. Periphery broadly rounded, test oval in end view. Proloculus globular, followed by 5 to 8 pairs of biserial chambers, increasing gradually in size as added. Early chambers wider than high, later chambers increasing in height more rapidly than in width, becoming higher than wide. Sutures narrow, distinct, very slightly depressed, strongly oblique, making an angle of about 45 degrees with horizontal.

95044—(3)

Surface of test usually smooth throughout, rare specimens ornamented on lower part by numerous very faint continuous striae. Test wall radiate in texture, finely and densely perforate, pores oval in outline, diameter 2 to 3 microns. Aperture broad, oval, with an imperforate margin, in some specimens directed to one side of test, reaching basal suture of chamber. Each chamber with well developed toothplate, at base extending across septal foramen, folded in upper part, free edge forming narrow tooth in aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·92	0·19	0·14
Paratype A	0·89	0·23	0·15
Paratype B	0·63	0·23	0·15

Occurrence: Holotype (CPC 6188) and paratypes A and B (CPC 6189 and 6190) from a sample of the 'Tubu Siltstone'. Tubu area, Papua (upper Miocene, locality 1d) other localities: 1b, 1g, 27.

The name under which *Brizalina macella* sp.nov. has been recorded is not known; it may be included in the records of *Bolivina* sp. 9.

Remarks: The length/breadth ratio of specimens of *B. macella* increases rapidly with the addition of biserial chambers and reflects the rapid increase in height of the chambers as against the slow increase in width. The holotype, with 8 pairs of biserial chambers, has a length/breadth ratio of 4·8; paratype A, with 7 pairs of biserial chambers, has a ratio of 3·8, and paratype B, with 5 pairs of biserial chambers, has a ratio of 2·7. The rare specimens which are faintly striate on the early chambers do not differ in any other feature from the more usual form, and no separation at specific or subspecific level is justified.

Brizalina macella does not resemble closely any other described species. The specimens figured by Brady (1884) as *Bolivina punctata* d'Orbigny are similar, and are possibly referable to *Brizalina macella.* Barker (1960) referred Brady's specimens to *Bolivina earlandi* Parr, but this species has a very narrow elongate aperture, chambers higher than wide throughout, and the last 3 pairs of biserial chambers form about two-thirds of the test.

The aperture of some specimens of *Brizalina macella* resembles that of the genus *Laterostomella* de Klasz & Rérat, 1962, particularly as shown by the species *L. striata.* However, most specimens of *Brizalina macella* have a median aperture.

The specific name is from the Latin *macellus,* lean, thin, referring to the outline of the test.

BRIZALINA VESCISTRIATA sp.nov.

(Pl. 2, figs 11–12)

Material examined: 47 specimens.

Diagnosis: A slender elongate species with rounded periphery; ornamented by low thin faint costae varying in extent; sutures oblique, slightly depressed; aperture narrow, elongate, toothplate small, narrowly folded.

Description: Test slender, elongate, both microspheric and megalospheric specimens usually reaching greatest width at fifth or sixth pair of biserial chambers, sides of test then parallel; rare specimens broadening throughout. Periphery rounded, test oval in end view, in both microspheric and megalospheric forms with narrow margin of clear shell material on proloculus and early biserial chambers, visible only on moistened specimens. Proloculus in megalospheric forms globular, followed by 8 or 9 pairs of biserial chambers, increasing gradually in size as added, microspheric specimens with 10 or 11 pairs of biserial chambers. Early chambers wider than high, later chambers increasing in height more quickly than in width, last 3 or 4 pairs of chambers higher than wide. Sutures narrow, distinct, slightly depressed, straight and oblique, forming angle of about 45 degrees to horizontal. Surface of test ornamented by 12 to 14 low, fine, often faint continuous striations which vary in extent, being confined to lower one-third or one-half of test, or extending over all but the last two chambers. Test wall radiate in texture, finely perforate, pore diameter 3 to 4 microns. Aperture narrow, elongate, with imperforate margin, reaching basal suture of chamber. Toothplate present in each chamber, small and narrowly folded, attached to margin of septal foramen, free edge forming small tooth in aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·72	0·16	0·10
Paratype	0·65	0·17	0·13

Occurrence: Holotype (CPC 6191) and paratype (CPC 6192) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

Brizalina vescistriata sp.nov. is not known to have been recorded previously from Papua-New Guinea.

Remarks: Eighteen megalospheric and six microspheric specimens of *B. vescistriata* have been found. The holotype is a microspheric form with 11 pairs of biserial chambers, and the paratype is megalospheric, with 8 pairs of biserial chambers.

B. vescistriata is similar to *Bolivina acerosa* Cushman from the Miocene of the Dominican Republic. However, in *Bolivina acerosa* the chambers are wider than high for all except the last pair of chambers, and the striations are not as strongly developed as in *Brizalina vescistriata.*

The specific name refers to the ornament of the test.

BRIZALINA SEMILINEATA sp.nov.

(Pl. 2, figs 13–16)

Material examined: 25 specimens.

Diagnosis: A slender elongate species with rounded periphery on later chambers; early chambers sometimes with a narrow keel; ornamented on early chambers by few continuous low costae; sutures oblique; aperture broad oval, toothplate well developed.

Description: Test elongate, microspheric forms broadening more rapidly than megalospheric, greatest width at last two chambers. Periphery of early part of test narrowly rounded or angular, sometimes with narrow keel of clear shell material, later rounded. Proloculus in megalospheric forms large, globular, followed by 4 or 5 pairs of biserial chambers, increasing very gradually in size as added, microspheric forms with 6 to 8 pairs of chambers. Early chambers wider than high, later chambers increasing in height more rapidly than in width, becoming higher than wide. Sutures narrow, distinct, slightly depressed, meeting at centre of test in small, smooth triangular areas of clear shell material, strongly oblique, forming angle of 45 to 50 degrees with horizontal. Lower part of test ornamented by 4 to 8 irregularly spaced distinct low costae.

Test wall radiate in texture, finely and densely perforate over entire chamber, pore diameter about 2 microns. Aperture broad oval, reaching to basal suture of chamber. Each chamber with well developed broad toothplate, extending full width of septal foramen, with small fold extending almost full length of free margin, forming small narrow tooth in aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·65	0·24	0·13
Paratype A	0·47	0·18	0·12
Paratype B	0·68	0·24	0·14

Occurrence: Holotype (CPC 6193) and paratypes A and B (CPC 6194 and 6195) from west of the wharf at the Roman Catholic Mission, Yule Island, Papua (lower Miocene, Burdigalian); other locality: 5.

Brizalina semilineata sp.nov. has been recorded as *Bolivina* sp. 9, ranging from the lower Miocene (Burdigalian) to the upper Miocene.

Remarks: Some megalospheric specimens of *B. semilineata* resemble shorter specimens of *B. macella* sp.nov. in the shape of the test and in chamber shape, but differ in being strongly costate on the lower part of the test. No specimens of *B. macella* observed resemble the microspheric specimens of *B. semilineata*. *Bolivina arta* Macfadyen from the Miocene of Egypt is similar in the general shape of the test and in chamber shape to *Brizalina semilineata*, but is a smooth form. The specimens figured by Cushman (1937, pl. 21, figs 7a–b, 8) as *Loxostomum hentyanum* (Chapman) are also similar; Cushman's illustrations show the aperture reaching to the basal suture and it is considered that the specimens should be referred to *Bolivina*. However, Jenkins (1958) demonstrated that the holotype of *hentyanum* is in fact an echinoid spine, and the correct allocation of Cushman's specimens is uncertain.

Brizalina semilineata is distinct from other striate species originally referred to the genus *Bolivina*. The holotype is megalospheric and the two paratypes are microspheric.

The specific name refers to the ornament of the test.

BRIZALINA PATULA sp.nov.

(Pl. 2, figs 17–19)

Material examined: 21 specimens.

Diagnosis: A broadly triangular species with narrow peripheral keel and longitudinal central depression; ornamented by two parallel central longitudinal costae and smaller irregular lateral costae; aperture large oval, toothplate large, with broad flaring base.

Description: Test broadly triangular in outline, with longitudinal central depression, most specimens with proloculus 32 to 40 microns in diameter, very rare specimens with proloculus 16–24 microns in diameter, possibly representing A_2 and A_1 generations respectively. Both forms broadening throughout to greatest width at last pair of chambers; periphery with distinct narrow fragile keel. Proloculus globular in $?A_2$ forms, followed by 5 to 7 pairs of biserial chambers increasing rapidly in width but slowly in height as added; $?A_1$ forms with 8 or 9 pairs of biserial chambers, increasing only slowly in size as added. Sutures wide, smooth, limbate, strongly oblique and curved, meeting in centre of test in raised triangular areas of imperforate shell material, more strongly developed on $?A_2$ specimens. Surface of test ornamented by two parallel central longitudinal costae, at either side of central groove, also more strongly developed on $?A_2$ forms; and by irregularly distributed finer lateral costae extending over several chambers or confined to individual chambers. Test wall radiate in texture, finely and densely perforate over entire chamber surface, pore diameter 2 microns. Aperture large, oval, with thickened imperforate margin, reaching to basal suture of chamber. Each chamber with well-developed toothplate, beginning within septal foramen, with broad flaring base; folded portion confined to upper part, increasing in width towards aperture, and forming elongate tooth within aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·64	0·46	0·23
Paratype A	0·65	0·43	0·20
Paratype B	0·76	0·45	0·19

Occurrence: Holotype (CPC 6196) and paratypes A and B (CPC 6197 and 6198) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); other localities: 1f, 15g.

Brizalina patula sp.nov. has been recorded as *Bolivina* sp. 7 and *Bolivina* sp. 17, occurring doubtfully in the lower Miocene (Burdigalian) and from the middle Miocene to the Pliocene.

Remarks: Specimens of *Brizalina patula* of the $?A_2$ generation are much more abundant than $?A_1$ forms, and the latter have been found in only one sample, with a ratio of 14 $?A_2$ specimens to one $?A_1$ specimen. The more abundant $?A_2$ specimens are generally shorter and broader than the $?A_1$ specimens and have a more strongly developed ornament. In other features, such as the marginal keel, toothplate and perforation of the test the two forms are identical.

The holotype and paratype A are ?A_2 forms and paratype B is an ?A_1 specimen.

Described species originally referred to the genus *Bolivina*, such as *B. hantkeniana* Brady, and *B. schwageriana* Brady, are similar in outline and chamber shape to *Brizalina patula*. *Bolivina hantkeniana* has a striate ornament but lacks the strong central longitudinal costae and the raised areas at the junction of the sutures of *Brizalina patula; Bolivina schwageriana* has the raised central areas but is otherwise smooth.

The specific name is from the Latin *patulus*, spread out, broad, referring to the broad test.

BRIZALINA HASTULA sp.nov.

(Pl. 2, figs 20–22)

Material examined: 9 specimens.

Diagnosis: A slender elongate species with narrowly rounded periphery; ornamented on early chambers by faint continuous striae; sutures oblique with small re-entrants on later chambers; aperture narrow elongate, toothplate small.

Description: Test slender, elongate, gradually broadening throughout to greatest width at last pair of chambers. Periphery narrowly rounded, test diamond-shaped to sharply elliptical in end view. Proloculus small, globular, followed by 10 to 12 pairs of biserial chambers, wider than high, increasing very slowly in size as added. Surface of lower one-third or one-half of test ornamented by very faint continuous striae. Sutures narrow, distinct, smooth, curved and strongly oblique, forming angle of about 45 degrees with horizontal, sometimes with small re-entrants near centre of test, particularly on later chambers. Test wall radiate in texture, coarsely perforate, pore diameter not determined. Aperture narrow, elongate, with imperforate margin, reaching to basal suture of chamber. Each chamber with small folded toothplate, not clearly observed.

Dimensions:	Length	Maximum Width	Maximum Thickness
Holotype	0·46	0·18	0·10
Paratype	0·48	0·17	0·10

Occurrence: Holotype (CPC 6199) and paratype (CPC 6200) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene); holotype from locality 1g, paratype from locality 1f; other locality: 1d.

B. hastula sp.nov. has been recorded as *B.* sp. 23, from the lower Miocene (Burdigalian) and middle Miocene on Yule Island, Papua.

Remarks: The small re-entrants along the sutures of *B. hastula* are similar to those of *B. robusta*, but are not as strongly developed, and no indication of associated internal ridges has been observed. All specimens found are infilled and this has prevented detailed observation of the toothplate and the pores.

Brizalina hastula is distinct from other described species originally referred to the genus *Bolivina* in the very slender elongate test and faint striate ornament on the early chambers.

The specific name is the Latin *hastula*, a small spear, referring to the outline of the test.

Brizalina karreriana (Brady, 1881)

(Pl. 2, figs 23–25)

1881 *Bolivina karreriana* Brady, p. 28.
1884 *Bolivina karreriana* Brady; Brady, p. 424, pl. 53, figs 19a–b, 20–21.
1911 *Bolivina karreriana* Brady; Cushman, p. 40, text-figs 65a–b.
1941*c* *Loxostomum karrerianum* (Brady); LeRoy, p. 115, pl. 2, figs 38–39.
1950 *Loxostoma karreriana* (Brady); Asano, pt 2, p. 11, figs 44–45.
1951*b* *Loxostoma karrerianum* (Brady); Hofker, p. 72, figs 37, 38a–d.
1954 *Loxostomum karrerianum* (Brady); Cushman, Todd, & Post, p. 353, pl. 88, fig. 7 (not fig. 6 as indicated).
1957 *Loxostomum karrerianum* (Brady); Agip Mineraria, pl. 31, fig. 10.
1957 *Loxostoma karrerianum* (Brady); Samaniego & Gonzales, p. 201, pl. 23, figs 2a–b.
1957 *Loxostoma karrerianum* (Brady); Daleon & Samaniego, p. 46, pl. 1, fig. 45.
1960 *Loxostomum karrerianum* (Brady); Barker, p. 110, pl. 53, figs 19a–b, 20–21.
1963 *Loxostoma karrerianum* (Brady); Decima, p. 88, pl. 1, figs 9a–b.
1964 *Loxostomum karrerianum* (Brady); LeRoy, p. 33, pl. 2, figs 26–27.

Material examined: 31 specimens.

B. karreriana occurs at numerous localities, but is never abundant in any one sample; most specimens observed have a distinct basal spine. The aperture is large and rounded, and although not reaching to the basal suture of the chamber does not become truly terminal. The toothplate begins within the septal foramen, with the fixed edge attached throughout its length to the chamber wall. The free edge has a narrow fold forming a small tooth in the aperture. Hofker (1951*b*) referred to the toothplate as straight, but figured (p. 46, fig. 18w) a toothplate with a small fold at the free edge. Hofker also stated that the toothplate never reaches the neck of the aperture, but in the present specimens the free edge continues to the outer apertural margin.

A discussion of the criteria which lead me to refer this species to *Brizalina* is given later under the genus *Rectobolivina.*

The erroneous plate reference given by Cushman, Todd, & Post (1954) was corrected by Todd & Low (1960).

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6201	0·50	0·20	0·14
CPC 6202	0·43	0·19	0·13

Occurrence: Figured specimens (CPC 6201 and 6202) from the creek west of Winge, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localities: 5, 13d, 16j, 21, 25, 27, 32, 34, 36.

Brizalina karreriana has been recorded as *Loxostomum karrerianum*, ranging from the upper Miocene to the Pliocene, with a similar form in the middle Miocene; it occurs also in Recent deposits.

Brizalina catenula sp.nov.

(Pl. 3, figs 1–2)

Material examined: 22 specimens.

Diagnosis: A small compressed elongate species with narrow keel on periphery of early chambers; ornamented by raised central ridge, irregular reticulate ornament on early chambers and rows of small reticulations along sutures; aperture small, narrow.

Description: Test small, usually broadening throughout from rounded initial end to greatest width at last pair of chambers, some specimens with sides of upper part of test parallel. Narrowly diamond-shaped in end view, periphery sharply angular on all except last one or two pairs of chambers, with narrow thin clear imperforate keel. Proloculus globular, followed by 6 to 8 pairs of biserial chambers, much wider than high, increasing very slowly in size as added. Surface of test with complex ornament consisting of a raised ridge at centre of test along junction of chambers and also along line of sutures, with coarse raised reticulations at centre of lower part of test and fine reticulations along base of chambers, extending from ridges along sutures. Last one or two pairs of chambers smooth. Sutures on early chambers marked by raised ornament, on last one or two pairs of chambers smooth, straight, strongly oblique, forming angle of 45 to 50 degrees to horizontal. Test wall radiate in texture, perforate, details of pores not observed. Aperture small, narrowly oval, with imperforate margin, reaching to basal suture of chamber. Each chamber with small toothplate, not clearly observed, extending about one-half width of septal foramen.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·41	0·22	0·12
Paratype	0·42	0·21	0·13

Occurrence: Holotype (CPC 6203) and paratype (CPC 6204) from near the culmination of the Popo Anticline, 3½ miles south-south-east of Popo village, Papua (upper Miocene); found only in this sample.

Previous references to *B. catenula* from Papua-New Guinea are not known.

Remarks: Available specimens of *B. catenula* are not sufficiently well preserved to enable details of the toothplate and the pores to be observed.

B. catenula most closely resembles *B. subreticulata* (Parr) in the nature of the ornament, but differs in having the large reticulations at the centre of the test, with a row of fine reticulations at the base of each chamber and also in having a keel at the periphery of the early chambers.

The specific name is the Latin *catenula*, a small chain, referring to the rows of small reticulations along the sutures.

BRIZALINA MASSULA sp.nov.

(Pl. 3, figs 3–4)

Material examined: 28 specimens.

Diagnosis: A compressed broadly triangular species with wide peripheral keel; ornamented by few irregular striations, very rarely smooth; aperture large, oval; toothplate large, with broad flaring base.

Description: Test large, triangular in outline, broadening from initial end to greatest width at last pair of chambers, with shallow central longitudinal depression; periphery with wide strong keel. Only megalospheric forms known; proloculus globular, ranging from 56 to 72 microns in diameter, followed by 4 to 5 pairs of biserial chambers, increasing slowly in size as added. Chambers inflated, with lobate outline, caused by basal margin of each chamber overlapping upper edge of earlier chamber. Sutures narrow, distinct, oblique, forming angle of about 30 degrees with horizontal, at first smooth or only slightly depressed, later deeply depressed, meeting at centre of test in large raised areas of imperforate shell material. Surface of test very rarely smooth, usually with irregularly distributed and variable striate ornament. Proloculus smooth or with 2 to 6 low rounded ridges, sometimes extending on to early biserial chambers; upper part of test with short discontinuous ridges crossing raised areas of shell material, occurring also along basal margin of some chambers and at times completely across chamber surface. Short low ridges may also occur around inner margin of aperture. Test wall radiate in texture, finely and densely perforate, pore diameter about 2 microns. Aperture large, oval, with thickened imperforate margin, reaching to basal suture of chamber. Each chamber with well-developed toothplate, beginning within and extending full width of septal foramen, broad and flaring at base, broadly folded in upper part, free margin forming elongate tooth in aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·98	0·70	0·23
Paratype	0·81	0·58	0·18

Occurrence: Holotype (CPC 6205) and paratype (CPC 6206) from Forsayth Plantation, Mushu Island, Sepik district, New Guinea (Pliocene); found only in this sample.

B. massula sp.nov. has not been recorded previously from Papua-New Guinea.

Remarks: The holotype shows the maximum observed ornamentation for this species, with short striae around the apertural margins and on the raised areas at the junction of the sutures, on the chamber walls and on the proloculus. The paratype represents the other extreme, with low rounded ridges on the proloculus and extending on to the first pair of biserial chambers, and occasionally on the raised areas of shell material.

Brizalina massula is distinct from other described species with a broad peripheral keel, originally referred to the genus *Bolivina*, such as *B. hantkeniana* Brady and *B. schwageriana* Brady. The specific name is the Latin *massula*, a small lump, referring to the raised imperforate shell material at the junction of the sutures.

Brizalina tuberosa sp.nov.

(Pl. 3, figs 5–7)

Material examined: 14 specimens.

Diagnosis: A compressed, elongate species with rounded periphery; ornamented by tubular projections forming openings for coarse pores; sutures oblique, margins of younger chambers often depressed, forming broad grooves; aperture narrow, oval, toothplate small.

Description: Test compressed, elongate, broadening gradually from rounded initial end to greatest width at last two chambers; periphery rounded. Proloculus globular, followed by 5 to 7 pairs of biserial chambers, increasing very slowly in size as added. Early biserial chambers indistinct, later chambers elongate, wider than high. Surface of test, except for last one or two pairs of biserial chambers, ornamented by raised rounded or tubular projections forming opening for coarse pores in wall, developed mainly along peripheral margins, also occurring irregularly on surface of chambers. Last one or two pairs of biserial chambers coarsely perforate, with one row of pores formed at distal chamber margin and others irregularly developed over chamber surface. Pore diameter ranging from 10 microns on early chambers to 6 microns on later chambers. Sutures indistinct on early chambers, on later chambers narrow, straight or slightly curved, strongly oblique, forming angle of about 45 degrees to horizontal. Inner margins of younger chambers often depressed, forming broad groove along line of sutures. Wall radiate in texture. Aperture narrowly oval, with slightly raised imperforate margin, reaching basal suture of chamber; each chamber with small toothplate having narrow folded free edge extending throughout its length and forming small tooth in aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·47	0·22	0·10
Paratype	0·33	0·19	0·09

Occurrence: Holotype (CPC 6207) and paratype (CPC 6208) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 3, 4.

B. tuberosa sp.nov. has been recorded as *Bolivina* sp. 18, ranging from the lower Miocene (Burdigalian) to the Pliocene. One specimen is present in a slide from shore sand at Apia, Samoa, collected by the late Mr W. G. Parr.

Remarks: Brizalina tuberosa is distinct from described species originally referred to the genus *Bolivina* in the ornament of raised tubules forming external openings for the pores. The pores of *B. tuberosa* are the largest observed in the species of *Brizalina* occurring in the present material.

The specific name is from the Latin *tuberosus*, full of lumps, referring to the tubular projections of the test.

BRIZALINA SEMICARINATA sp.nov.

(Pl. 3, figs 12–13)

Material examined: 11 specimens.

Diagnosis: A slender, elongate species with narrow keel on lower part of test; ornamented on early chambers by 10 to 15 continuous low costae; early sutures obscured, later narrow, oblique; aperture small, oval, toothplate not observed.

Description: Test slender, elongate, some specimens broadening very slowly throughout to greatest width at last pair of chambers, others reaching maximum width after first 3 or 4 pairs of biserial chambers, sides of test then parallel. Periphery of lower part of test with narrow distinct keel, rounded in upper part. Proloculus globular, followed by 7 to 10 pairs of biserial chambers, increasing very slowly in size as added. Early part of test ornamented by 10 to 15 continuous low narrow longitudinal costae, surface of later chambers smooth. Sutures of early chambers obscured by ornament, later narrow, distinct, smooth, strongly oblique, forming angle of about 45 degrees with horizontal. Test wall radiate in texture, coarsely and densely perforate, pore diameter not determined. Aperture small, oval, with low rounded imperforate rim, reaching to basal suture of chamber, with narrow tooth; toothplate not observed.

Dimensions:	Length	Maximum Width	Maximum Thickness
Holotype	0·72	0·26	0·16
Paratype	0·64	0·22	0·13

Occurrence: Holotype (CPC 6209) from the base of a section through the 'Murua Mudstone', Yamuiti Creek, Malalaua-Saw Mountains area, Papua (upper Miocene, locality 12f); paratype (CPC 6210) from Poison Creek, ½ mile west of the Kapau River, Malalaua-Saw Mountains area, Papua (middle Miocene); found only in these two samples.

Brizalina semicarinata sp.nov. has been recorded as *Bolivina* sp. 22, only from the middle Miocene, mainly in the Yule Island area, Papua.

Remarks: Insufficient well-preserved specimens of *B. semicarinata* are available to permit detailed investigation of the pore pattern and internal structure; most specimens found have the chambers completely infilled.

Brizalina semicarinata does not closely resemble any other described species. The specific name refers to the narrow keel occurring only on the lower part of the test.

BRIZALINA sp. A
(Pl. 4, figs 8–9)

Three specimens only of this species have been found, in one sample from New Guinea. They resemble in some features *Brizalina patula* sp.nov., but it is doubtful if they fall within the range of variation of *patula*. The test is ornamented by two strong central longitudinal costae, and raised areas of shell material at the junction of the sutures, as in *B. patula*, but lacks the irregular lateral costae. In outline they are more slender and elongate than *patula*, with a different chamber shape. The test is also more finely and densely perforate, with a pore diameter ranging from about 1·5 to 2 microns. The three specimens probably represent a new species.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6211	0·93	0·46	0·21
CPC 6212	0·89	0·44	0·19

Occurrence: Figured specimens (CPC 6211 and 6212) from a sample in the creek north of Ibab village, Wewak subdistrict, Sepik district, New Guinea (upper Miocene); found only in this sample.

It is not known if specimens of this type have been recorded previously from Papua-New Guinea.

Genus LATEROSTOMELLA de Klasz & Rérat, 1962

LATEROSTOMELLA VOLUTA sp.nov.

(Pl. 3, figs 14–16; text-fig. 1: 2)

Material examined: 37 specimens.

Diagnosis: A small, slender species with test twisted, sometimes through angle of 90 degrees; ornamented by 10 to 12 low thin continuous costae except for last pair of chambers; early sutures indistinct, later slightly depressed, almost horizontal; aperture large, rounded, to one side of test, reaching basal suture of chamber; toothplate small, narrowly folded.

Description: Test small, slender, oval to rounded in end view, broadening very gradually from proloculus to greatest width at last pair of chambers; test twisted to different degrees, sometimes through angle of 90 degrees from first to last pair of biserial chambers. Proloculus globular, followed by 5 to 6 pairs of biserial chambers, increasing slowly in size as added. Surface of test ornamented by 10 to 12 low thin continuous costae on all except last pair of biserial chambers. Sutures on early chambers indistinct, or obscured by ornament, later narrow, distinct, depressed, forming only low angle with horizontal. Test wall finely and densely perforate, pore diameter 2 microns, radiate in texture. Aperture large, rounded, directed to one side of test, reaching basal suture of chamber. Each chamber with small toothplate, extending at base across septal foramen, upper part narrowly folded, smooth free edge forming small tooth in aperture.

Dimensions:

	Length	Maximum Width
Holotype	0·32	0·13
Paratype	0·31	0·13

Occurrence: Holotype (CPC 6216) and paratype (CPC 6217) from the 'Murua Mudstone', Yamuiti Creek, Malalaua-Saw Mountains area, Papua, 400 feet below the top of the section (upper Miocene, locality 12c); other localities: 7a, 12b, 26.

L. voluta sp.nov. has been recorded as *Bolivina* sp. 11, ranging from the lower Miocene (Burdigalian) to the Pliocene.

Remarks: The twisting of the test of *L. voluta* results from the chambers being added at an angle of slightly more than 180 degrees. Except for this feature, not covered in the generic definition, the morphology of the new species *voluta* enables it to be referred to the genus *Laterostomella.*

In external appearance, *L. voluta* differs from the species *Laterostomella striata* de Klasz & Rérat, described from the lower Miocene of Gabon, in being twisted, less heavily ornamented and more compressed, with an oval rather than rounded outline in end view. It also resembles *Bolivina yabei* Takayanagi, but is more strongly twisted and more strongly costate.

The specific name is the Latin *voluta*, spiral, referring to the twisting of the test.

Genus Rectobolivina Cushman, 1927

The definition of *Rectobolivina* given by Loeblich & Tappan (1964*a*) is followed here, with species biserial to uniserial in the microspheric generation included in this genus. *Siphogenerina* is restricted to include only those species triserial to uniserial in the microspheric generation. Previously, *Rectobolivina* and *Siphogenerina* were separated mainly on the shape of the adult stage of the test in cross-section, compressed species being placed in *Rectobolivina* and rounded species in *Siphogenerina*. The toothplate of the two genera is similar, and each has a radiate wall texture.

The discussion given by Hofker (1951*b*, 1956*b*, 1957) concerning the distinction between *Bolivina* and *Loxostomum* (=*Loxostomoides*, part) may equally well be applied to the distinction between *Brizalina* and *Rectobolivina*. Several species in the Papua-New Guinea material show apertures which do not reach the basal suture of the chamber but are not truly terminal Of these, the species *karreriana* Brady, which has usually been referred to *Loxostomum* (=*Loxostomoides*, part) does not develop uniserial chambers and the fixed edge of the toothplate remains attached to the chamber wall throughout. This species has here been referred to the genus *Brizalina*. In other species investigated, *Rectobolivina limbata* (Brady), *R.* sp.cf. *R. carinata* (Millett), *R. papula* sp.nov., *R. fasciata* sp.nov., and *R. tenuicostata* sp.nov., the toothplate develops a fold at each edge before full uniserial growth is developed. Höglund (1947) illustrated a similar development of the toothplate in *R. porrecta* (Brady), in which the chamber arrangement in adult stages is not fully uniserial. Hofker (1956*b*, p. 62), discussing the species *Bolivina barbata* Phleger & Parker, referred it to *Loxostomum*, since microspheric specimens 'have the toothplate of a *Loxostoma* but the aperture of a *Bolivina*'. The figures given by Hofker show that the specimens do not develop uniserial growth and that the aperture is at one side of the test, in one case seeming to reach the basal suture. In the present specimens the position of the aperture is in some cases no different from that of *Brizalina karreriana*, but the difference in form of the toothplate is easily observed. The feature here taken to distinguish *Rectobolivina* from *Brizalina* is the development of a toothplate folded at each edge, not dependent on uniserial growth.

Rectobolivina bifrons (Brady, 1881)

(Pl. 9, figs 13–14)

1881 *Sagrina bifrons* Brady, p. 64.
1884 *Sagrina bifrons* Brady; Brady, p. 582, pl. 75, figs 18–20.
1950 *Rectobolivina bifrons* (Brady); Asano, pt 2, p. 11, figs 46–47.
1951*b* *Rectobolivina bifrons* (Brady); Hofker, p. 60, figs 27a–c.
1958 *Rectobolivina bifrons* (Brady); Asano, p. 28, pl. 5, figs 10–11. (Synonymy).
1960 *Rectobolivina bifrons* (Brady); Barker, p. 156, pl. 75, figs 18–20.
1964 *Rectobolivina bifrons* (Brady); Huang, tab. 1, pl. 2, fig. 28.
1964 *Rectobolivina bifrons* (Brady); Ishiwada, pl. 4, fig. 68.
1964 *Rectobolivina bifrons* (Brady); LeRoy, p. 34, pl. 3, figs 1–2.

Material examined: 22 specimens.

Specimens of *R. bifrons* occur commonly in two samples from the Madang area, New Guinea, for which an exact locality is not known. Megalospheric forms predominate, with 2 to 4 pairs of biserial chambers; only one microspheric specimen has been found, with 6 pairs of biserial chambers. The test is compressed and oval in section, and has a longitudinal central depression, or a small central depression at the base of each chamber. The test is perforate and the wall is radiate in texture. Each chamber has a broad toothplate, which is identical with that figured by Hofker (1951*b*) for Recent specimens.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6219	0·65	0·20	0·15
CPC 6220	0·68	0·19	0·15

Occurrence: Figured specimens (CPC 6219 and 6220) from sample JT21, Madang area, New Guinea, exact locality not known; also occurring in sample JT6 from the same area.

R. bifrons is recorded from the upper Miocene and the Pliocene; it also occurs in Recent deposits.

RECTOBOLIVINA INDICA (LeRoy, 1941)

(Pl. 9, figs 5–6)

1884 *Sagrina raphanus*, part, Brady, p. 585, pl. 75, fig. 23 (not figs 21–22, 24). (Not of Parker & Jones).
1941*a* *Siphogenerina indica* LeRoy, p. 37, pl. 2, figs 64–65.
1960 *Siphogenerina raphanus*, part, Barker, p. 156, pl. 75, fig. 23 (not figs. 21–22, 24). (Not of Parker & Jones).

Material examined: 46 specimens.

R. indica occurs abundantly in several samples. The test is cylindrical, broadening only very gradually in width towards the apertural end; the chamber arrangement is biserial to uniserial in all specimens observed. The toothplate is a broad plate with a small fold at each margin, twisted through an angle of 180 degrees in successive chambers. The test is finely perforate and the wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6221	0·83	0·22
CPC 6222	0·55	0·19

Occurrence: Figured specimens (CPC 6221 and 6222) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1a); other localities: 1b, 1d, 1f, 1g, 36.

R. indica is recorded from the middle Miocene to the Pliocene; it occurs also in Recent deposits.

Rectobolivina dimorpha (Parker & Jones, 1865)

(Pl. 9, figs 7–8)

1865 *Uvigerina (Sagrina) dimorpha* Parker & Jones, p. 364, pl. 18, fig. 18.
1884 *Sagrina dimorpha* Parker & Jones; Brady, p. 582, pl. 76, figs 1–3.
1947 *Siphogenerina dimorpha* (Parker & Jones) Höglund, p. 284, pl. 23, figs 5, 6a–b, 7a–b. (Synonymy).
1951*b* *Rectobolivina dimorpha* (Parker & Jones); Hofker, p. 116, figs 69a–d, 70a–b, 71a–c.
1954 *Rectobolivina dimorpha* (Parker & Jones); Parker, p. 519, pl. 7, fig. 37.
1964 *Rectobolivina dimorpha* (Parker & Jones); LeRoy, p. 34, pl. 3, figs 3–4.

Material examined: 59 specimens.

The prominent depressions at the base of the chambers, a feature given by Cushman (1926*e*) as typical of *R. dimorpha* var. *pacifica*, are not well shown by the Papua-New Guinea specimens, and this variety is not recognized from the present samples. The surface of the test is covered by an irregular reticulate ornament, more strongly developed on the early chambers. The internal structure is as figured by Hofker (1951*b*) for Recent specimens. The pores have not been seen, but the wall is radiate in texture. All specimens observed have a biserial arrangement of the early chambers.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6223	0·44	0·16
CPC 6224	0·38	0·17

Occurrence: Figured specimens (CPC 6223 and 6224) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 12c, 25, 29.

R. dimorpha is recorded from the lower Miocene (Burdigalian) to the Pliocene; it occurs also in Recent deposits.

Rectobolivina columellaris (Brady, 1881)

(Pl. 9, figs 9–12)

1881 *Sagrina columellaris* Brady, p. 64.
1884 *Sagrina collumellaris* Brady; Brady, p. 581, pl. 75, figs 15–17.
1941*a* *Rectobolivina columellaris* (Brady); LeRoy, p. 35, pl. 1, figs 57–58.
1950 *Siphogenerina columellaris* (Brady); Asano, pt 2, p. 13, figs 54–55.
1951*b* *Rectobolivina columellaris* (Brady); Hofker, p. 68, figs 33a–c, 34a–e, 35a–b.
1958 *Siphogenerina columellaris* (Brady); Asano, p. 30, pl. 7, figs 14–15. (Synonymy).
1960 *Rectobolivina columellaris* (Brady); Barker, p. 156, pl. 75, figs 15–17.

Material examined: 38 specimens.

Specimens of *R. columellaris* from localities 1d, 18, and 21 are as described by Hofker (1951*b*) for Recent specimens, with the megalospheric forms smooth and the microspheric forms ornamented. The costae on the microspheric specimens are fine and not strongly developed. At locality 27, rare megalospheric specimens are costate and some microspheric specimens smooth. Both the megalospheric and microspheric specimens have a toothplate identical with that illustrated by Hofker. The test is finely perforate and the wall is radiate in texture. The biserial chambers of microspheric specimens are compressed, but the adult stages of both microspheric and megalospheric specimens are rounded.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6225	0·83	0·20
CPC 6226	0·70	0·24
CPC 6227	1·28	0·26
CPC 6228	0·93	0·23

Occurrence: Figured specimens (CPC 6225 to 6228) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 1d, 18, 21.

Specimens here referred to *R. columellaris* have been recorded as *Siphogenerina zitteli* Karrer, occurring in the upper Miocene and the Pliocene.

RECTOBOLIVINA TENUICOSTATA sp.nov.

(Pl. 4, figs 10–11; text-fig. 4: 2)

Material examined: 51 specimens.

Diagnosis: A slender elongate species, biserial to uniserial; early chambers compressed, later inflated; ornamented by low wavy costae; sutures at first smooth, later depressed; aperture terminal, oval; toothplate narrowly folded, both margins free.

Description: Test slender, elongate, biserial to uniserial in chamber arrangement; maximum width quickly reached, sides of test then parallel. Biserial chambers compressed, uniserial chambers inflated, oval to almost circular in end view. Proloculus small, globular, followed by 4 to 5 pairs of biserial chambers, then one or two chambers transitional to uniserial growth, with a maximum of 4 uniserial chambers observed; biserial chambers increasing slowly in size as added, uniserial chambers uniform in size. Sutures on biserial chambers smooth, oblique, making angle of about 45 degrees with horizontal; on uniserial chambers narrow, distinct, depressed, horizontal. Surface of test ornamented by numerous low, narrow, distinct, wavy costae, on early chambers, becoming faint on last one or two chambers, sometimes bifurcating and with smaller costae intercalated. Test wall radiate in texture, perforate, pore diameter not determined. Aperture on uniserial chambers terminal, elongate oval, with slightly raised lip. Each chamber with narrowly folded toothplate, alternating in direction, with both margins free before uniserial growth attained.

Dimensions:

	Length	Maximum Width
Holotype	0·77	0·15
Paratype	0·63	0·15

Occurrence: Holotype (CPC 6229) and paratype (CPC 6230) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); other locality: 32.

Rectobolivina tenuicostata sp.nov. has not been recorded previously from Papua-New Guinea.

Remarks: R. tenuicostata is distinct from other described species of *Rectobolivina*, or of species previously placed under *Loxostomum*, in its compressed biserial and inflated uniserial chambers, and in the wavy ornament, more strongly developed on the early chambers.

The specific name is from the Latin *tenuis*, thin, and *costatus*, ribbed, referring to the ornament.

RECTOBOLIVINA LIMBATA (Brady, 1881)

(Pl. 4, figs 12–15; text-fig. 4: 1)

1881 *Bolivina limbata* Brady, p. 27.
1884 *Bolivina limbata* Brady; Brady, p. 419, pl. 52, figs 26–28.
1937 *Loxostomum limbatum* (Brady); Cushman, p. 186, pl. 21, figs 26a–b, 27–28, 29a–b. (Synonymy).
1942 *Loxostoma limbatum* (Brady); Cushman, p. 35, pl. 10, figs 1a–b. (Synonymy).
1958 *Loxostomum limbatum* (Brady); Tinoco, p. 38, pl. 6, figs 15a–c.
1959 *Loxostomum limbatum* (Brady); Graham & Militante, p. 84, pl. 12, figs 30a–b, 31a–b, 32a–b. (Synonymy).
1960 *Loxostomum limbatum* (Brady); Barker, p. 108, pl. 52, figs 26–28.

Material examined: 9 specimens.

Specimens of *R. limbata* have been found only rarely in the present material. Included under this name are smooth forms and also striate forms similar to the specimen described by Cushman (1922*b*) as *Bolivina limbata* var. *costulata*. Cushman (1937) noted that this variety is 'much more common than the typical form wherever the species occur', and repeated this observation in 1942. This is possibly a case similar to that of *Cassidulina laevigata* d'Orbigny, which occurs as both carinate and non-carinate types, the former being the more common. Detailed investigations should be made of such features as the toothplate and pores of both striate and smooth forms occurring together. The smooth forms from the present material appear to be more densely perforate than the striate types, but there are not sufficient specimens available for a detailed comparison to be made.

Dimensions of figured specimens:	Length	Maximum Width	Maximum Thickness
CPC 6232	0·80	0·25	0·17
CPC 6233	0·66	0·24	0·14
CPC 6234	0·69	0·24	0·13

Occurrence: Figured specimens (CPC 6232 and 6233) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); figured specimen (CPC 6234) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in these two samples.

Rectobolivina limbata has been recorded as *Loxostomum limbatum*, ranging from the middle Miocene to the Pliocene; it occurs also in Recent deposits.

RECTOBOLIVINA PAPULA sp.nov.

(Pl. 4, figs 16–19; text-fig. 4: 3)

Material examined: 33 specimens.

Diagnosis: A narrow elongate species with rounded periphery; ornamented by 14 to 20 strong costae, usually continuous; aperture terminal, large oval, toothplate well developed with two free margins in uniserial chambers.

Description: Test narrow, elongate, oval in end view, with broadly rounded periphery. Megalospheric form with broadly rounded initial chambers, microspheric form pointed, both forms broadening to maximum width at middle of test, sides then parallel; periphery lobate in side view on later chambers. Proloculus in megalospheric forms large and globular, followed by 3 to 4 pairs of biserial chambers before uniserial chambers begin; microspheric forms with 7 to 8 pairs of biserial chambers preceding uniserial chambers. Surface of test ornamented by 14 to 20 strong costae, usually continuous, extending on to base of last chamber, those in centre of test passing through raised areas of shell material formed at junction of sutures; other costae restricted to lower or upper part of test or even very rarely to surface of one chamber. Megalospheric forms more strongly ornamented on early chambers than microspheric specimens. Sutures on early chambers often obscured by ornament, straight, smooth, oblique, forming angle of 30 to 45 degrees with horizontal; on uniserial chambers narrow, depressed, only slightly inclined, sometimes sigmoidal. Test wall finely perforate, radiate in texture, pore diameter about 2 microns. Aperture terminal, large, oval, with raised imperforate rim. Each chamber with well developed toothplate beginning within and extending full width of septal foramen; base broad and flaring, in uniserial chambers both margins free, one margin (previously fixed margin) with small fold, other margin broadly folded and forming tooth in aperture.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·96	0·39	0·24
Paratype A	0·93	0·40	0·23
Paratype B	1·08	0·35	0·24

Occurrence: Holotype (CPC 6236) and paratypes A and B (CPC 6237 and 6238) from the sea cliff 250 yards north of the L.M.S. Mission, Delena, Papua (lower Miocene, Burdigalian); found only in this sample.

Rectobolivina papula has been recorded as *Loxostomum* sp. 3, ranging from the lower Miocene (Burdigalian) to the middle Miocene.

Remarks: Seventeen megalospheric and five microspheric specimens of *R. papula* have been found. No specimen observed has more than two uniserial chambers. *R. papula* is clearly distinguished from other strongly ornamented species previously referred to *Loxostomum*, such as *L. amygdalaeforme* (Brady) by the longitudinal rather than oblique costate ornament, which does not bifurcate, and the raised areas of shell material at the junction of the sutures.

The holotype and paratype A are megalospheric specimens; paratype B is microspheric.

The specific name is the Latin *papula*, pustule, pimple, referring to the raised shell material at the junction of the sutures.

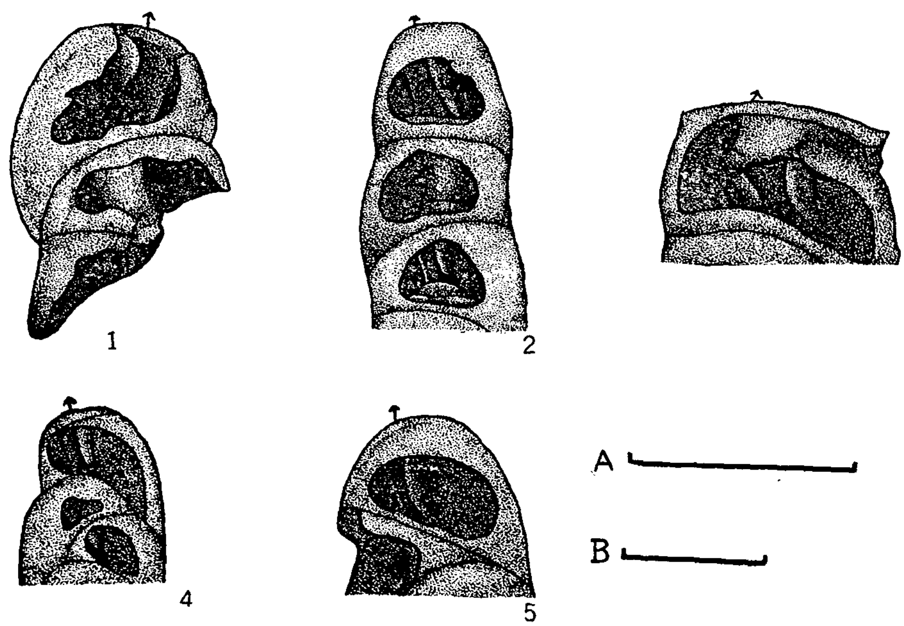
RECTOBOLIVINA sp.cf. R. CARINATA (Millett, 1900)

(Pl. 4, figs 20–21; text-fig. 4: 4)

cf. 1900 *Bolivina karreriana* Brady var. *carinata* Millett, p. 546, pl. 4, figs 8a–b.

Material examined: 25 specimens.

Specimens occurring in several samples from Papua-New Guinea are tentatively referred to *R. carinata*. They are more slender than the holotype and the specimens figured by Cushman (1937), and are also less heavily costate. However, they are close to *R. carinata*, and a comparison with topotypic material showing the full range of variation is necessary to determine whether or not a new specific name is needed for the Papua-New Guinea specimens.



TEXT-FIGURE 4

1 CPC 6235 *Rectobolivina limbata* (Brady), locality 27. Toothplate.
2 CPC 6231 *Rectobolivina tenuicostata* sp.nov., locality 17. Toothplate.
3 CPC 6239 *Rectobolivina papula* sp.nov., locality 3. Toothplate.
4 CPC 6242 *Rectobolivina sp.cf. R. carinata* (Millett), locality 1d. Toothplate.
5 CPC 6245 *Rectobolivina fasciata* sp. nov., locality 27. Toothplate.

Each scale represents 0·25 mm.
Figures 1–2, 4–5, to scale A.
Figure 3 to scale B.

The toothplate of the present specimens has two free margins, unlike that of the species *karreriana* Brady, which in this paper has been referred to the genus *Brizalina.* For this reason the variety described by Millett has been given specific rank, although the nature of the toothplate in topotype specimens is not known.

Dimensions of figured specimens:

	Length	Maximum Width	Maximum Thickness
CPC 6240	0·63	0·24	0·12
CPC 6241	0·59	0·24	0·12

Occurrence: Figured specimen (CPC 6240) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); figured specimen (CPC 6241) from a sample of the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1g); other localities: 1d, 7a, 29.

Specimens here tentatively referred to *Rectobolivina carinata* have been recorded as *Loxostomum* sp. 6, ranging from the lower Miocene (Burdigalian) to the Pliocene.

RECTOBOLIVINA FASCIATA sp.nov.

(Pl. 4, figs 22–23; text-fig. 4: 5)

Material examined: 26 specimens.

Diagnosis: An elongate, compressed, somewhat twisted species with narrow peripheral keel; sutures narrow; ornamented by low often faint costae; aperture narrow, elongate; toothplate well-developed, both margins free, often tightly folded, appearing tubular.

Description: Test elongate, compressed, somewhat twisted, broadening rapidly to greatest width at fourth or fifth pair of biserial chambers, sides of test then parallel; periphery with narrow thin keel. Proloculus globular, followed by four to six pairs of biserial chambers before transition to uniserial chambers. Chambers at first wider than high, increasing only slowly in size as added, later chambers increasing rapidly in height and becoming higher than wide. Surface of test except for last one or two chambers ornamented by low and often faint costae, in centre of test extending for full length, at periphery becoming oblique with new costae appearing on successive chambers. Sutures on early biserial chambers narrow, smooth, strongly oblique, forming angle of about 35 degrees to horizontal, meeting at centre of test in smooth or slightly raised areas of shell material; on later chambers, transitional to uniserial stage, depressed, wavy or sigmoidal. Test wall finely perforate, pore diameter 4 microns, radiate in texture. Aperture narrow, elongate, with raised imperforate margin, in larger specimens terminal, in others towards one side of test but not reaching basal suture of chamber. Each chamber with well developed toothplate becoming free at each margin before full uniserial growth developed; folded at each edge, in some specimens margins almost touching, giving toothplate tubular appearance.

Dimensions:

	Length	Maximum Width	Maximum Thickness
Holotype	0·84	0·24	0·13
Paratype	0·74	0·24	0·13

Occurrence: Holotype (CPC 6243) and paratype (CPC 6244) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other locality: 32.

Rectobolivina fasciata has been recorded as *Loxostomum* sp. 4, ranging from the lower Miocene (Burdigalian) to the upper Miocene.

Remarks: Very few specimens of *R. fasciata* showing full uniserial development have been found; available specimens generally show only the transitional stage to uniserial growth. The toothplate at this stage already has both margins free, and according to the criterion given previously, *fasciata* is referred to the genus *Rectobolivina.*

R. fasciata resembles *R. digitalis* (d'Orbigny), but this species is less strongly costate and is also more rounded, lacking the keel at the periphery. *R. mayori* (Cushman) is also similar, but is a more elongate form and again is more rounded, with no peripheral keel.

The specific name is the Latin *fasciatus*, banded, striped, referring to the ornament of the test.

Family ISLANDIELLIDAE Loeblich & Tappan, 1964

Genus CASSIDULINOIDES Cushman, 1927

The type species of *Cassidulinoides, Cassidulina parkeriana* Brady, is stated to have a radiate wall (Wood, 1949). The three species here placed in *Cassidulinoides* are granular, but in view of the uncertainty regarding the wall texture of the genus *Favocassidulina* (see p. 145) I consider it undesirable to erect a new generic name for them at this time. There is in fact no defined generic name for granular uncoiled biserial species of this type, now that Loeblich & Tappan (1964*a*) have restricted the genus *Cassidulinoides* to radiate forms. Nevertheless, I feel that a full re-examination of the wall texture and internal structure of uncoiled species should be made before proposing any further generic names.

CASSIDULINOIDES BRADYI (Norman, 1881)

(Pl. 26, figs 22–27; text-figs 17: 17–18)

1881 *Cassidulina bradyi* Norman; Brady, p. 59.
1884 *Cassidulina bradyi* Norman (part); Brady, p. 431, pl. 54, figs 6–9 (not figs 10a–b).
1925 *Cassidulina bradyi* Norman; Cushman, p. 52, pl. 8, figs 3–5.
1930 *Cassidulinoides bradyi* (Norman); Cushman, p. 58, pl. 11, figs 8a–b.
1933 *Cassidulinoides bradyi* (Norman); Cushman & Cahill, p. 33, pl. 12, figs 4a–b.
1945 *Cassidulinoides bradyi* (Norman); Cushman & Stainforth, p. 65, pl. 12, figs 6a–b.
1949 *Cassidulinoides bradyi* (Norman); Bermudez, p. 270, pl. 20, figs 29–31.
1959 *Cassidulinoides bradyi* (Norman); Dieci, p. 86, pl. 7, figs 15a–b.
1960 *Cassidulinoides bradyi* (Norman); Barker, p. 112, pl. 54, figs 6–9.
1964 *Cassidulinoides bradyi* (Norman); Ishiwada, pl. 7, fig. 107.
1964 *Cassidulinoides bradyi* (Norman); LeRoy, p. 41, pl. 12, figs 5–6.

Material examined: 18 specimens.

C. bradyi occurs rarely in several samples. The test is strongly uncoiled, with an elongate oval aperture in a depression in the apertural face, reaching to the basal suture and not truly terminal; a small apertural flap is developed. Each chamber has a narrow internal ledge around the apertural margin, formed by inward folding of the apertural face and extending as a low ridge to the upper margin of the depression containing the septal foramen. The test is finely perforate and the wall is granular in texture; the pore diameter has not been determined.

Dimensions of figured specimens:	Length	Maximum Breadth	Maximum Width
CPC 6246	0·33	0·15	0·13
CPC 6247	0·31	0·16	0·13

Occurrence: Figured specimens (CPC 6246 and 6247) from the creek north of Ibab village, Wewak subdistrict, Sepik district, New Guinea (Pliocene); other localities: 13b, 18, 27, 31, 32, 36, 39.

C. bradyi has been recordered from the lower Miocene (Burdigalian) to the Pliocene; it also occurs in Recent deposits.

CASSIDULINOIDES INFLATUS (LeRoy, 1944)

(Pl. 26, figs 14–17; text-fig. 17: 13–14)

1944*a* *Cassidulina inflata* LeRoy, p. 37, pl. 4, figs 30–31.

Material examined: 35 specimens.

C. inflatus occurs frequently to abundantly in several samples from New Guinea, but has been found only very rarely in Papua. A broad flap attached to the previous chamber covers the large apertural opening, leaving only a narrow curved slit along its outer margin. The test is tightly coiled and does not show any tendency for the later chambers to become erect and move away from the earlier chambers. Each chamber has a narrow internal ledge above the aperture, formed by infolding of the apertural face and not reaching to the septal foramen. The test is finely and densely perforate and the wall is granular in texture; the pore diameter has not been determined.

Dimensions of figured specimens:	Maximum Diameter	Minimum Diameter	Width
CPC 6250	0·54	0·41	0·33
CPC 6251	0·50	0·41	0·34

Occurrence: Figured specimen (CPC 6250) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); figured specimen (CPC 6251) from Pagansop village, north-north-east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 7a, 18, 27, 30, 31, 38.

C. inflatus has not been recorded previously from Papua-New Guinea.

Remarks: No specimens of *Cassidulinoides parkerianus* (Brady), the type species of *Cassidulinoides*, are available for examination, but the apertural characteristics and internal structure of *inflatus* are similar to those of *C. bradyi*. Obviously, *inflatus* should not now be referred to *Cassidulina* and is here placed in *Cassidulinoides* although it differs from most species of that genus in not being uncoiled.

Cassidulinoides seranensis Germeraad, 1946
(Pl. 26, figs 18–21; text-figs 17: 15–16)

1946 *Cassidulinoides seranensis* Germeraad, p. 72, pl. 5, figs 5–6.

Material examined: 14 specimens.

C. seranensis has been found only rarely in samples from New Guinea. The later chambers are erect and do not envelop the earlier whorls, but the test is not as strongly uncoiled as that of *Cassidulinoides parkerianus* (Brady), or of other species referred to *Cassidulinoides*. The species *seranensis* is undoubtedly congeneric with *C. inflatus* (LeRoy) and is retained in *Cassidulinoides*.

Well preserved specimens of *seranensis* have a large triangular apertural flap attached to the previous chamber, with a narrow elongate curved opening along its outer margin. The flap may be broken away, giving the appearance of a very large apertural opening. Each chamber has a small internal ledge above the aperture, formed by inward folding of the apertural face and not connected to the septal foramen, but reaching a point near the peripheral margin of the foramen. The test is finely and densely perforate and is granular in texture; the pore diameter has not been determined.

Dimensions of figured specimens:	Maximum Diameter	Minimum Diameter	Width
CPC 6253	0·44	0·25	0·21
CPC 6254	0·53	0·33	0·27

Occurrence: Figured specimens (CPC 6253 and 6254) from east of Yekimbolje village, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other locality: 27.

C. seranensis has not been recorded previously from Papua-New Guinea.

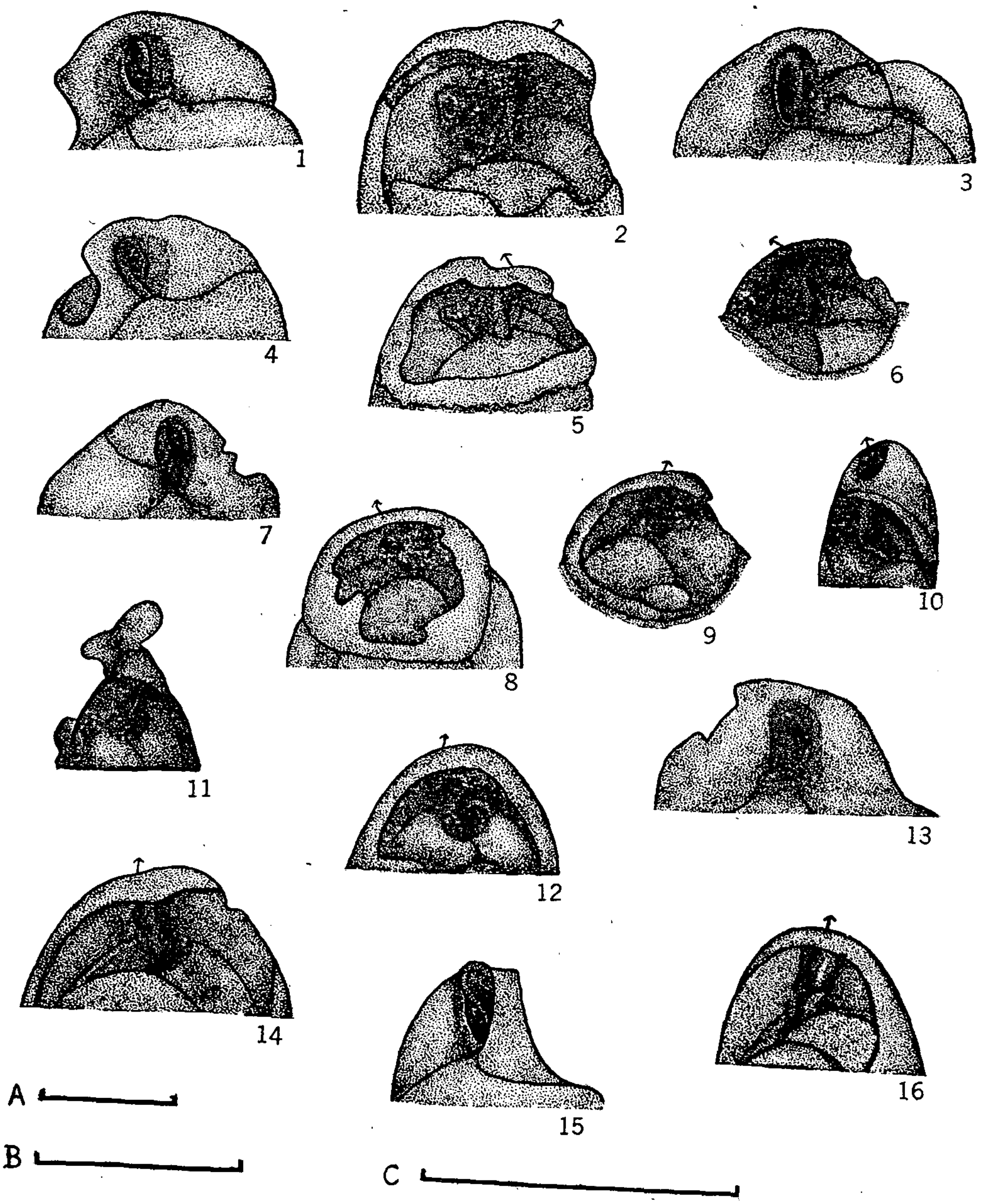
Family BULIMINIDAE Jones, 1875

Subfamily BULIMININAE Jones, 1875

Genus Bulimina d'Orbigny, 1826

Bulimina marginata d'Orbigny, 1826
(Pl. 5, figs 4–5; text-figs 5: 4–5; text-figs 7: 2–3)

1826 *Bulimina marginata* d'Orbigny, p. 269, pl. 12, figs 10–12.
1884 *Bulimina marginata* d'Orbigny; Brady, p. 405, pl. 51, figs 3–5.
1927*a* *Bulimina marginata* d'Orbigny; Galloway & Wissler, p. 73, pl. 11, fig. 17.
1939 *Bulimina marginata* (d'Orbigny); Phleger, p. 1403, pl. 3, fig. 23.
1945 *Bulimina marginata* d'Orbigny; Cushman & Todd, p. 39, pl. 6, fig. 8.
1947 *Bulimina marginata* d'Orbigny; Cushman & Parker, p. 119, pl. 28, figs 5a–b, 6a–b. (Synonymy).
1949 *Bulimina marginata* d'Orbigny; Cushman, p. 30, pl. 6, fig. 6.
1949 *Bulimina marginata* d'Orbigny; Said, p. 26, pl. 3, fig. 4.
1950 *Bulimina marginata* d'Orbigny; Asano, pt 2, p. 4, figs 13–14.
1951*b* *Bulimina marginata* d'Orbigny; Hofker, p. 154, figs 95, 96a–b.
1951 *Bulimina marginata* d'Orbigny; Phleger & Parker, p. 16, pl. 7, figs 27–28.
1954 *Bulimina marginata* d'Orbigny; Parker, p. 510, pl. 6, fig. 20.
1957 *Bulimina marginata* d'Orbigny; Samaniego & Gonzales, p. 200, pl. 22, fig. 7.
1957 *Bulimina marginata* d'Orbigny; Daleon & Samaniego, p. 43, pl. 1, fig. 38.
1957 *Bulimina marginata* d'Orbigny; Todd & Bronnimann, p. 32, pl. 8, figs 4–5.
1959 *Bulimina marginata* d'Orbigny; Parker, p. 262, pl. 2, fig. 23.
1960 *Bulimina marginata* d'Orbigny; Barker, p. 104, pl. 51, figs 3–5.
1964 *Bulimina marginata* d'Orbigny; Ishiwada, pl. 4, figs 52–53.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
A
B
C

Material examined: 18 specimens.

B. marginata occurs only rarely in the present material. The specimens have a broad toothplate similar in shape to that of *B. aculeata,* with a narrowly folded free edge forming a small tooth in the aperture. The free edge does not show the striations figured by both Höglund (1947) and Hofker (1951*b*), probably because of wear during preservation; it continues around the apertural margin as a thin high rim. The base of the toothplate is attached not only to the previous chamber but also to the wall of still earlier chambers, in this respect differing from that of *B. aculeata.* As in *B. aculeata* the basal margin of the toothplate cuts across the inner part of the septal foramen, resulting in the 'distinct second foramen' of Hofker (1951*b*). This 'second foramen' is not found in association with the final aperture but occurs only at a septal foramen. The inner basal margin of each toothplate extends down into the trough of the previous toothplate, attached to its free edge and rear and lateral walls, just above the base. Höglund (1947) figured a narrower toothplate than I have observed on either Papua-New Guinea specimens or Recent specimens from the north Atlantic, but showed the base of the toothplate extending down into the trough of the previous toothplate.

The test is very finely perforate, the pore diameter ranging from about 0·4 to 0·6 microns, and the wall is radiate in texture. Contrary to the observations of Hofker (1951*b*), I have found *aculeata* to be more coarsely perforate than *marginata.* The pores in Papua-New Guinea specimens of *marginata* are usually about 0·4 microns in diameter. Höglund (1947) recorded 0·2 microns for his specimens, but from the illustrations given some pores have a diameter of 0·5 microns. The pores in the present specimens range from 1 to 2 microns apart, as was recorded by Höglund.

TEXT-FIGURE 5

1–3		***Bulimina aculeata*** **d'Orbigny, locality 23. 1–2, CPC 6264; 1, aperture; 2, toothplate; 3, CPC 6265 showing toothplate crossing base of septal foramen to form a 'second foramen'.**
4–5	**CPC 6259**	***Bulimina marginata*** **d'Orbigny, from a sample in the Madang area, New Guinea. 4, aperture; 5, toothplate.**
6	**CPC 6273**	***Bulimina alazanensis*** **Cushman, locality 16f. Toothplate.**
7–8	**CPC 6269**	***Bulimina striata*** **d'Orbigny, locality 39. 7, aperture; 8, toothplate.**
9	**CPC 6277**	***Bulimina subacuminata*** **Cushman & R. E. Stewart, locality 40. Toothplate.**
10	**CPC 6285**	***Bulimina ampliapertura,*** **sp.nov., locality 13b. Toothplate.**
11	**CPC 6280**	***Bulimina subornata*** **Brady, locality 27. Toothplate.**
12	**CPC 6288**	***Bulimina senta*** **Finlay, locality 5. Toothplate.**
13–14	**CPC 6294**	***Protoglobobulimina pupoides*** **(d'Orbigny), locality 18. 13, aperture; 14, toothplate.**
15–16		***Protoglobobulimina ovata*** **(d'Orbigny), locality 28. 15, CPC 6300 aperture; 16, CPC 6301 Toothplate.**

Each scale represents 0·25 mm.
Figures 1–3, 7–8, 12–14 to scale A.
Figures 4–6, 9–11 to scale B.
Figures 15–16 to scale C.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6257	0·27	0·15
CPC 6258	0·25	0·17

Occurrence: Figured specimens (CPC 6257 and 6258) from east of Atemble, Lower Ramu-Atitau area, New Guinea (Pliocene); other locality: 36, and also in samples from the Madang area, New Guinea, for which an exact locality is not known.

B. marginata is recorded from the upper Miocene and the Pliocene; it occurs also in Recent deposits.

Remarks: All specimens of *B. marginata* from Papua-New Guinea have sharply 'undercut' lower chamber margins, with a spinose rim; Hofker (1951*b*) noted that all specimens seen by him were of this type. Höglund (1947) gave a wide interpretation of *B. marginata*, including specimens of the type referred to *B. aculeata*. I have examined Recent specimens of *B. marginata* from two 'Goldseeker' stations, one in the North Minch, west of Scotland, at 108 metres and the second at 61° 34′ N., 02° 04′ E., at 330 metres. Some specimens, particularly those from the second locality, are strongly spinose, with distinctly 'undercut' chambers; some specimens from the North Minch are quite smooth on the later chambers, with no indication of overlapping chamber margins, but the earlier chambers of all specimens are spinose and 'undercut'. The pores of these Recent specimens are indentical with those of the Papua-New Guinea specimens (see text-figure 7), and the toothplate is the same for each group. The development of smooth chambers in later growth-stages seems to be a feature restricted to specimens from the North Atlantic, but this does not give any basis for separation of the two forms, even at subspecific level.

B. marginata and *B. aculeata* are closely related species, but in the present samples at least there is no difficulty in distinguishing between them on external appearance. Some Recent specimens of *marginata* from the North Atlantic have later chambers similar to those of *aculeata*, but the early chambers are invariably 'undercut', and a clear distinction may be made by examination of the finer details of the test.

BULIMINA ACULEATA d'Orbigny, 1826

(Pl. 5, figs 1–3; text-fig. 5: 1–3; text-fig. 7: 1)

1826 *Bulimina aculeata* d'Orbigny, p. 269, no. 7.
1884 *Bulimina aculeata* d'Orbigny; Brady, p. 406, pl. 51, figs 7–9.
1939 *Bulimina aculeata* (d'Orbigny); Phleger, p. 1403, pl. 3, fig. 24.
1945 *Bulimina aculeata* d'Orbigny; Cushman & Todd, p. 39, pl. 6, fig. 11.
1947 *Bulimina aculeata* d'Orbigny; Cushman & Parker, p. 120, pl. 28, figs 8a–b, 9a–b, 10a–b, 11. (Synonymy).
1950 *Bulimina aculeata* d'Orbigny; Asano, pt 2, p. 3, figs 8–9.
1951*b* *Bulimina aculeata* d'Orbigny; Hofker, p. 151, figs 92, 93a–b, 94a–d.
1954 *Bulimina aculeata* d'Orbigny; Todd & Post, p. 350, pl. 87, fig. 21.
1954 *Bulimina aculeata* d'Orbigny; Parker, p. 510, pl. 6, fig. 19.
1957 *Bulimina aculeata* d'Orbigny; Samaniego & Gonzales, p. 199, pl. 22, figs 3a–b.
1957 *Bulimina aculeata* d'Orbigny; Daleon & Samaniego, p. 43, pl. 1, fig. 39.
1959 *Bulimina aculeata* d'Orbigny; Parker, p. 261, pl. 2, figs 17–18.

1960 *Bulimina aculeata* d'Orbigny; Subbotina, Pischvanova & Ivanova, p. 87, pl. 6, figs 1a–d.
1960 *Bulimina aculeata* d'Orbigny; Barker, p. 104, pl. 51, figs 7–9.
1962 *Bulimina aculeata* d'Orbigny; McKnight, p. 119, pl. 18, fig. 104.
1963 *Bulimina aculeata* d'Orbigny; Pezzani, p. 618, pl. 36, fig. 11. (Synonymy).
1964 *Bulimina aculeata* d'Orbigny; Ishiwada, pl. 4, fig. 51.
1964 *Bulimina aculeata* d'Orbigny; LeRoy, p. 30, pl. 11, fig. 7.

Material examined: 125 specimens.

B. aculeata is very abundant and widespread in the Papua-New Guinea material. Höglund (1947) placed *aculeata* in the synonymy of *marginata*, but from a comparison of the two forms and an examination of the toothplate and pores, I regard *aculeata* as a distinct species. All specimens of *B. aculeata* in the present material have thick-walled inflated chambers, spinose at the lower border, the spines varying in number and length on specimens from different localities; the proloculus usually has a single strong spine. The toothplate is a broad structure attached largely to the surface of the previous chamber, and extending across the base of the septal foramen to form the 'distinct second foramen' mentioned by Hofker (1951*b*). This 'second foramen' occurs only at a septal foramen and is not associated with the aperture of the final chamber, as described and figured by Hofker. The base of each toothplate continues down into the trough of the previous toothplate, attached to the free edge and the rear and lateral walls some distance below the upper margin. The inner border of the toothplate is broadly rounded, with a short fold, the free edge somewhat irregular but not as strongly dentate as in the specimens figured by Hofker (1951*b*), and not forming as large a tooth in the aperture. These minor differences are probably due to the breaking or smoothing of the toothplate of the Papua-New Guinea specimens during preservation. The free edge of the toothplate continues around the apertural margin as a thin high collar. The test is finely perforate, the pore diameter being about 0·5 microns, with a maximum of 1 micron; the wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6262	0·67	0·49
CPC 6263	0·64	0·50

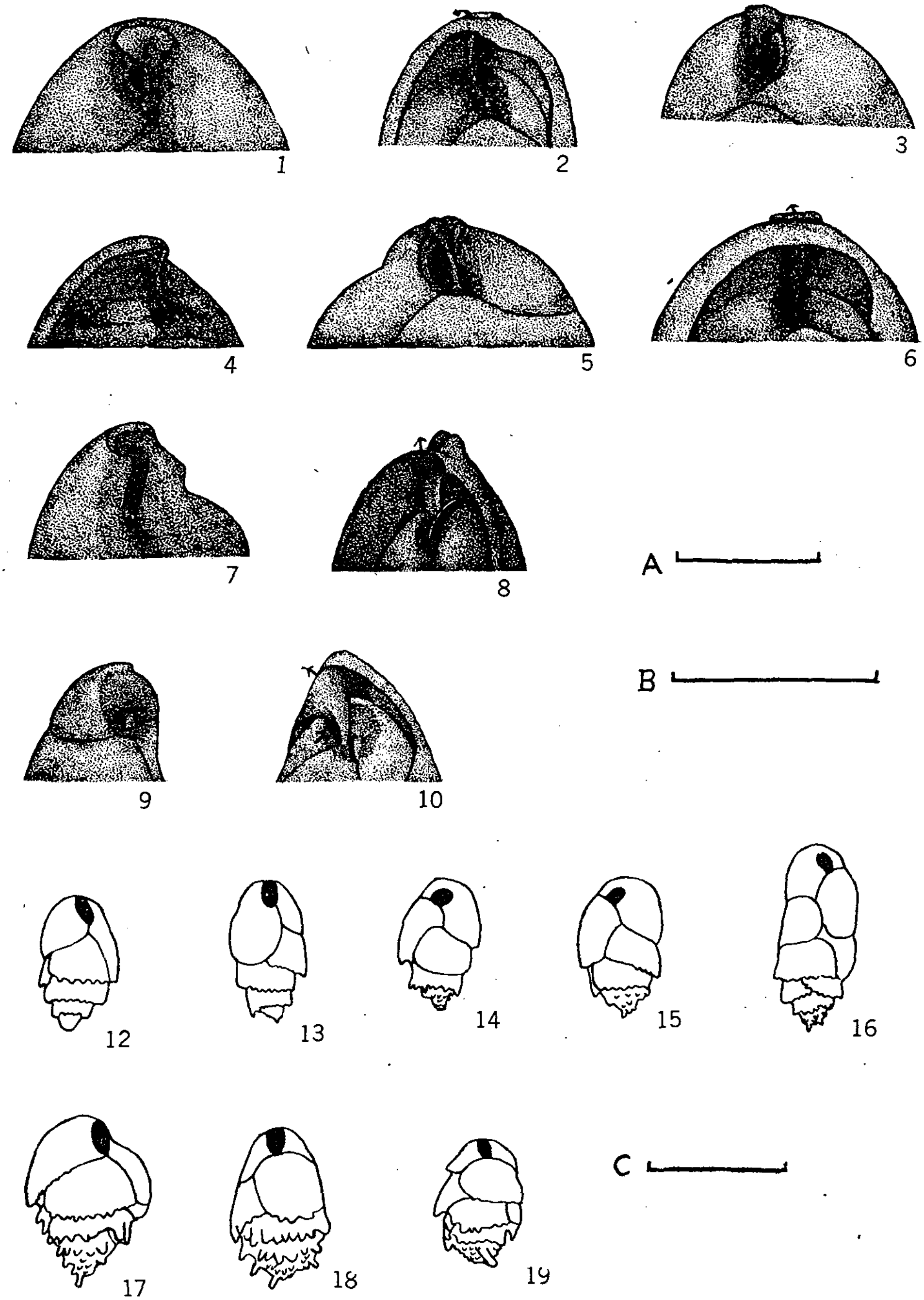
Occurrence: Figured specimens (CPC 6262 and 6263) from 2 miles east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 18, 21, 23, 25, 27, 35, 40.

B. aculeata is recorded from the lower Miocene (Burdigalian) to the Pliocene, although it has been noted that more than one species may be represented; it occurs also in Recent deposits.

Bulimina striata d'Orbigny, 1826

(Pl. 5, figs 6–8; text-fig. 5: 7–8; text-fig. 7: 11)

1826 *Bulimina striata* d'Orbigny, p. 269, No. 2.
1947 *Bulimina striata* d'Orbigny; Cushman & Parker, p. 119, pl. 28, figs 1a–b, 2–3.
1949 *Bulimina striata* d'Orbigny; Boomgaart, p. 106, pl. 11, fig. 6.
1941*a* *Bulimina inflata* LeRoy, p. 32, pl. 2, figs 71–72 (not of Seguenza).
1941*b* *Bulimina inflata* LeRoy, p. 79, pl. 1, fig. 5 (not of Seguenza).
1944*b* *Bulimina inflata* var. LeRoy, p. 85, pl. 7, fig. 21 (not of Seguenza).


1
2
3
4
5
6
7
8
A
B
9
10
12
13
14
15
16
17
18
19
C

Material examined: 55 specimens.

Specimens from Papua-New Guinea referred to *B. striata* have more strongly spinose lower margins than the figure given by Fornasini, which was reproduced by Cushman & Parker (1947); they are of the form figured by these authors on plate 28, figure 2. Included here in *B. striata* are specimens which develop short blunt spines at the lower margin of the costae, approaching the form of specimens described by Cushman (1922*a*) as *Bulimina inflata* Seguenza var. *mexicana*, and referred by Cushman & Parker (1940; 1947) and Cushman & Todd (1945) to *B. striata* d'Orbigny var. *mexicana* Cushman. The specimen figured by LeRoy (1944*b*) is also of this type.

The test is finely perforate, the pores being circular in outline and the diameter 1 to 1·2 microns; the wall is radiate in texture. Each chamber has a strongly developed toothplate, the base extending the full width of the septal foramen. The free edge is curved at the base and becomes folded towards the upper part, extending as a narrow tooth into the aperture and continuing as a thin high collar around the apertural margin. At the base the toothplate is attached to the full length of the upper margin of the previous toothplate, and does not cut across the septal foramen at the inner border as in *B. aculeata*; no small 'second foramen' occurs in *B. striata*.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6267	0·57	0·42
CPC 6268	0·49	0·41

Occurrence: Figured specimens (CPC 6267 and 6268) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 9c, 12f, 13a, 23, 25, 38, 39, 40.

Specimens here referred to *B. striata* have been recorded as *B. inflata* Seguenza, ranging from the lower Miocene (Burdigalian) to the Pliocene; the specimens figured by Brady (1884) were taken to be typical of *B. inflata*. Cushman & Parker (1947) referred Brady's figures to *B. costata* d'Orbigny, but Barker (1960), while doubtfully referring them to this species, noted that they appear to be more closely

TEXT-FIGURE 6

1–2 CPC 6316 ***Protoglobobulimina* sp. A, locality. 39 1. aperture; 2, toothplate.**

3–4 ***Protoglobobulimina affinis* (d'Orbigny), locality 39. 3, CPC 6305 aperture; 4, CPC 6306 toothplate.**

5–6 CPC 6310 ***Protoglobobulimina microlongistriata* (LeRoy), locality 1d. 5, aperture; 6, toothplate.**

7–8 CPC 6320 ***Praeglobobulimina spinescens* (Brady), locality 30. 7, aperture; 8, toothplate.**

9–10 CPC 6152 ***Buliminella* sp.cf. *B. tenuata* Cushman, locality 40. 10, aperture; 11, toothplate.**

12–19 ***Bulimina marginata* d'Orbigny, showing variations in the outline of the test. 12–16, from 'Goldseeker' haul 125, in the North Minch, west of Scotland, at 108 metres. 17–19, 'Goldseeker' fry net haul 8209, station 9, 61° 34′ N., 02° 04′ E., at 330 metres.**

Scales A and B represent 0·25 mm; scale C represents 0·5 mm.

Figures 2, 3–4, 7–9 to scale A.

Figures 1, 5–6, 10–11 to scale B.

Figures 12–19 to scale C.

allied to *B. striata*. Cushman & Parker also noted (p. 119) that Brady's figures 10 to 13 are somewhat similar to *B. striata* d'Orbigny var. *mexicana* Cushman, and Barker doubtfully referred Brady's figures 10 to 12 to this variety. In the discussion of *striata* var. *mexicana*, Cushman & Parker noted that a somewhat similar form occurs in the Pliocene of Kar Nicobar (*B. inflata* Schwager, not Seguenza). These specimens are possibly conspecific with those from Papua-New Guinea.

BULIMINA ALAZANENSIS Cushman, 1927

(Pl. 5, figs 9–11; text-fig. 5: 6; text-fig. 7: 6)

1927*d* *Bulimina alazanensis* Cushman, p. 161, pl. 25, fig. 4.
1947 *Bulimina alazanensis* Cushman; Cushman & Parker, p. 103, pl. 24, figs 14a–c, 15–16.
1951 *Bulimina alazanensis* Cushman; Phleger & Parker, p. 16, pl. 7, figs 24, 29.
1954 *Bulimina alazanensis* Cushman; Parker, p. 510, pl. 6, fig. 21.
1956*b* *Bulimina alazanensis* Cushman; Hofker, p. 75, pl. 8, figs 21–25.
1964 *Bulimina alazanensis* Cushman; Parker, p. 624, pl. 98, fig. 19.

Material examined: 22 specimens.

Specimens from Papua-New Guinea here referred to *B. alazanensis* are of the type placed by Brady (1884) in *B. buchiana* d'Orbigny and referred to by Barker (1960) as *B.* sp.nov. In numerous papers specimens of this type have been identified as *B. rostrata* Brady, but do not resemble the holotype of *rostrata* (Brady, 1884, pl. 51, figs 14–15), which is a specimen narrowing at each end and ornamented by strong continuous longitudinal costae. None of these papers mention the specimens referred by Brady to *B. buchiana* (see Cushman, 1942; Cushman & Parker, 1947; Hofker, 1951*b*; Cushman, Todd, & Post, 1954; Bandy, 1953, 1961; Pierce, 1956).

According to Hofker (1956*b*) the costae of *B. rostrata* show a rupture at the basal suture of the chambers, while in *B. alazanensis* they continue on to the basal spine; the costae on the present specimens do not show any interruption at the sutures. However, the illustration of the holotype of *rostrata* does not indicate that the costae are broken at the base of each chamber. Cushman (1911, p. 88) stated that *rostrata* has continuous costae of sufficient strength to obscure the sutures of the test. Concerning the perforation of the test, Hofker (1951*b*) stated that in *rostrata* only the sides of the test are perforate, the upper part not showing pores; later (1956*b*) the pores of *rostrata* were said to occur on the 'end-face' of the test, while in *alazanensis* the end of the test is poreless. All specimens that I have observed from Papua-New Guinea have the pores confined to the lower part of each chamber, indicating that on Hofker's (1956*b*) diagnosis they are to be referred to *alazanensis*. However, the conclusions reached by Hofker cannot be fully accepted, as he also stated 'the species may be different from *B. alazanensis* Cushman, as the specimens described here are smaller'.

The test of the Papua-New Guinea specimens is finely and sparsely perforate, the pore diameter being 1·6 to 2 microns; the wall is radiate in texture. The toothplate is a broad narrowly folded structure with a smooth free edge forming a small tooth in the aperture. The inner basal margin of the toothplate cuts off part of the septal foramen to form a small 'second foramen'.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6271	0·50	0·35
CPC 6272	0·48	0·29

Occurrence: Figured specimens (CPC 6271 and 6272) from a sample in the Aipa Hills, east of the Ekiere fault, Kerema-Karova Creek area, Papua (middle Miocene); other localities: 3, 5, 16f, 21, 27, 31.

Specimens of the type here referred to *B. alazanensis* have been recorded as *B. rostrata*, ranging from the lower Miocene (Burdigalian) to the Pliocene; similar specimens also occur in Recent deposits.

Remarks: B. alazanensis was originally described from the Eocene of Mexico. Cushman & Parker (1947) stated that it also occurs in the Eocene of Cuba, and the Cipero Formation of Trinidad; and that similar forms occur in the Pliocene of California, and in Recent deposits in the South Pacific and North Atlantic. *B. rostrata* is recorded mainly from Recent deposits in the North and South Pacific, but also from the Pliocene of California; Hofker (1956*b*) stated that *rostrata* is known to occur in the Pacific as well as in the West Indian region.

I am not able to separate the Papua-New Guinea specimens from specimens occurring in the Repetto Formation, Malaga Cove, Los Angeles Basin, California. The Papua-New Guinea specimens are generally larger, but do not differ in any other observable feature. Specimens from 'Atlantis' station 2993, 23° 24′ N., 08° 44′ W., at 580 fathoms, and U.S.S. 'Hydrographer' station 37, 29° 25′ N., 86° 53′ W., at 1602 feet, are also identical with the present specimens.

Finlay (1940) described as *Bulimina forticosta* specimens very similar in outline and ornament to those here referred to *alazanensis.* Finlay compared *forticosta* to *B. jacksonensis* Cushman, with no mention of *alazanensis.* Other specimens described by Finlay as *B. bremneri* were compared by him to *B. truncana* Gümbel; Cushman & Parker (1947) compared *alazanensis* to *truncana.* Samaniego & Gonzales (1957) recorded costate specimens similar to those from Papua-New Guinea as *Bulimina* cf. *alazanensis*; they mentioned that the specimens may also be related to *B. bremneri* Finlay and *B. truncana* Gümbel. Daleon & Samaniego (1957) identified specimens of the same type as *B.* cf. *bremneri* Finlay. It seems possible that some New Zealand specimens are referable to *B. alazanensis,* or at least are conspecific with specimens from Papua-New Guinea here referred to *alazanensis.*

The uncertainty in the identification of these conical costate species, which in the case of *rostrata* and *alazanensis* apparently overlap geographically, cannot be overcome without a comparison of topotype specimens and an investigation of intraspecific variability. Meanwhile, specimens from Papua-New Guinea, of a type often referred previously to *Bulimina rostrata*, are placed in *B. alazanensis.*

BULIMINA SUBACUMINATA Cushman & R. E. Stewart, 1930

(Pl. 5, figs 12–14; text-fig. 5: 9)

1930 *Bulimina subacuminata* Cushman & R. E. Stewart, p. 65, pl. 5, figs 2, 3a–b.
1947 *Bulimina subacuminata* Cushman & R. E. Stewart; Cushman & Parker, p. 116, pl. 27, figs 8a–c.
1955 *Bulimina subacuminata* Cushman & R. E. Stewart; Walton, p. 1004, pl. 102, fig. 10.

Material examined: 25 specimens.

B. subacuminata has been found in only two samples, and is very rare in one of these. *B. rinconensis* Cushman & Laiming is a similar species, but according to Cushman & Parker (1947) *rinconensis* has more rounded costae and lacks an initial spine. As figured by Cushman & Parker, *subacuminata* tapers towards the apertural end, whereas *rinconensis* is broadly rounded.

The test is finely and densely perforate, with the pores decreasing in number on the upper part of the chambers; the pore diameter has not been determined. The wall is radiate in texture. Each toothplate is attached to the upper margin of the previous toothplate, at the base extending the width of the septal foramen; the free edge becomes tightly folded in the upper part, forming a narrow tooth in the aperture, close to the fixed apertural margin. The base of the toothplate does not cut off part of the septal foramen to form a 'second foramen'. A thin high collar is developed around the apertural border.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6275	0·44	0·29
CPC 6276	0·43	0·29

Occurrence: Figured specimens (CPC 6275 and 6276) from Pagansop village, north-north-east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other locality: 38.

B. subacuminata has been recorded as *B.* sp. 2, ranging from the middle Miocene to the Pliocene.

Bulimina subornata Brady, 1884

(Pl. 5, figs 15–17; text-fig. 5: 11; text-fig. 7: 4–5)

1884 *Bulimina subornata* Brady, p. 402, pl. 51, figs 6a–b.
1900 *Bulimina subornata* Brady; Millett, p. 276, pl. 2, fig. 3.
1947 *Bulimina subornata* Brady; Cushman & Parker, p. 124, pl. 28, figs 32–33.
1960 *Bulimina subornata* Brady; Barker, p. 104, pl. 51, figs 6a–b.

Material examined: 6 specimens.

Rare specimens of *B. subornata* have been found in one sample. The test is densely perforate, the pores ranging from irregularly circular to elongate oval in outline; the pore diameter for the early chambers is 2 to 4 microns and for the younger chambers 1 to 2 microns. The toothplate is typically buliminid, at the base extending the full width of the septal foramen, and attached to the upper margin of the previous toothplate. The free edge is narrowly folded in the upper part, forming a small tooth in the aperture.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6278	0·56	0·20
CPC 6279	0·49	0·21

Occurrence: Figured specimens (CPC 6278 and 6279) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

B. subornata is recorded only from the Pliocene; it also occurs in Recent deposits.

BULIMINA AMPLIAPERTURA sp.nov.

(Pl. 5, figs 18–21; text-fig. 5: 10)

Material examined: 21 specimens.

Diagnosis: A slender, elongate species with inflated chambers; ornamented on lower part of test by thin continuous costae; sutures narrow; aperture large, rounded, each chamber with large toothplate.

Description: Test slender, elongate, 2½ to 3 times as long as wide, increasing very gradually in width from sharply rounded initial end to greatest width at apertural end. Chambers inflated, increasing rapidly in height as added, last whorl forming about one-half of test. Lower part of test ornamented by numerous thin high continuous costae. Sutures on early chambers obscured by ornament, later narrow, distinct, depressed. Test wall radiate in texture, finely perforate, pore diameter not determined. Aperture large, rounded, reaching to base of chamber. Toothplate large, well-developed, extending across septal foramen, free edge smooth and broadly folded, forming small tooth in aperture.

Dimensions:

	Length	Maximum Width
Holotype	0·35	0·14
Paratype A	0·34	0·15
Paratype B	0·30	0·13

Occurrence: Holotype (CPC 6282) and paratypes A and B (CPC 6283 and 6284) from the north-west flank of the Wira Anticline, Puri-Purari River area, Papua, near base of the section (upper Miocene, locality 13b); also in other samples from this area.

B. ampliapertura sp.nov. has been recorded as *B.*sp.4, occurring in the upper Miocene and the Pliocene.

Remarks: *B. ampliapertura* resembles *B. subornata* Brady in the ornament of the test, but differs in the very broad aperture and the more strongly developed and heavily built toothplate, with a broad base.

The specific name is from the Latin *amplus*, large, and *apertura*, an opening, referring to the large aperture.

BULIMINA SENTA Finlay, 1940

(Pl. 6, figs 1–3; text-fig. 5: 12; text-fig. 7: 7)

1940 *Bulimina senta* Finlay, p. 454, pl. 64, figs 73–74.

Material examined: 30 specimens.

Dr N. de B. Hornibrook of the New Zealand Geological Survey identified and forwarded specimens of *B. senta* from locality N134/530, Hawkes Bay, New Zealand; other specimens of *B. senta* examined occur in a slide from sample 3021, collected by H. J. Finlay, Mata River, Tutamoe Survey District, and also from a sample between Whangara Beach and Tohaga Bay, of Awamoan age. Papua-New Guinea specimens are identical with these.

B. senta is similar to *B. aculeata* d'Orbigny, but *aculeata* has more rounded and inflated chambers, while the spines of *senta* are fewer, shorter, and stronger, and the sutures more oblique. The toothplate of *senta* is narrower at the base than that of *aculeata* and does not cut off part of the septal foramen to give a 'second foramen'. The folded portion of the toothplate of *senta* is also much broader than that of *aculeata* and forms a more elongate tooth in the aperture.

Dimensions of figured specimens:

	Length (incl. basal spine)	Maximum Width
CPC 6286	0·50	0·39
CPC 6287	0·53	0·39

Occurrence: Figured specimens (CPC 6286 and 6287) from 2½ miles north-north-west of the Olipai River-Lakekamu River junction, Papua (upper Miocene); other localities: 4, 10, 13a.

B. senta has not previously been recorded from Papua-New Guinea; references to *B. aculeata* may well include specimens of the type here identified as *B. senta*.

Genus GLOBOBULIMINA Cushman, 1927

GLOBOBULIMINA sp. A

(Pl. 7, figs 1–2)

Material examined: 35 specimens.

Specimens of a species of *Globobulimina* in samples from the Wira Anticline, Papua, are short and wide, with an oval to almost circular outline, and strongly overlapping chambers; only in rare specimens do the chambers of the last whorl completely cover the previous whorls. The aperture is elongate, and in the terminology of Höglund (1947) is either open, or closed with suture. Specimens with a closed aperture on the last chamber show an open aperture on earlier chambers; in one such specimen the aperture of the penultimate chamber is open. The toothplate is narrow, attached at the base to the upper margin of the previous toothplate, with a small fold at the free edge and with the upper part expanded into a fan-shaped flap with a smooth edge extending towards the outer apertural border. The free apertural border is smooth, with no indication of a collar. The test is finely and densely perforate, the pores being oval in outline with a diameter of about 2 microns; the wall is radiate in texture.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6290	0·73	0·59
CPC 6291	0·65	0·60

Occurrence: Figured specimens (CPC 6290 and 6291) from the north-west flank of the Wira Anticline, Puri-Purari River area, Papua, at base of the section (upper Miocene, locality 13a); known from other samples in this area.

The only species of *Globobulimina* recorded from Papua-New Guinea is *G. pacifica* Cushman, ranging from lower Miocene (Burdigalian) to Pliocene; these records may include specimens of the type figured in this paper.

Remarks: Lack of detailed information on the aperture and toothplate of undoubted specimens of *G. pacifica* makes it impossible to say whether or not the present specimens are referable to this species; the same applies to *G. globosa* LeRoy (1944*a*), which in its short broad test resembles the present specimens. Hofker (1951*b*) described *G. pacifica* as having an open aperture, with an apertural collar, and his specimens are therefore clearly different from those from Papua-New Guinea.

Genus PROTOGLOBOBULIMINA Hofker, 1951

Loeblich & Tappan (1964*a*) placed *Protoglobobulimina* in the synonymy of the genus *Praeglobobulimina* Hofker, as they considered that pore shape is not valid for generic distinction and that the proportions of the toothplate are specific rather than generic in importance. I agree with the first of these statements, but consider that the difference of the toothplates justifies the recognition of two genera. *Praeglobobulimina* has a broad toothplate, attached partly to the wall of the preceding chamber, whereas *Protoglobobulimina* has a narrower toothplate running directly to the upper margin of the previous toothplate, giving the appearance of a narrow tube extending through the chambers.

PROTOGLOBOBULIMINA PUPOIDES (d'Orbigny, 1846)

(Pl. 6, figs. 4–5; text-fig. 5: 13–14; text-fig 7: 8)

1846 *Bulimina pupoides* d'Orbigny, p. 185, pl. 11, figs 11–12.
1884 *Bulimina pupoides* d'Orbigny; Brady, p. 400, pl. 50, figs 15a–b.
1947 *Bulimina pupoides* d'Orbigny; Cushman & Parker, p. 105, pl. 25, figs 3a–c, 4a–c, 5a–c, 6a–c, 7a–c.
1951*b* *Protoglobobulimina pupoides* (d'Orbigny); Hofker, p. 252, figs 168a–c.
1952 *Bulimina pupoides* d'Orbigny; Asano, p. 11, figs 59–60.
1960 *Bulimina pupoides* d'Orbigny; Barker, p. 102, pl. 50, figs. 15a–b.
1964 *Bulimina pupoides* d'Orbigny; LeRoy, p. 30, pl. 11, figs 4–5.

Material examined: 14 specimens.

Rare very large specimens referred to *P. pupoides* have been found in one sample. In external appearance the specimens most closely resemble that figured from the Eocene of Cuba by Cushman & Parker (1947, pl. 25, fig. 6); the last whorl forms a greater proportion of the test than in the specimen figured by these authors from the Miocene of the Vienna Basin.

Hofker (1951*b*) described the toothplate of *pupoides* as a thick straight plate. In the present specimens the free edge is curved at the base and becomes folded in the upper part, extending as a small tooth into the aperture, and continuing as a thin high collar around the free apertural border. Most specimens have an open aperture, with the apertural collar extending across the basal apertural margin, but two have a closed aperture with suture. Successive apertures approach the relative position described by Cushman & Parker (1947) for *Desinobulimina*, that is with the lower part of one aperture joining the upper part of the previous aperture.

The toothplate has a broad base, partly attached to the wall of the previous chamber; the free edge runs directly to the upper margin of the previous toothplate, attached just below its protruding border, giving the appearance of a continuous narrow trough extending through the chambers. The test is very finely perforate, the pore diameter generally being slightly less than 2 microns, with the pores circular in outline; no finer pores have been observed between the larger series as figured by Hofker (1951*b*). The wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6292	1·14	0·58
CPC 6293	1·11	0·61

Occurrence: Figured specimens (CPC 6292 and 6293) from east of Amaimon, between the Gogol River and Amaimon, New Guinea (upper Miocene); found only in this sample.

P. pupoides has been recorded as *Bulimina pupoides*, ranging from lower Miocene (doubtfully in the Aquitanian, definitely in the Burdigalian) to upper Miocene; it also occurs in Recent deposits.

Remarks: Brady (1884) questioned the value of *B. pupoides*, *B. ovata* d'Orbigny, and *B. affinis* d'Orbigny as separate species, and it is apparent from the literature that it is diffcult to draw a sharp line between these species on external appearance only. Cushman & Parker (1947) stated that *pupoides* differs from *ovata* in the shape of the test, which is tapering and not oval, and also in the nature of the sutures, which in *ovata* curve downward rather than extending at right angles to the vertical axis. The sutures of *ovata*, according to Haynes (1954), are 'considerably oblique to the vertical axis, or relatively rather more than at right angles to it, towards the type of *B. pupoides* d'Orbigny'. *B. pupoides* was also said to be distinguished by its greater size and number of whorls, and more inflated chambers. Haynes described the toothplate of *ovata* and referred this species to the genus *Praeglobobulimina*; from the description and illustrations given by Haynes, the toothplate of *ovata* is similar in form to that of *pupoides*, and the test is more nearly biserial in the later chambers. The recognition of the three species *pupoides*, *ovata*, and *affinis* is here based not only on the form of the toothplate; but also on its position in relation to the septal foramen, and the attachment of each toothplate to the previous toothplate. The relative position of the toothplate and the septal foramen is affected by the rate of coiling of the test. The pores show distinct, and for the several specimens of each species examined constant, differences which are useful for specific definition.

PROTOGLOBOBULIMINA OVATA (d'Orbigny, 1846)

(Pl. 6, figs 6–9; text-fig. 5: 15–16; text-fig. 7: 9)

1846 *Bulimina ovata* d'Orbigny, p. 185, pl. 11, figs 13–14.
1947 *Bulimina ovata* d'Orbigny; Cushman & Parker, p. 106, pl. 25, figs 8a–c, 9a–c. (Synonymy).
1952 *Bulimina ovata* d'Orgigny; Asano, p. 11, figs 57–58.
1954 *Praeglobobulimina ovata* (d'Orbigny); Haynes, p. 190, text-figs 9–12, 17–19; pl. 35, figs 2–3.
1961 *Bulimina ovata* d'Orbigny; Kaasschieter, p. 191, pl. 9, figs 6a–b.

Material examined: 26 specimens.

Haynes (1954) redescribed *ovata* and referred it to the genus *Praeglobobulimina*; the toothplate was also described, but it is not clear if the figured toothplate is that of a topotype from the Vienna Basin or of a specimen from the Thanet sands. The toothplate of Papua-New Guinea specimens is as described by Haynes, beginning within the trough of the previous toothplate. The later chambers have a higher rate of coiling than do specimens referred here to *P. pupoides*, and each toothplate runs directly to the upper margin of the previous toothplate, with no attachment to the wall of the previous chamber. The position of the toothplate in relation to the septal foramen is quite different from that of *Praeglobobulimina spinescens* (Brady). In addition, the aperture of *spinescens* is more elongate and narrow than that of *ovata*, and the toothplate is more tightly folded, the free edge not protruding and extending for the full length of the aperture close to the fixed apertural border. In my opinion, *ovata* is to be referred to *Protoglobobulimina* rather than *Praeglobobulimina*. The apertural characters and toothplate of *P. ovata* are similar to those of *P. pupoides*, and are more highly developed in that there is no attachment of the toothplate to the wall of the previous chamber. Specimens of *P. ovata* are more finely and densely perforate than those referred to *pupoides*, the pore diameter being 1 to 1·6 microns, with the pores circular in outline. No finer pores have been detected between the larger series.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6296	0·53	0·28
CPC 6297	0·56	0·27
CPC 6298	0·50	0·25
CPC 6299	0·46	0·22

Occurrence: Figured specimens (CPC 6296 to 6299) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1g); other localities: 1d, 28.

Previous records of *P. ovata* are uncertain. The species is recorded as ranging from lower Miocene (Burdigalian) to Pliocene, but the specimens figured by Brady (1884, pl. 50, figs 13a-b) were regarded as typical. These specimens were named *Bulimina notovata* by Chapman (1941).

PROTOGLOBOBULIMINA AFFINIS (d'Orbigny, 1839)
(Pl. 6, figs 14–16; text-fig. 6: 3–4; text-fig. 7: 12)

1839*a* *Bulimina affinis* d'Orbigny, p. 105, pl. 2, figs 25–26.
1947 *Bulimina affinis* d'Orbigny; Cushman & Parker, p. 122, pl. 28, figs 23a-b, 24–25. (Synonymy).
1954 *Bulimina affinis* d'Orbigny; Cushman, Todd, & Post, p. 350, pl. 87, fig. 22.
1963 *Bulimina affinis* d'Orbigny; Pezzani, p. 619, pl. 36, fig. 13.
1964 *Globobulimina affinis* (d'Orbigny); Parker, p. 625, pl. 98, fig. 22.

Material examined: 10 specimens.

Rare specimens referred to *P. affinis* have been found in the Papua-New Guinea material. The test of all specimens is broadest at the base of the last whorl, with a sharply pointed initial end and tapering towards the aperture. Cushman & Parker

(1947) referred the specimen figured by Brady (1884, pl. 50, figs 14a-b) doubtfully to *pupoides* and were followed in this by Barker (1960); the present specimens are very similar in outline to Brady's specimen. They differ from *pupoides* in the aperture, the toothplate, and the perforation of the test, and I do not consider them to be only microspheric forms of that species. The aperture of the specimens referred to *affinis*, in the terminology of Höglund (1947), is closed with suture, whereas in all except two specimens of *pupoides* it is open. The toothplate of *affinis* is a narrow, tightly folded pillar-like structure beginning within the trough of the previous toothplate and attached to its upper margin. At the base the free edge of the toothplate is close to the wall of the chamber but is never attached to it. Haynes (1954) stated that *Globobulimina* and its allies (which would include *Protoglobobulimina*) differ from *Bulimina* in possessing a tongue (i.e. toothplate) in which both shanks are fixed. Neither Höglund (1947) nor Hofker (1951*b*) described this feature of the globobuliminid toothplate and I have not observed it in any species examined during this study. The strongly folded upper margin of the toothplate, if preserved, extends well above the apertural margin. An apertural collar is present, but there is no indication of a fan-shaped extension of the toothplate, although this may be broken from all specimens observed. Compared with *P. pupoides* the toothplate in *affinis* is much narrower and more tightly folded, and is not attached to the wall of the previous chamber owing to the relative position of successive apertures; it is similar to that of some species referred to *Globobulimina*. The pore pattern of *affinis* differs from that of *pupoides*, the pores being oval in outline with a diameter of 2 to 3 microns, and there are indications of smaller pores between the larger series. The wall is thick and is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6303	0·79	0·53
CPC 6304	0·72	0·47

Occurrence: Figured specimens (CPC 6303 and 6304) from east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); other localities: 9c, 39.

P. affinis has not previously been recorded from Papua-New Guinea.

PROTOGLOBOBULIMINA MICROLONGISTRIATA (LeRoy, 1941)

(Pl. 6, figs 17–18; text-fig. 6: 5–6; text-fig. 7: 13–15)

1941*a* *Bulimina microlongistriata* LeRoy, p. 32, pl. 1, figs 97–98.
1947 *Bulimina microlongistriata* LeRoy; Cushman & Parker, p. 114, pl. 30, figs 14a–b.
1964 *Bulimina microlongistriata* LeRoy; LeRoy, p. 30, pl. 11, fig. 9.

Material examined: 33 specimens.

From the brief description given by LeRoy (1941*a*), specimens occurring commonly in the Tubu area, Papua, seem to be referable to *P. microlongistriata*. The tests are oval in outline with a pointed or sharply rounded initial end and the greatest width at the base of the last whorl, tapering towards the aperture. The surface of the test is ornamented by numerous low continuous longitudinal striations, more strongly developed on the early chambers. The striated appearance is accentuated, at least on the early chambers, by a linear arrangement of the pores, which are large and oval in outline with the longer axis parallel to the axis of the test. The pore diameter on early chambers is usually 7 to 8 microns, on the longer axis: one pore observed had a diameter of 12 microns; on the shorter axis the diameter is 5 to 6 microns. On younger chambers the pores are more circular, with a diameter of 5 to 6 microns, and on the last chambers the diameter is 3 to 4 microns, with the pores still showing a preferred linear arrangement. The pores become fewer on the upper part of the chambers, particularly in the apertural region; the wall is radiate in texture.

The aperture of *P. microlongistriata* is open; successive apertures are in contact. The toothplate is narrow and pillar-like in appearance, running directly to the previous toothplate and attached to its upper margin. The upper part of the free edge is expanded outwards into a small fan-shaped extension which does not cover the outer margin of the aperture ; there is no indication of an apertural collar.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6308	0·69	0·36
CPC 6309	0·56	0·32

Occurrence: Figured specimens (CPC 6308 and 6309) from the 'Tubu Silstone', Tubu area, Papua (upper Miocene, locality 1d); other localities: 1d, 1f, 1g.

P. microlongistriata has not previously been recorded from Papua-New Guinea. Glaessner (1943) regarded it as a Miocene index fossil.

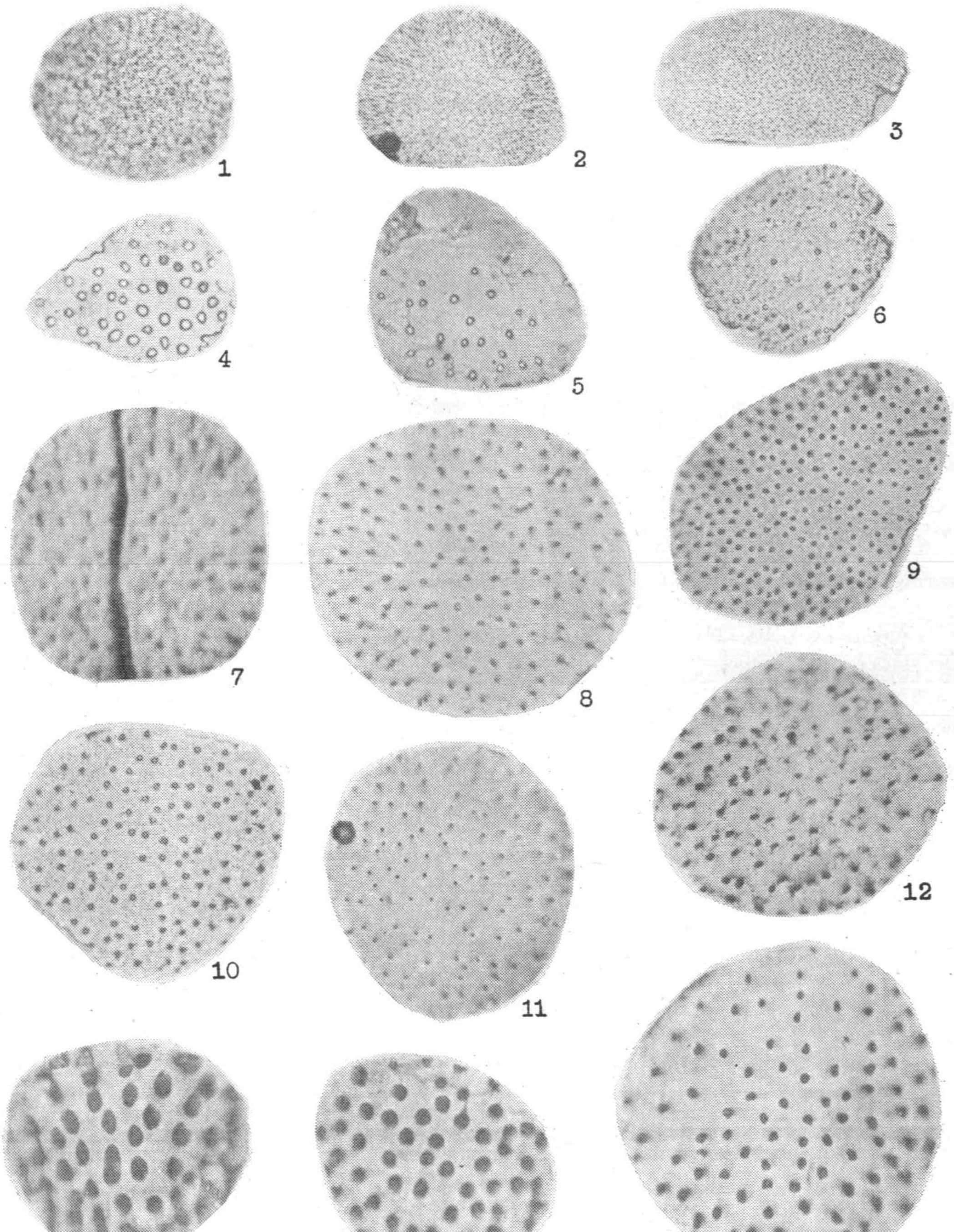
PROTOGLOBOBULIMINA sp. A.

(Pl. 6, figs 10–13; text-fig. 6: 1–2; text-fig. 7: 10)

Material examined: 65 specimens.

Specimens here referred to as *Protoglobobulimina* sp. A are very similar to those figured by Brady (1884) as *Bulimina ovata* d'Orbigny, and named by Chapman (1941) *Bulimina notovata.* As stated by Ellis & Messina (1940 et. seq., footnote to *B. notovata* Chapman), neither Brady nor Chapman gave a description; the specific name *notovata* is therefore unavailable.

As may be seen from the illustrations, some specimens referred to *P.* sp. A are in external view very similar to *P. pupoides* (d'Orbigny). These externally similar specimens may be distinguished by an examination of the finer details of the test. *P.* sp. A has more strongly overlapping chambers than does *pupoides* and more nearly approaches a biserial arrangement of the later chambers; successive apertures are in contact and each toothplate runs directly to the upper margin of the previous toothplate, not being attached to the wall of the previous chamber as in *pupoides.* The toothplate of *P.* sp. A is not as broad at the base as that of *pupoides* and is more narrowly folded. The upper margin of the free edge is developed into a small fan-shaped extension over the outer apertural border; this feature was not seen in *pupoides*, although it may have been broken from the specimens examined. The aperture of *P.* sp. A is open and has a thin apertural collar, similar to that of *pupoides*,


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

extending across the basal margin of the aperture but not observed on all specimens. *P.* sp. A also has a different pore pattern from that of *pupoides*, the pore diameter ranging from 1·6 to 2 microns; very fine pores occur between the larger series.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6312	0·52	0·35
CPC 6313	0·56	0·38
CPC 6314	0·71	0·36
CPC 6315	0·68	0·37

Occurrence: Figured specimen (CPC 6312) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); figured specimens (CPC 6313 to 6315) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 17, 30, 33.

Specimens of the type figured by Brady (1884) have been recorded as *Bulimina ovata*, ranging from lower Miocene (Burdigalian) to Pliocene.

Genus PRAEGLOBOBULIMINA Hofker, 1951

PRAEGLOBOBULIMINA SPINESCENS (Brady, 1884)

(Pl. 6, figs 19–21; text-fig. 6: 7–8)

1884 *Bulimina pyrula* d'Orbigny var. *spinescens* Brady, p. 400, pl. 50, figs 11–12.
1947 *Bulimina pyrula* d'Orbigny var. *spinescens* Brady; Cushman & Parker, p. 124, pl. 28, figs 30–31. (Synonymy).
1951*b* *Praeglobobulimina spinescens* (Brady); Hofker, p. 249, figs 165a–b, 166a–b, 167a–c.
1960 *Bulimina pyrula* d'Orbigny var. *spinescens* Brady; Barker, p. 102, pl. 50, figs 11–12.

TEXT-FIGURE 7: Pores, all figures X 500

1 **CPC 6266** ***Bulimina aculeata*** **d'Orbigny, locality 40.**
2 **CPC 6260** ***Bulimina marginata*** **d'Orbigny, locality 37.**
3 **CPC 6261** ***Bulimina marginata*** **d'Orbigny, 'Flying Falcon' Log 3, 51° 02′ N., 11° 27′ W., off south-west Ireland, at 345 fathoms.**
4–5 **CPC 6281** ***Bulimina subornata*** **Brady, locality 27. 4, early chambers; 5, later chambers, showing absence of pores from the apertural area.**
6 **CPC 6274** ***Bulimina alazanensis*** **Cushman, locality 16f.**
7 **CPC 6289** ***Bulimina senta*** **Finlay, locality 5.**
8 **CPC 6295** ***Protoglobobulimina pupoides*** **(d'Orbigny), locality 18.**
9 **CPC 6302** ***Protoglobobulimina ovata*** **(d'Orbigny), locality 1g.**
10 **CPC 6317** ***Protoglobobulimina*** **sp. A, locality 39.**
11 **CPC 6270** ***Bulimina striata*** **d'Orbigny, locality 39.**
12 **CPC 6307** ***Protoglobobulimina affinis*** **(d'Orbigny), locality 39.**
13–15 **CPC 6311** ***Protoglobobulimina microlongistriata*** **(LeRoy), locality 1d, showing decrease in pore size from oldest to youngest chambers, linear arrangement of pores, particularly in 13 and 15, and elongation of pores along length of test in 13.**

Material examined: 6 specimens.

P. spinescens is distinguished in external view by strongly overlapping chambers ornamented at the lower margin by numerous small spinose projections. Barker (1960) noted that *spinescens* is the type species of the genus *Praeglobobulimina*, but did not definitely accept the validity of the genus. *P. spinescens* is distinctly different from the type species of the genera *Bulimina, Protoglobobulimina*, and *Globobulimina* in its apertural characteristics and in the nature and position of the toothplate; these constant differences are here considered to justify the recognition of *Praeglobobulimina* as a valid genus. Hofker (1951*b*) also regarded the pores as features of generic significance, but no observations made on the present material support this view. Haynes (1954) considered the pores to be of only specific value; he also redefined the genus *Praeglobobulimina* to include some characters shown by the species *Bulimina ovata* d'Orbigny, which is here considered to be referable to *Protoglobobulimina*. The aperture of *P. spinescens* is narrow and elongate, with a curve at the base where it extends for a short distance along the basal suture.

The rate of coiling of *P. spinescens* is not as high as in *Protoglobobulimina pupoides* and *Globobulimina pacifica* Cushman; in addition, the aperture is inclined away from the septal foramen rather than towards it. Because of this, the relationship between the toothplate and the septal foramen is quite different from that in *Protoglobobulimina* and many species referred to *Globobulimina*, where each toothplate begins within the trough of the previous toothplate. The toothplate of *Praeglobobulimina* is a broad narrowly folded structure attached at the base to the apertural face of the previous chamber, with only the inner basal margin attached to the previous toothplate, about midway along its length.

The free edge of the toothplate in the Papua-New Guinea specimens forms a narrow tooth extending the full length of the aperture close to the fixed apertural margin. This observation conflicts with that of Hofker (1951*b*) who stated, concerning the toothplate of *spinescens*, 'its attached part runs along one of the borders of the mouth, whereas the free folded part forms only a narrow band along the other side of the aperture'. The free edge of the toothplate is continued around the apertural margin as a thin high collar, as figured by Hofker. The test is very finely perforate, the pore diameter being about 1 micron, with the pores generally oval in outline, some appearing circular; the wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6318	0·81	0·56
CPC 6319	0·55	0·36

Occurrence: Figured specimens (CPC 6318 and 6319) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 30, 39.

P. spinescens has been recorded as *Bulimina pyrula* var. *spinescens*, ranging from upper Miocene to Pliocene; it also occurs in Recent deposits.

Subfamily PAVONININAE Eimer & Fickert, 1899

Genus REUSSELLA Galloway, 1933

REUSSELLA ACULEATA Cushman, 1945

(Pl. 9, fig. 15)

1884 *Verneuilina spinulosa* Brady (part), p. 384, pl. 47, figs 2(2), 3, (not fig. 1). (Not of Reuss).
1945 *Reussella aculeata* Cushman, p. 41, pl. 7, figs 10–11.
1949 *Reussella aculeata* Cushman; Said, p. 30, pl. 3, fig. 18.
1950 *Reussella aculeata* Cushman; Asano, pt 2, p. 12, fig. 50.
1958 *Reussella aculeata* Cushman; Asano, p. 16, pl. 1, figs 16a–b, 17a–b.
1959 *Reussella aculeata* Cushman; Graham & Militante, p. 85, pl. 13, figs 2a–b.
1964 *Reussella aculeata* Cushman; Ishiwada, pl. 4, fig. 69.

Material examined: 32 specimens.

Specimens of *Reussella* occurring in one sample are referred to the species *aculeata.* In outline, the specimens range from short and triangular to slender and elongate, the length/breadth ratio ranging from 1·3 to 1·8. Some specimens are distinctly spinose, but none have spines as long as those on the specimen figured by Brady (pl. 47, fig. 3); others have weak spines or a smooth periphery, the absence of spines obviously being due to abrasion.

R. aculeata was stated by Asano (1958) to differ from *R. spinulosa* in the more tapering form and the long curved spines from each chamber, but these criteria cannot be applied to the present specimens. In my opinion, only one species is represented in the Papua-New Guinea specimens, which are here referred to *aculeata.*

Dimensions of figured specimen:	Length	Maximum Width
CPC 6321	0·54	0·29

Occurrence: Figured specimen (CPC 6321) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

Specimens here referred to *R.aculeata* have been recorded as *R.spinulosa*, ranging from lower Miocene (Burdigalian) to Pliocene. *R.aculeata* also occurs in Recent deposits.

Family UVIGERINIDAE Haeckel, 1894

Genus EUUVIGERINA Thalmann, 1952

EUUVIGERINA PEREGRINA (Cushman, 1923)

(Pl. 7, figs 3–7;)

1923 *Uvigerina peregrina* Cushman, p. 166, pl. 42, figs 7–10.
1927*a* *Uvigerina peregrina* Cushman; Galloway & Wissler, p. 76, pl. 12, figs 1, 2a–b.
1927*d* *Uvigerina peregrina* Cushman; Cushman, p. 158, pl. 3, fig. 13.
1939 *Uvigerina peregrina* Cushman; Phleger, p. 1404, pl. 3, figs 5–6.
1951*b* *Euuvigerina peregrina* (Cushman); Hofker, p. 219, figs 148a–b, 149.
1953 *Uvigerina peregrina* Cushman; Redmond, p. 723, pl. 75, figs 27a–b.
1954 *Uvigerina peregrina* Cushman; Parker, p. 521, pl. 8, fig. 5.
1955 *Uvigerina peregrina* Cushman; Walton, p. 1016, pl. 102, figs 22–23.
1956 *Uvigerina peregrina* Cushman; White, p. 259, pl. 32, figs 7a–b.

Material examined: 175 specimens.

Species of the group of costate and hispido-costate forms, which includes *E.peregrina*, are obviously to be separated only after detailed examination. An illustration of this is given by the specimens identified by Höglund (1947) as *Uvigerina peregrina;* the toothplate was described as having a wing. Höglund also believed that the species *Uvigerina mediterranea* Hofker is a synonym of *peregrina.* Hofker (1951*b*) retained *mediterranea* (referred to as *mediterranensis*) as a distinct species, although it is apparently very similar to *peregrina*, differing only in having thicker costae, and with the last chambers either costate or smooth, never granular. As pointed out by Hofker, the toothplate of the specimen referred by Höglund to *peregrina* places it in the genus *Neouvigerina;* Hofker also indicated that the toothplate of *mediterranea* has the same structure as in *peregrina,* and in 1960 he referred *mediterranea* to the genus *Euuvigerina.*

As originally described by Cushman (1923), and as interpreted by Hofker (1951*b*), the costae of *peregrina* are broken up into irregular short portions or replaced by spines towards the basal and apertural ends of the test. One specimen figured by Cushman (1923, fig. 10) appears to be wholly costate. In the definition of the variety *parvula* Cushman, no reference was made to ornament, and it was said to be smaller, shorter, and stouter than the typical form, with a more inflated last chamber. Hofker (1956*b*) observed that on *peregrina* the costae are never broken up into pustules; the development of pustules on the later chambers was said to be a characteristic of *parvula*, except for typical A_2 forms. Phleger & Parker (1951) figured both *peregrina* and *peregrina* var. *parvula* from Recent sediments in the Gulf of Mexico; in each of these categories were included specimens either wholly costate or with spinose later chambers. These authors believed that on the basis of the Gulf of Mexico specimens the variety *parvula* should be given specific rank. Parker (1954, p.521) noted that more than one species may have been included in her population counts of *U.parvula.* However, it was stated that all the specimens are distinct from *peregrina*, which is usually larger, with higher plate-like costae, broken into spines on the upper part of the test.

Other varieties and subspecies of *peregrina* have been proposed, established on the differing degree of development of costae or spines. Some examples are *E.peregrina* (Cushman) var. *dirupta* (Todd), which was placed by Uchio (1960) in the synonymy of *U.curticosta* Cushman, and *E.peregrina* (Cushman) *shiwoensis* (Asano). Species such as *E.hispido-costata* (Cushman & Todd) are also similar to *peregrina;* the ornament of this species was said to be variable, and it was distinguished from the variety *parvula* by the larger size and more compact form.

Uchio (1960) compared topotype and other specimens of *E.peregrina* with specimens from the Pacific identified as *peregrina* and considered the two forms to be distinct. No topotype specimens of *peregrina* are available to me, but in a slide labelled 'Albatross' station 2584, 39° 05′ 30″ N., 72° 23′ 20″ W., are 17 specimens which I consider to be referable to *peregrina.* Some specimens are wholly costate, others have the costae broken into spines on the last chambers. These Recent specimens from the Atlantic are larger than those from Papua-New Guinea, and the costae are higher, but considering the distribution of the costae, the shape of the chambers, and the outline of the test I am not able to separate specimens from the two areas. Hofker (1951*b*) regarded Recent specimens from the Pacific as true *peregrina*, differing from specimens of *peregrina* in the Caribbean area only in the smaller size.

The variation in specimens from Papua-New Guinea referred to *peregrina* is illustrated in text figure 13. In the same sample there occur specimens which are either wholly costate or become spinose on the last chamber; the costae on earlier chambers may also be continuous or broken up into smaller parts. The height of the costae varies on specimens from different areas, but there is no difference in number of costae, which are always interrupted at the sutures. At one locality, strongly costate specimens with a pointed initial end occur; these specimens differ in outline from those at other localities, but occur together with specimens having rounded costate or hispid initial chambers, and probably represent the microspheric form. I do not consider them to be separable from other specimens here referred to *peregrina*.

The toothplate of specimens from all areas in Papua-New Guinea is the same, a narrow folded structure attached to the lip of the septal foramen by the full length of the base, the free edge forming a small tooth in the aperture. The test is finely perforate, but the pores have not been clearly observed, owing either to unsuitable preservation or to the thickness of the wall, which is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6322	0·57	0·34
CPC 6323	0·60	0·32
CPC 6324	0·66	0·34
CPC 6325	0·71	0·35

Occurrence: Figured specimens (CPC 6322 to 6325) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 7a, 23, 25, 35, 38, 40.

Specimens referred to *Uvigerina peregrina* and *U. peregrina* var. are recorded from lower Miocene (Burdigalian) to Pliocene.

Remarks: In unpublished reports it has been noted, concerning the specimens referred to *Uvigerina peregrina* and *U. peregrina* var., that they are most probably the variety *parvula* Cushman; they have also been compared to *U. hispido-costata* Cushman & Todd. The specimen figured by Brady (1884, pl. 74, fig. 26) was regarded as typical; this specimen was referred by Fornasini (1900) to *U. bradyana*. Barker (1960), in the absence of comparative material, also used the name *bradyana*, but referred to the possibility that more than one species may be represented in Brady's figures. Some specimens from the present material are as spinose on the last chamber as that illustrated by Brady, but do not develop spines on the earlier chambers.

In view of the confusion and uncertainty which already exists, and in the absence of adequate comparative material, no subspecific identification or further differentiation is attempted in this very variable group. To overcome the confusion, population studies accurately documenting the variation of specimens in different areas are necessary.

EUUVIGERINA ACULEATA (d'Orbigny, 1846)

(Pl. 7, figs 8–13)

1846 *Uvigerina aculeata* d'Orbigny, p. 191, pl. 11, figs 27–28.
1884 *Uvigerina aculeata* d'Orbigny; Brady, p. 578, pl. 75, figs 1–3.
1950 *Uvigerina aculeata* d'Orbigny; Asano, pt 2, p. 14, figs 58–59.
1951*b* *Euuvigerina aculeata* (d'Orbigny), part; Hofker, p. 226, figs 150a–f, 151a–b, 152a–c (not figs 153a–b, 154a–c).
1958 *Uvigerina aculeata* d'Orbigny; Asano, p. 33, pl. 6, figs 3–4. (Synonymy).
1960 *Euuvigerina aculeata* (d'Orbigny); Barker, p. 156, pl. 75, figs 1–3.
1964 *Uvigerina aculeata* d'Orbigny; LeRoy, p. 34, pl. 3, figs 40–41.

Material examined: 105 specimens.

Abundant specimens of *E. aculeata* occur in the Papua-New Guinea samples. The variation recorded by Hofker (1951*b*) is also shown by the present specimens. Microspheric specimens have a strong initial spine, and the spinose ornament is sharp and narrow. Megalospheric specimens with an initial spine are very rare, but the early chambers are ornamented by sharp spines as in the microspheric specimens. Two types of ornament occur on the later chambers, one essentially spinose but with the spines broader than those of microspheric specimens, the second having the spines replaced by short thin high ridges with a pointed lower margin. These two types have not been related to variation in size of the proloculus, but correspond to the forms referred by Hofker (1951*b*) to A_1 and A_2 generations respectively. The variation observed in the outline and ornament of the test is shown in Text-figure 14. The test is finely perforate, but the pore diameter has not been determined; the wall is radiate in texture. Each chamber has a toothplate, which is as described by Hofker (1951*b*).

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6326	0·74	0·38
CPC 6327	0·73	0·37
CPC 6328	0·79	0·45
CPC 6329	0·66	0·40

Occurrence: Figured specimen (CPC 6326) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); figured specimens (CPC 6327 to 6329) the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 18, 21.

E. aculeata has been recorded as *Uvigerina aculeata*, only from the Pliocene; it occurs also in Recent deposits.

EUUVIGERINA HISPIDA (Schwager, 1866)

(Pl. 7, figs 14–16)

1866 *Uvigerina hispida* Schwager, p. 249, pl. 7, fig. 95.
1929*a* *Uvigerina hispida* Schwager; Cushman, p. 95, pl. 13, fig. 35.
1941*a* *Uvigerina hispida* Schwager; LeRoy, p. 36, pl. 1, figs 102–103.
1941*b* *Uvigerina hispida* Schwager; LeRoy, p. 82, pl. 2, fig. 15.
1956 *Uvigerina hispida* Schwager; White, p. 258, pl. 32, figs 2a–b.
1959 *Uvigerina hispida* Schwager; Chiji, p. 25, pl. 7, fig. 2.
1961 *Uvigerina hispida* Schwager; Bandy, p. 21, pl. 5, fig. 7.
1964 *Uvigerina hispida* Schwager; LeRoy, p. 34, pl. 4, figs 2–3.

Material examined: 49 specimens.

E. hispida is abundant in the Papua-New Guinea material. All specimens observed show the characteristic heavy hispid ornament; rare specimens have a spine on the proloculus, but usually the base of the test is broadly rounded. Specimens range from short and broad to elongate and slender, and the observed variation includes specimens of the type figured by LeRoy (1941*b*, pl. 15, fig. 16) as *Uvigerina asperula* Czjzek; LeRoy noted that his specimens were questionably assigned to this species.

The specimens are usually covered and largely infilled with matrix, and this together with the thick wall and hispid ornament, has prevented close observation of the pores; the wall is radiate in texture. Each chamber has a broadly folded toothplate attached by the full length of the base to the lip of the septal foramen, with the smooth free edge forming a curved narrow tooth in the aperture. The nature of the toothplate places *hispida* in the genus *Euuvigerina.*

Dimensions of figured specimens:	Length	Maximum Width
CPC 6330	1·20	0·70
CPC 6331	0·95	0·45

Occurrence: Figured specimens (CPC 6330 and 6331) from Upper Maipora Creek, west of the Saw Mountains, Malalaua-Saw Mountains area, Papua (middle Miocene); other localities: 5, 7a, 12f, 21, 38, 39.

E. hispida has been recorded as *Uvigerina hispida,* ranging from lower Miocene (Burdigalian) to upper Miocene. The specimen figured by Brady (1884, pl. 75, fig. 9) as *Uvigerina asperula* Czjzek var. *auberiana* d'Orbigny was referred to *U. hispida.* Thalmann (1932, p. 307) referred this specimen to *U. asperula* Czjzek, and was followed in this by Barker (1960). None of the present specimens have spines as long as those on Brady's figured specimen.

Hispid specimens similar to those here referred to *E. hispida* are recorded from New Zealand as *Uvigerina notohispida* Finlay, and from the Caribbean area as *U. rustica* Cushman & Edwards.

EUUVIGERINA CRASSICOSTATA (Schwager, 1866)
(Pl. 7, figs 17–20)

1866 *Uvigerina crassicostata* Schwager, p. 248, pl. 7, fig. 94.
1944*b* *Uvigerina crassicostata* Schwager; LeRoy, p. 86, pl. 2, fig. 7.
1949 *Uvigerina crassicostata* Schwager; Boomgaart, p. 117, pl. 12, fig. 8.
1950 *Uvigerina crassicostata* Schwager; Asano, pt 2, p. 15, figs 63–64.
1964 *Uvigerina crassicostata* Schwager; LeRoy, p. 35, pl. 4, fig. 1.

Material examined: 85 specimens.

E. crassicostata is abundant in several samples from Papua-New Guinea. The specimens are ornamented by thin high costae, continuous over the sutures, with the upper part of the last chamber smooth. The toothplate is typically euuvigerinid, attached by the whole of the base to the lip of the septal foramen, with a curved free edge forming a small tooth in the aperture. The test is finely perforate, but the pore diameter has not been determined; the wall is radiate in texture.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6332	1·01	0·68
CPC 6333	0·68	0·50
CPC 6334	0·96	0·58

Occurrence: Figured specimens (CPC 6332 and 6333) from 2½ miles north-north-west of the Olipai River-Lakekamu River junction, Papua (upper Miocene); figured specimen (CPC 6334) from west of the wharf at the Roman Catholic Mission, Island, Papua (lower Miocene, Burdigalian); other localities: 9c, 12f, 41.

E. crassicostata has been recorded as *Uvigerina crassicostata*, ranging from lower Miocene (Burdigalian) to upper Miocene.

EUUVIGERINA FLINTI (Cushman, 1923)

(Pl. 7, fig. 21–23)

1923 *Uvigerina flintii* Cushman, p. 165, pl. 42, fig. 13.
1949 *Uvigerina flintii* Cushman; Bermudez, p. 204, pl. 13, figs 31–32.
1951 *Uvigerina flintii* Cushman; Phleger & Parker, p. 18, pl. 8, figs 15–16.
1954 *Uvigerina flintii* Cushman; Parker, p. 520, pl. 8, fig. 2.
1956*b* *Euuvigerina flintii* (Cushman); Hofker, p. 80, pl. 9, figs 4–9.

Material examined: 83 specimens.

E. flinti was described from Recent material at 'Albatross' station D.2641. Specimens from this station are available and I am not able to distinguish between them and specimens occurring abundantly in one area in Papua. The outline of the test, the ornament, the chamber shape, the nature of sutures, and the thickened rings around the apertural neck are identical in specimens from both areas. The only feature that I have not observed in the Papuan specimens is the winglike extension at the base of the toothplate, recorded by Hofker (1956*b*) in *E. flinti* from the West Indies. This feature may not have survived in the fossil specimens, and at this time its apparent absence is not taken to indicate the necessity for a new specific name. Most Papuan specimens are costate throughout, but some specimens are only faintly costate or smooth on the last one or two chambers; the same variation is shown by Recent specimens from the Atlantic.

The similarity between the Papuan specimens and the Recent Atlantic specimens may be due to homeomorphism. However, I cannot see any feature to separate forms from the two areas, and at present refer the Papuan specimens to *E. flinti.*

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6335	0·49	0·32
CPC 6336	0·49	0·31

Occurrence: Figured specimens (CPC 6335 and 6336) from the 'Tubu Silstone', Tubu area, Papua (upper Miocene, locality 1g); other locality: 1f.

Specimens here referred to *E. flinti* have been recorded as *Uvigerina* sp. 9, ranging from lower Miocene (Burdigalian) to Pliocene.

Remarks: LeRoy (1941*a*) figured as *Uvigerina hantkeni* Cushman & Edwards specimens very similar to those here placed in *flinti*. The holotype of *hantkeni* as figured by Cushman & Edwards (1937) is more coarsely costate than the present specimens. Other species which resemble *E. flinti* are *Uvigerina finelineata* Keijzer (particularly as figured by Bermudez, 1949), *U. laviculata* Coryell & River, and *U. gemmaeformis* Schwager. These species all lack the distinctive apertural rims of *flinti*. Samaniego & Gonzales (1957) recorded *Uvigerina hantkeni*, the illustrations showing what appear to be apertural rims. Specimens identical with those from Papua-New Guinea occur also in a slide from 'Challenger' station 185, Raine Island, Torres Strait, at 155 fathoms; the apertural rims are very strongly developed.

EUUVIGERINA SCHWAGERI (Brady, 1884)

(Pl. 8, figs 1-5)

1884 *Uvigerina schwageri* Brady, p. 575, pl. 74, figs 8–10.
1941*a* *Uvigerina schwageri* Brady; LeRoy, p. 36, pl. 2, figs 73–74.
1941*b* *Uvigerina schwageri* Brady; LeRoy, p. 82, pl. 1, figs 12,
1944*b* *Uvigerina schwageri* Brady; LeRoy, p. 86, pl. 2, fig. 6.
1949 *Uvigerina schwageri* Brady; Boomgaart, p. 120, pl. 12, fig. 11.
1950 *Uvigerina schwageri* Brady; Asano, pt 2, p. 17, figs 76–77.
1951*b* *Euuvigerina aculeata* (d'Orbigny), part; Hofker, p. 226, figs 153a–b, 154a–c (not figs 150–152).
1958 *Uvigerina schwageri* Brady; Asano, p. 38, pl. 6, figs 1–2.
1959 *Uvigerina schwageri* Brady; Chiji, p. 27, pl. 7, fig. 6.
1960 *Uvigerina schwageri* Brady; Barker, p. 154, pl. 74, figs 8–10.
1964 *Uvigerina schwageri* Brady; Ishiwada, pl. 5, fig. 80.

Material examined: 9 specimens.

E. schwageri occurs rarely in one sample. The costae are few, low, and rounded, either extending the full length of the test, interrupted at the sutures, or occurring on only one chamber. The toothplate is a curved structure attached to the lip of the septal foramen by the full length of the base, and the free edge forms a small tooth in the aperture. The pores have not been observed; the wall is radiate in texture.

Most specimens have sharply pointed initial chambers, the proloculus in a sectioned specimen being 33 microns in diameter. Three specimens have been found with a larger globular proloculus, which in a sectioned specimen is 92 microns in diameter. These two forms of the species probably represent the A_1 and A_2 generations respectively. The shape of the test is the only difference between the two forms, the ornament and toothplate being identical.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6337	0·61	0·39
CPC 6338	0·66	0·39

Occurrence: Figured specimens (CPC 6337 and 6338) from a sample on the sea-cliff, 250 yards north of the L.M.S. Mission, Delena, Papua (lower Miocene, Burdigalian); found only in this sample.

E. schwageri has been recorded as *Uvigerina schwageri*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Remarks: Hofker (1951*b*) regarded *E. schwageri* as the megalospheric generation of *E. aculeata*, basing this conclusion on the similarity of the internal structure and the fact that the two forms occurred together at many stations. He also stated 'types of *aculeata* are always microspheric, and those of typical *schwageri* always are megalospheric'. However, there are some inconsistencies in Hofker's observations, as three generations were recognized in essentially spinose specimens referred to *aculeata*. In my opinion the differences between the A_2 specimens referred by Hofker to *aculeata* are too great to be attributed to intra-specific variation, and I consider that the name *schwageri* should be retained for those specimens with strong low rounded costae. There is no resemblance between the low strong costae of *schwageri* and the thin high ridges occurring on some megalospheric specimens of *aculeata*. Barker (1960) considered the association of *aculeata* and *schwageri* in the same sample to be due to environment, and retained as a valid species. As can be seen from the thin section of *schwageri* illustrated, at least two generations are present in the Papua-New Guinea material and there is no difference in the ornament of the test.

Euuvigerina nitidula (Schwager, 1866)

(Pl. 8, figs 6–8)

1866 *Uvigerina nitidula* Schwager, p. 248, pl. 7, fig. 93.
1950 *Uvigerina nitidula* Schwager; Asano, pt 2, p. 16, figs 69–70.
1957 *Uvigerina nitidula* Schwager; Todd, p. 273 (tab.), pl. 73, fig. 6.

Material examined: 10 specimens.

Rare specimens from one sample are referred to *nitidula*: they have numerous low rounded costae and agree well with the original description and figure and other published figures. The toothplate has not been clearly observed, due to infilling of the chambers, and the species is only tentatively referred to *Euuvigerina; nitidula* appears to be related to species such as *crassicostata* and *schwageri*, which have typical euuvigerinid toothplates. The wall of the test is radiate in texture; the pores have not been observed.

Dimensions of figured specimens:

	Length	Maximum Width
CPC 6341	0·87	0·46
CPC 6342	0·80	0·42

Occurrence: Figured specimens (CPC 6341 and 6342) from east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); found only in this sample.

E. nitidula has been recorded as *Uvigerina nitidula*, ranging from lower Miocene (Burdigalian) to upper Miocene.

Euuvigerina reineri sp.nov.

(Pl. 8, figs 22–24)

Material examined: 24 specimens.

Diagnosis: An elongate species, megalospheric forms at first loosely triserial, microspheric twisted triserial, both forms later approaching uniserial arrangement; sutures narrow, distinct; ornamented by low fine costae; aperture central, with neck and lip; each chamber with narrow curved toothplate.

Description: Test elongate, irregularly oval in end view; broadly rounded and lobate in side view. Megalospheric forms common, with large globular proloculus, test broadening only very slightly with growth. Microspheric forms very rare, with sharply pointed initial chambers, broadening rapidly to greatest width about midway along length, sides of test then parallel. Early chambers of megalospheric forms arranged in loosely triserial coil, rate of coiling increasing in later growth stages, last chambers of some specimens transitional to uniserial growth. Microspheric specimens with twisted triserial initial stage, chambers at first increasing only slowly in size as added, then increasing rapidly in size and approaching uniserial arrangement. Surface of test ornamented by numerous low fine costae only rarely crossing sutures. Sutures narrow, distinct, depressed, curved, often sinuous. Test wall finely and densely perforate, pore diameter not determined, radiate in texture. Aperture central, with long neck and lip. Each chamber with narrow curved toothplate, partly attached at base to lip of septal foramen; free edge extending across septal foramen, attached to previous toothplate and forming narrow curved tooth in aperture.

Dimensions:

	Length	Maximum Width
Holotype	0·95	0·33
Paratype	0·73	0·31

Occurrence: Holotype (CPC 6343) and paratype (CPC 6344) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other locality: 23. Also found in a sample from the Madang area, New Guinea, for which an exact locality is not known.

E. reineri sp.nov. has been recorded as *Uvigerina* sp. 12, occurring only in the Pliocene.

Remarks: Both the holotype and paratype of *E. reineri* sp. nov. are megalospheric specimens. It resembles *Uvigerina schencki* Asano, but does not have the deeply incised sutures of this species, is more finely striate, and has larger initial chambers, particularly in the megalospheric form. No specimens of *Euuvigerina reineri* have been observed to develop fully uniserial chambers, as does the holotype of *Uvigerina schencki.*

The toothplate of *E. reineri* differs from the normal euuvigerinid toothplate in that part of the base extends across the septal foramen and is attached to the previous toothplate. In its general form, a simple curved plate, it is nearer to the euuvigerinid type than to any other described toothplate, and the generic name *Euuvigerina* is therefore used. Although some specimens show a transitional stage towards uniserial growth, no true uniserial chambers with transverse sutures have been observed, and the species is therefore not referred to *Rectuvigerina* Mathews, 1945. However, some species such as *Siphogenerina costostriata* Galloway & Heminway, and *S. smithi* Kleinpell, which have inclined sutures in the adult stages, were placed by Mathews in *Rectuvigerina.* One distinction between *Uvigerina* and *Rectuvigerina* given by Mathews, namely that *Rectuvigerina* has an internal siphon, whereas *Uvigerina* does not, can no longer be maintained.

This species is named for Dr E. Reiner, formerly of the Division of Land Research and Regional Survey, C.S.I.R.O., Canberra, Australia, who collected many of the samples used in this study.

Genus RECTUVIGERINA Mathews, 1945

RECTUVIGERINA STRIATA (Schwager, 1866)

(Pl. 9, figs 1–2)

1866 *Dimorphina striata* Schwager, p. 251, pl. 7, figs 2, 99.
1941*a* *Siphogenerina striata* (Schwager); LeRoy, p. 37, pl. 3, figs 88–89.
1945 *Rectuvigerina striata* (Schwager); Mathews, p. 597, pl. 81, figs 3–4.
1964 *Rectuvigerina striata* (Schwager); LeRoy, p. 35, pl. 3, fig. 8.

Material examined: 23 specimens.

Following Mathews (1945) the species *striata* Schwager is referred to the genus *Rectuvigerina.* Microspheric specimens have a small triserial neanic stage, followed by a brief biserial stage before the uniserial chambers; megalospheric specimens have a large globular proloculus followed by one oblique chamber or one pair of biserial chambers before the development of uniserial chambers. The test is finely perforate and the wall is radiate in texture. The aperture has a distinct neck and lip, and each chamber has a narrow toothplate similar to that of the genus *Euuvigerina.*

Dimensions of figured specimens:	Length	Maximum Width
CPC 6345	0·76	0·22
CPC 6346	0·57	0·18

Occurrence: Figured specimens (CPC 6345 and 6346) from the 'Murua Mudstone', Yamuiti Creek, Malalaua-Saw Mountains area, Papua (upper Miocene, locality 12c); other localities: 9c, 27, 30.

R. striata has been recorded as *Siphogenerina striata*, ranging from lower Miocene (Burdigalian) to upper Miocene and occurring doubtfully in the Pliocene.

RECTUVIGERINA sp. A

(Pl. 8, fig. 25)

Only two specimens of this form have been found. The larger specimen (illustrated) has a small apparently triserial initial stage followed by two biserial chambers and four uniserial chambers. The smaller specimen has a large globular proloculus followed by three biserial and three uniserial chambers. The early chambers have a spinose ornament, which becomes costate on the later chambers, the costae broken at the sutures and with spinose projections at the base. The sutures are deeply depressed and the aperture has a long neck, broken in both specimens. The pores and toothplate have not been examined.

Dimensions of figured specimen:	Length	Maximum Width
CPC 6347	1·16	0·35

Occurrence: Figured specimen (CPC 6347) from east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); other locality: 8a.

Rectuvigerina sp. A has been recorded as *Uvigerina*? sp. 13, ranging from lower Miocene (Burdigalian) to upper Miocene.

Remarks: *Rectuvigerina* sp. A is very similar to *Siphogenerina spinea* Bermudez, but from the illustration of the holotype of *spinea* given by Bermudez (1949) differs in having fewer and stronger costae, and stronger spines on the early chambers.

Genus SIPHOGENERINA Schlumberger, 1883

S. costata Schlumberger is here accepted as the type species of the genus *Siphogenerina*, following Loeblich & Tappan (1964*a*). Cushman (1913) designated *S. raphana* (Parker & Jones) as the type species, but later (1927*c*) noted that as this species had not been included by Schlumberger at the time of erection of *Siphogenerina*, the type species should be designated as *S. costata* Schlumberger. However, it was also noted that *S. costata* is apparently a synonym of *S. raphana*; this synonymy was also proposed by Galloway (1933, p. 374). Mathews (1945) regarded *S. costata* as a valid species and gave three criteria distinguishing between *S. costata* and *S. raphana*. Bandy & Burnside (1951) considered *S. glabra* Schlumberger to be the type species, on the grounds that this was the first species mentioned by Schlumberger; however, Bandy (1952) recognized the validity of Cushman's designation of *S. costata* as the type. In the same paper, Bandy discussed the features cited by Mathews (1945) as distinguishing between *S. costata* and *S. raphana* and concluded that they were not valid, placing *S. costata* in the synonymy of *S. raphana*.

Cushman (1927*b*, p. 69) described the chambers of *Siphogenerina* as typically triserial in the early stages, then uniserial. Plummer (1931) and Hofker (1951*b*) also considered that the initial chambers of *Siphogenerina* are triserial. Mathews (1945) stated that the early chamber arrangement is biserial. Bandy & Burnside (1951) reported a biserial to uniserial chamber arrangement in *S. glabra*, which they then regarded as the type species, but recognized that dimorphism occurred, with some microspheric specimens having a small triserial early stage. Later, Bandy (1952) observed both biserial and triserial initial chambers in specimens of *S. costata* from Tahiti. Sigal (1952) regarded *Siphogenerina* as biserial to uniserial, with the triserial stage brief ('rapide') or absent. Loeblich & Tappan (1964*a*) recognized both *costata* Schlumberger and *raphana* (Parker & Jones) as valid species; *costata* was stated to be triserial to uniserial in the microspheric form and was designated the type species of *Siphogenerina*, but *raphana* was observed to be biserial to uniserial in microspheric specimens, and was transferred to the genus *Rectobolivina*.

Most specimens of *S. costata* from Papua-New Guinea have a small triserial initial stage; there are no true biserial chambers, but before uniserial chambers are developed the coiling becomes looser and a biserial chamber arrangement is approached. The same feature is shown by the specimen figured by Bandy (1952) as *S. raphana*.

SIPHOGENERINA COSTATA Schlumberger, 1883
(Pl. 9, figs 3–4)

1883 *Siphogenerina costata* Schlumberger, p. 118, fig. B.

Material examined: 47 specimens.

S. costata has been found in two samples. Most specimens have a small triserial initial stage, followed by uniserial adult chambers, but rare specimens are biserial to uniserial. The ornament on both forms consists of low rounded continuous costae, ranging from 8 to 14 in number. Loeblich & Tappan (1964*a* p. C553) stated that *S. costata* has 5 or 6 costae; however, the apertural view of the microspheric specimen figured by Cushman (1942*a*) as *S. raphana*, reproduced by Loeblich & Tappan (figure 449: 2b) as *S. costata*, shows at least 11 costae. The toothplate is also the same for both microspheric and megalospheric specimens, a broad curved plate with a small fold at each edge, successive toothplates in the uniserial chambers twisted through an angle of 180 degrees. The test is finely perforate and the wall is radiate in texture.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6348	1·00	0·28
CPC 6349	0·88	0·28

Occurrence: Figured specimens (CPC 6348 and 6349) from Forsayth Plantation, Mushu Island, Sepik district, New Guinea (Pliocene); found also in a sample from the Madang area, New Guinea, for which an exact locality is not known.

S. costata has been recorded as *S. raphana*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Genus SIPHOUVIGERINA Parr, 1950

SIPHOUVIGERINA INTERRUPTA (Brady, 1879)
(Pl. 8, figs 9–11)

1879 *Uvigerina interrupta* Brady, p. 60, pl. 8, figs 17–18.
1884 *Uvigerina interrupta* Brady; Brady, p. 580, pl. 75, figs 12–14.
1951*b* *Neouvigerina interrupta* (Brady); Hofker, p. 213, figs 139a–d.
1960 *Neouvigerina interrupta* (Brady); Barker, p. 156, pl. 75, figs 12–14.

Material examined: 25 specimens.

Specimens of *S. interrupta* occur in two samples. The specimens are small, with a fine hispid ornament, and do not develop completely separated chambers as in the specimens figured by Brady (1884); they closely resemble the specimens figured by Hofker (1951*b*). Hofker noted that interruption of the chambers is not very prominent in the A-forms. The test is finely perforate, but the pore diameter has not been determined; the wall is radiate in texture. The toothplate is difficult to observe, as the lip of the septal foramen extends almost to the base of the aperture. It is a narrow plate with a small part of the base not attached to the septal foramen.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6350	0·47	0·18
CPC 6351	0·43	0·16
CPC 6352	0·39	0·15

Occurrence: Figured specimens (CPC 6350 to 6352) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene); figured specimen 1 from locality 1d, figured specimens 2 and 3 from locality 1a. Found only in these two samples.

S. interrupta has been recorded as *Uvigerina interrupta,* from the middle and upper Miocene, with a similar form recorded from the lower Miocene (Burdigalian); it also occurs in Recent deposits.

SIPHOUVIGERINA PROBOSCIDEA (Schwager, 1866)

(Pl. 8, figs 12–18)

1866 *Uvigerina proboscidea* Schwager, p. 250, pl. 7, fig. 96.
1942*a* *Uvigerina proboscidea* Schwager; Cushman, p. 49, pl. 14, figs 1a–b, 2a–b, 3a–b, 4. (Synonymy).
1944*b* *Uvigerina proboscidea* Schwager; LeRoy, p. 86, pl. 2, fig. 5.
1945 *Uvigerina proboscidea* Schwager; Cushman & Todd, p. 50, pl. 7, figs 28a–b.
1949 *Uvigerina proboscidea* Schwager; Bermudez, p. 209, pl. 13, fig. 45.
1950 *Uvigerina proboscidea* Schwager; Asano, pt 2, p. 16, fig. 73.
1953 *Uvigerina proboscidea* Schwager; Drooger, p. 136, pl. 21, fig. 28.
1953 *Uvigerina proboscidea* Schwager; Bandy, p. 177, pl. 25, figs 11a–b.
1954 *Uvigerina proboscidea* Schwager; Cushman, Todd, & Post, p. 355, pl. 88, fig. 18.
1957 *Uvigerina proboscidea* Schwager; Todd, p. 278 (tab.), pl. 76, fig. 1.
1958 *Uvigerina proboscidea* Schwager; Asano, p. 25, pl. 6, figs 14–16.
1959 *Uvigerina proboscidea* Schwager; Chiji, p. 26, pl. 7, fig. 5.

Material examined: 142 specimens.

S. proboscidea is abundant in the Papua-New Guinea samples. The initial chambers range from rounded to sharply pointed and many specimens of both types have a single basal spine. Some specimens are also attenuated in later growth stages, the coiling becoming loose and the last chambers smaller than previous chambers. The ornament of specimens referred to *proboscidea* varies widely, from strongly hispid to weakly hispid, with smooth last chambers; the variation is shown by the figured specimens. The full variation has not been observed on specimens from the same sample. However, it does occur on specimens from different samples in the same general area, and may reflect some unknown environmental influence. Considering the variation attributed to *Uvigerina juncea* Cushman & Todd by Uchio (1960), no attempt is made here to separate the present specimens on the basis of ornamental difference. The test is finely perforate, but the pore diameter has not been determined. The toothplate is the same in both strongly hispid and weakly hispid specimens, and is of the form described by Hofker (1951*b*) for the genus *Neouvigerina,* with part of the base free from the upper edge of the septal foramen. The attachment of the toothplate extends below the lip of the septal foramen. Loeblich & Tappan (1964*a*) placed *Neouvigerina* in the synonymy of *Siphouvigerina.*

Dimensions of figured specimens:	Length	Maximum Width
CPC 6353	0·84	0·32
CPC 6354	0·70	0·28
CPC 6355	0·64	0·24
CPC 6356	0·60	0·29
CPC 6357	0·52	0·29

Occurrence: Figured specimens (CPC 6353 to 6355) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); figured specimens (CPC 6356 and 6357) from 2½ miles north-north-west of the Olipai-Lakekamu river junction, Papua (upper Miocene); other localities: 4, 72, 9c, 12f, 21, 23, 25, 32, 38, 40.

S. proboscidea has been recorded as *Uvigerina proboscidea*, ranging from lower Miocene (Burdigalian) to Pliocene; it occurs also in Recent deposits.

SIPHOUVIGERINA (?) sp. cf. *S.* (?) UNISERIALIS (LeRoy, 1944)
(Pl. 8, figs 19–21)

cf. 1944*a* *Uvigerina uniserialis* LeRoy, p. 32, pl. 8, fig. 43.

Material examined: 3 specimens.

Very rare specimens tentatively referred to *S.? uniserialis* occur in one sample. They are costate on the lower part of the test, with the upper chambers smooth and tending to become uniserial. The figure given by LeRoy shows a somewhat 'undercut' margin to the early chambers, not shown by the present specimens, which also have higher chambers than the holotype of *S.? uniserialis.* Insufficient specimens are available to permit investigation of the pores or toothplate, and the generic name *Siphouvigerina* is therefore used only provisionally.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6358	0·52	0·18
CPC 6359	0·43	0·17

Occurrence: Figured specimens (CPC 6358 and 6359) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

Specimens of the type here provisionally referred to the species *uniserialis* have not been recorded previously from Papua-New Guinea.

Genus TRIFARINA Cushman, 1923

TRIFARINA BRADYI Cushman, 1923
(Pl. 9, figs 16–17)

1884 *Rhabdogonium tricarinatum* Brady, p. 525, pl. 67, figs 1–3 (not of d'Orbigny).
1923 *Trifarina bradyi* Cushman, p. 99, pl. 22, figs 3a–b, 4a–b, 5–8, 9a–b.
1929*a* *Trifarina bradyi* Cushman; Cushman, p. 96, pl. 13, fig. 39.
1941*a* *Trifarina bradyi* Cushman; LeRoy, p. 82, pl. 2, fig. 24.
1941*b* *Trifarina bradyi* Cushman; LeRoy, p. 82, pl. 2, fig. 24.

1942 *Trifarina bradyi* Cushman; Cushman, p. 59, pl. 15, figs 13a–b. (Synonymy).
1945 *Trifarina bradyi* Cushman; Cushman & Stainforth, p. 50, pl. 8, fig. 4.
1948 *Trifarina bradyi* Cushman; Renz, p. 172, pl. 7, fig. 33.
1949 *Trifarina bradyi* Cushman; Bermudez, p. 225, pl. 13, fig. 75.
1951 *Trifarina bradyi* Cushman; Phleger & Parker, p. 18, pl. 8, figs 10–11.
1951*b* *Angulogerina (Trifarina) tricarinata* Hofker, p. 196, figs 127a–b, 128a–b, 129a–c, 130a–k. (Not of d'Orbigny).
1954 *Trifarina bradyi* Cushman; Cushman, Todd, & Post, p. 356, pl. 88, fig. 21.
1954 *Trifarina bradyi* Cushman; Parker, p. 522, pl. 8, fig. 9.
1958 *Trifarina bradyi* Cushman; Batjes, p. 136, pl. 5, figs 18a–b.
1958 *Trifarina bradyi* Cushman; Asano, p. 40, pl. 7, figs 7–8. (Synonymy).
1959 *Trifarina bradyi* Cushman; Graham & Militante, p. 88, pl. 13, figs 10a–b.
1959 *Trifarina bradyi* Cushman; Dieci, p. 75, pl. 6, fig. 16.
1964 *Trifarina bradyi* Cushman; LeRoy, p. 35, pl. 3, figs 17–18.

Material examined: 48 specimens.

T. bradyi occurs at several localities. The only variation noted is in the number of uniserial chambers developed. Most specimens have only one or two uniserial chambers, but some elongate specimens have as many as five.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6360	0·44	0·14
CPC 6361	0·38	0·15

Occurrence: Figured specimens (CPC 6360 and 6361) from Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); other localities: 1f, 1g, 9c, 12f, 13a, 21, 27, 29, 36, 40.

T. bradyi is recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Superfamily DISCORBACEA Ehrenberg, 1838

Family DISCORBIDAE Ehrenberg, 1838

Subfamily DISCORBINAE Ehrenberg, 1838

Genus DISCORBINELLA Cushman & Martin, 1935

The species *Rosalina bertheloti* d'Orbigny, here referred to *Discorbinella,* has also been placed in the genera *Discorbina, Discorbis, Discopulvinulina,* and *Hanzawaia. Rosalina bertheloti* was designated the type species of the genus *Discopulvinulina* by Hofker (1951*a*, *b*); this genus has been regarded as a synonym of *Rosalina* by many authors, as Hofker also referred species of *Rosalina* to *Discopulvinulina,* including the type species *Rosalina globularis* d'Orbigny (see Hofker, (1951*b*, 1956*b*). However, the group of species for which *Rosalina bertheloti* is the type is morphologically distinct from species of *Rosalina.* A strong case for the suppression of *Discopulvinulina* in favour of *Hanzawaia* was given by Hofker (1955), who discussed the significance of the degree of overlap of the chambers for generic determination, and suggested that genera be established without regard to the degree of overlap. This seems reasonable in view of the observed specific variation of this feature. Sections through two species referred to *Discopulvinulina* were figured by Hofker (1951*a*), one with involute and one with evolute chambers; it is obvious from these that differing chamber overlap has no effect on the organization of the test.

Loeblich & Tappan (1964*a*) have now defined *Hanzawaia* as a granular genus, thus excluding from it radiate species such as *Rosalina bertheloti*. *Discopulvinulina* is placed by these authors in the synonymy of *Discorbinella*. *Hanzawaia* and *Discorbinella* are very similar in external morphology, and examination of the wall texture would be necessary to assign species definitely to one or the other genus.

DISCORBINELLA BERTHELOTI (d'Orbigny, 1839)
(Pl. 12, figs 15–22; text-fig. 8: 1–2; text-fig 9: 1–2)

1839*a* *Rosalina bertheloti* d'Orbigny, p. 135, pl. 1, figs 28–30.
1884 *Discorbina bertheloti* d'Orbigny, sp. (part); Brady, p. 650, pl. 89, figs 11–12 (not figs 10a–c).
1931 *Discorbis bertheloti* (d'Orbigny); Cushman, p. 16, pl. 3, figs 2a–c. (Synonymy).
1951 *Discorbis bertheloti* (d'Orbigny); Phleger & Parker, p. 20, pl. 10, figs 1a–b, 2a–b.
1954 *Rosalina bertheloti* d'Orbigny; Parker, p. 523, pl. 8, figs 22–23.
1956*b* *Discopulvinulina bertheloti* (d'Orbigny); Hofker, p. 184, pl. 27, figs 22–25; pl. 28, fig. 1.
1957 *Discorbis bertheloti* (d'Orbigny); Agip Mineraria, pl. 38, fig. 7.
1960 *Discopulvinulina bertheloti* (d'Orbigny); Barker, p. 184, pl. 89, figs 11–12.
1961 *Discopulvinulina bertheloti* (d'Orbigny); Hornibrook, p. 106, pl. 14, fig. 286.
1961 *Hanzawaia bertheloti* (d'Orbigny); Bandy, p. 21, pl. 3, figs 10a–c.

Material examined: 51 specimens.

Specimens of *D. bertheloti* occur abundantly in one sample. The dorsal and ventral chamber walls are finely and densely perforate, the pore diameter being 1.6 to 2 microns. All chambers on the dorsal side are perforate, but on the ventral side there is considerable variation in pore distribution. Pores may occur on all the ventral chambers , or the early chambers of the last whorl may be imperforate, pores then appearing at the umbilical area and on later chambers spreading over the entire ventral wall. Recent specimens examined show the same variation in pore distribution, but some also have a small imperforate area near the aperture, a feature not shown by the Papua-New Guinea specimens.

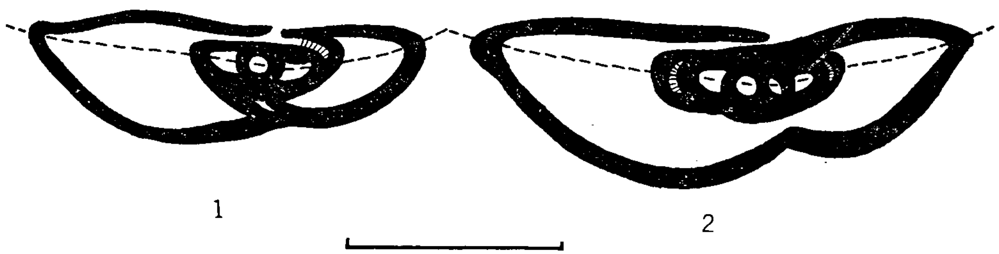
Published figures of specimens referred to *D. bertheloti* show considerable variation in the involution of the chambers on the more convex surface, here regarded as ventral. The holotype, as figured by d'Orbigny (1839*c*) and reproduced by Cushman (1931), is strongly involute on both sides of the test. Phleger & Parker (1951) figured two specimens, one strongly involute ventrally, the other with the later chambers becoming evolute. Hornibrook (1961) figured a specimen with involute ventral chambers. The specimens figured by Cushman (1948*a*, 1949) and by Hofker (1956*b*; 1960) are strongly evolute on the ventral side (regarded by both those authors as the dorsal side). Brady (1884), discussing *D. bertheloti*, stated '. . . the more distinctly spiral face is flat or nearly so; the reverse side convex'. This is borne out by the present specimens, in which the chambers on the convex ventral side are wholly involute and on the flat to slightly concave dorsal side strongly involute. They are identical with Recent specimens of *bertheloti* from 'Goldseeker' haul 135, station 9, 61° 34′ N., 02° 04′ E., at 370 metres. The apertural lips on the dorsal side of the Papua-New Guinea specimens are well developed on younger chambers, with the aperture along their inner margin. A sharp angle occurs at the proximal margin of each lip, at the point where it meets the suture, but no open protoforamen such as is figured by Hofker (1956*b*, pl. 28, fig. 1) has been observed. The wall is radiate in texture and the septal walls are single. Hofker (1956*b*, pl. 27, fig. 23) illustrated a reduced toothplate in *D. bertheloti*, but this feature has not been observed. The chamber wall is slightly indented at the proximal margin of the aperture but it has no connexion with the septal foramen.

The aperture of *D. bertheloti* is here considered to be dorsal. Text-figure 8 shows camera-lucida drawings of two of the the vertical sections used in determining the apex of the coil.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6362	0·70	0·24
CPC 6363	0·62	0·25
CPC 6364	0·55	0·18

Occurrence: Figured specimens (CPC 6362 to 6364) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

D. bertheloti has been recorded as *Cibicides bertheloti*, occurring doubtfully in the middle Miocene and in the upper Miocene; it also occurs in Recent deposits.



1 2

TEXT-FIGURE 8

***Discorbinella bertheloti* (d'Orbigny), vertical sections to determine the dorsal side of the text. 1. 'Goldseeker' haul 135, station 9, 61° 34′ N., 02° 04′ E., at 370 metres. 2. Locality 27.**

DISCORBINELLA SUBBERTHELOTI (Cushman, 1924)

(Pl. 13, figs 1–5)

1884 *Discorbina bertheloti* d'Orbigny, sp. (part); Brady, p. 650, pl. 89, figs 10a–c (not figs 11–12).
1915 *Discorbis bertheloti* Cushman, p. 20, pl. 7, figs 3a–c (not of d'Orbigny).
1921 *Discorbis bertheloti* Cushman, p. 305, pl. 59, figs 1a–c (not of d'Orbigny).
1924 *Discorbis subbertheloti* Cushman, p. 33, pl. 10, fig. 1.
1960 *Discopulvinulina subbertheloti* (Cushman); Barker, p. 184, pl. 89, figs 10a–c.

Material examined: 13 specimens.

As stated by Barker (1960), *D. subbertheloti* is very close to *D. bertheloti* (d'Orbigny). Specimens here referred to *D. subbertheloti* occur in only one sample; they are more compressed than specimens of *bertheloti*, are more evolute on the ventral side, and have 5 to 6 chambers in the last whorl. The pores are fine, the pore diameter being 2 to 3 microns on the dorsal side and about 2 microns on the ventral side. The ventral chamber wall is more densely perforate than that of *D. bertheloti*, but on the dorsal side *bertheloti* is the more densely perforate. The wall is radiate in texture and the septal walls are single; no indication of an internal structure has been observed.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6367	0·44	0·13
CPC 6368	0·36	0·10

Occurrence: Figured specimens (CPC 6367 and 6368) from a creek north of Ibab village, Wewak subdistrict, Sepik district, New Guinea (Pliocene); found only in this sample.

D. subbertheloti is not known to have been recorded previously from Papua-New Guinea.

Genus LATICARININA Galloway & Wissler, 1927

LATICARININA PAUPERATA (Parker & Jones, 1865)

(Pl. 14, figs 9–13)

1865 *Pulvinulina repanda*, var. *menardii*, subvar. *pauperata* Parker & Jones, p. 395, pl. 16, figs 50–51.
1884 *Pulvinulina pauperata* Parker and Jones; Brady, p. 696, pl. 104, figs 3–11.
1915 *Pulvinulina pauperata* Parker and Jones; Cushman, p. 61, text-figs 58a–b; pl. 23, figs 2–3.
1921 *Pulvinulina pauperata* Parker and Jones; Cushman, p. 340, pl. 68, fig. 2.
1927*d* *Pellatispira pauperata* (Parker and Jones); Cushman, p. 176, pl. 6, fig. 13.
1931 *Laticarinina pauperata* (Parker and Jones); Cushman, p. 114, pl. 20, figs 4a–c; pl. 21, figs 1a–c. (Synonymy).
1940 *Laticarinina pauperata* (Parker and Jones); Coryell & Rivero, p. 333, pl. 42, fig. 33.
1941 *Laticarinina pauperata* (Parker and Jones); Cushman & Todd, p. 103, pl. 24, figs 10a–b, 11a–b, 12a–b.
1941*a* *Laticarinina pauperata* (Parker and Jones); LeRoy, p. 46, pl. 2, figs 18–19.
1941*b* *Laticarinina pauperata* (Parker and Jones); LeRoy, p. 88, pl. 6, figs 30–31.
1942*a* *Laticarinina pauperata* (Parker and Jones); Cushman & Todd, p. 15, pl. 4, figs 1–3, 4a–c, 5–6. (Synonymy).
1951*b* *Laticarinina pauperata* (Parker and Jones); Hofker, p. 408, figs 283a–c, 284a–c, 285b.
1951 *Laticarinina pauperata* (Parker and Jones); Phleger & Parker, p. 32, pl. 18, fig. 3.
1952 *Laticarinina pauperata* (Parker and Jones); Bermudez, p. 93, pl. 16, figs 7a–c.
1954 *Laticarinina pauperata* (Parker and Jones); Parker, p. 540, pl. 12, fig. 3.
1957 *Laticarinina pauperata* (Parker and Jones); Todd, p. 279 (tab.), pl. 80, fig. 5.
1964 *Laticarinina pauperata* (Parker and Jones); LeRoy, p. 44, pl. 9, fig. 25.
1964 *Laticarinina pauperata* (Parker & Jones); Parker, p. 262, pl. 100, fig. 30.

Material examined: 34 specimens.

L. pauperata, a widely distributed species, occurs rarely in numerous samples. Finlay (1940), from an examination of topotype and other material, concluded that *pauperata* is a synonym of *halophora* Stache (see *Cristellaria* (*Robulina*) *halophora* Stache, 1865). Bandy (1963) believed that the species of Stache and of Parker & Jones belong to different genera, as Stache's original figure shows a robuline aperture; this has been confirmed by Hornibrook (1963), who from a study of the original material referred *halophora* Stache to the genus *Planularia*.

The chambers of *Laticarinina* are divided into two unequal lobes by the broad thin keel which extends through the proximal part of each chamber. As pointed out by Hofker, this keel is formed before the chamber in which it occurs; on complete specimens the marginal keel extends forward beyond the distal margin of the final chamber. Thin sections show that the keel has two layers of shell material, and it is here regarded as a tightly folded part of the lamina forming each chamber. I believe Cushman & Todd (1941) to have been correct in regarding the plate as a continuation of the keel, rather than Hofker (1951*b*), who interpreted it as a tooth-plate forming a keel at the margin. Each chamber is built around the marginal keel, and at the same time the forward extension of the keel, which will divide the next chamber, is formed. The keel itself sometimes shows the line of junction between successive laminae; this feature is well shown on the specimen illustrated by Phleger & Parker (1951).

All specimens of *L. pauperata* from Papua-New Guinea have a small rounded peripheral aperture on the dorsal side of the keel, which forms the septal foramen. An elongate narrow aperture also occurs on the ventral side, along the inner and proximal borders of the chambers. The ventral aperture is not always clearly visible and has not been observed on some specimens. Subsequent shell laminae cover the ventral apertures, which are then visible as elongate backwardly directed extensions of the inner ventral margins of the chambers. The test is very finely perforate, but the pore diameter has not been determined; the wall is radiate in texture. The septal walls appear to be single.

Dimensions of figured specimens:	Maximum Diameter (including keel)	Height
CPC 6369	1·05	0·20
CPC 6370	0·80	0·18

Occurrence: Figured specimen (CPC 6369) from two miles east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); figured specimen (CPC 6370) from west of Yangoru, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localities: 7a, 18, 21, 40, 42.

L. pauperata is recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Genus PARVICARININA Finlay, 1940

Loeblich & Tappan (1964*a*) placed *Parvicarinina* in the synonymy of *Laticarinina*, but it is here recognized as a distinct genus. The apertural characteristics of *Laticarinina* and *Parvicarinina* are the same, but *Laticarinina* is more loosely coiled, with a much more strongly developed peripheral keel, which divides each chamber. In *Parvicarinina altocamerata* from Papua-New Guinea, the narrow peripheral keel is curved toward the dorsal side, forming a distinct channel.

PARVICARININA ALTOCAMERATA (Heron-Allen & Earland, 1922)

(Pl. 14, figs 14–16)

1884 *Truncatulina tenuimargo* Brady, part, p. 662, pl. 93, figs 2a–c (not fig. 3).
1922 *Truncatulina tenuimargo* var. *altocamerata* Heron-Allen & Earland, p. 209, pl. 7, figs 24–27.
1940 *Parvicarinina altocamerata* (Heron-Allen and Earland); Finlay, p. 467, pl. 62, figs 30–34.
1960 *Parvicarinina altocamerata* (Heron-Allen and Earland); Barker, p. 192, pl. 93, figs 2a–c,
1961 *Parvicarinina altocamerata* (Heron-Allen and Earland); Hornibrook, p. 118, pl. 14, figs 296. 299, 301–302, 305.

Material examined: 15 specimens.

P. altocamerata occurs rarely in several samples. The apertural characteristics are the same as those of *Laticarinina pauperata,* with a small rounded interiomarginal aperture at the periphery or slightly toward the dorsal side, and ventral apertures at the inner and proximal margins of the chambers. As noted by Hornibrook (1961), the size of the peripheral flange of *altocamerata* varies considerably, but it is very much reduced compared to the keel in *Laticarinina.* In *altocamerata* the keel is curved toward the dorsal side, forming a distinct channel around the periphery of the test. The ventral surface varies from flat to concave; the height of the chambers on the dorsal side is variable, with the upper surface usually rounded. Specimens from one locality (30) have very high pointed dorsal chambers. The test is very finely perforate, but the pore diameter has not been determined. The wall is radiate in texture and the septal walls are single.

Dimensions of figured specimen:	Maximum Diameter	Height
CPC 6372	0·41	0·15

Occurrence: Figured specimen (CPC 6372) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 7a, 21, 30, 40.

P. altocamerata is recorded from the middle and upper Miocene; it also occurs in Recent deposits.

Genus Rosalina d'Orbigny, 1826

Rosalina ponticulus sp.nov.

(Pl. 13, figs 12–16; text fig. 9:3)

Material examined: 33 specimens.

Diagnosis: A trochoid species with rounded periphery; dorsal surface convex, ventral surface flat or concave; umbilicus wide, open; chambers in 2 to 2½ whorls, last chamber forming one-half of test; three chambers visible from ventral side; aperture interiomarginal; well-developed toothplate.

Description: Test trochoid, oval in outline, periphery slightly lobate in side view, rounded in edge view; dorsal surface convex, ventral surface flat or concave. Umbilicus wide and open, umbilical margin of early chambers often thickened and ornamented with pustules of imperforate shell material. Chambers arranged in 2 to 2½ whorls, at first increasing slowly in size, in last whorl increasing very rapidly in size and strongly overlapping, last chamber forming one-half of test; all chambers visible from dorsal side, three from ventral side. Dorsal surface densely perforate, pore diameter 3 to 4 microns, no pores observed on ventral surface. Wall radiate in texture, septal walls single. Aperture interiomarginal, opening into umbilicus, with distinct indentation (protoforamen) at proximal margin, associated with well developed toothplate attached to previous whorl, at distal margin with small extension over septal foramen.

Dimensions:

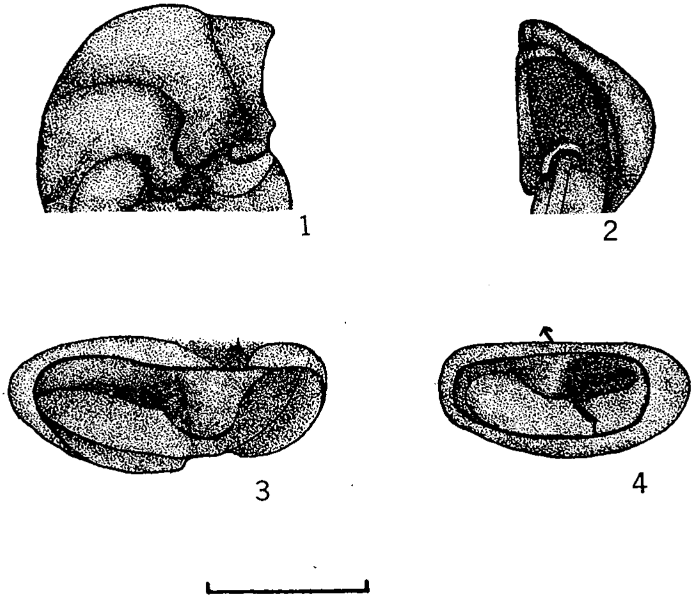
	Maximum Diameter	Height
Holotype	0·44	0·18
Paratype	0·36	0·16

Occurrence: Holotype (CPC 6373) and paratype (CPC 6374) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); known only from this sample.

Rosalina ponticulus sp.nov. has been recorded as *Discorbis globularis* (d'Orbigny), ranging from lower Miocene (Burdigalian) to Pliocene.

Remarks: The indentation at the proximal margin of the aperture of *R. ponticulus* sp.nov. is caused by infolding of the apertural face. This fold is attached to the ventral surface of the previous chamber and forms a wall closing off the proximal half of the chamber from the umbilicus. The toothplate appears to be formed by two distinct units. A small thin fragile plate extending from the distal margin of the internal fold forms a bridge across the septal foramen; it appears to be attached to the main toothplate rather than forming part of it.

R. ponticulus sp.nov. is similar to the Recent Pacific species *R. bradyi* (Cushman) in the outline of the test and the apertural characteristics; *ponticulus* has only three chambers visible from the ventral side as against four to five for *bradyi*. *R. bradyi*



TEXT-FIGURE 9

1–2 CPC 6366 *Discorbinella bertheloti* **(d'Orbigny), locality 27. 1, dorsal view showing apertural lips; 2, internal view.**

3 CPC 6375 *Rosalina ponticulus*, **sp.nov., locality 17. Internal structure, showing the small extension over the septal foramen.**

4 CPC 6376 *Rosalina bradyi* **(Cushman), Recent, Lord Howe Island. Internal structure.**

The scale represents 0·25 mm.

lacks the thin plate forming the bridge across the septal foramen, is more coarsely perforate on the dorsal side, with a pore diameter of 6 microns, and develops fine pores on the ventral side, at least on the last chamber.

The specific name is the Latin *ponticulus*, diminutive of *pons, pontis*, bridge, referring to the extension of the internal structure over the septal foramen.

Subfamily BAGGININAE Cushman, 1927

Genus BAGGINA Cushman, 1926

BAGGINA INDICA (Cushman, 1921)
(Pl. 15, figs 10–14)

1884 *Pulvinulina hauerii*, part Brady, p. 690, pl. 106, figs 6a–c (not fig. 7). (Not of d'Orbigny).
1921 *Pulvinulina indica* Cushman, p. 332. (Synonymy).
1942*b* *Cancris indicus* (Cushman); Cushman & Todd, p. 91, pl. 23, figs 7a–c; pl. 24, figs 1a–c, 2a–c.
1951 *Cancris indicus* (Cushman); Asano, pt 14, p. 20, figs 146–147.
1959 *Baggina indica* (Cushman); Graham & Militante, p. 91, pl. 13, figs 17a–c. (Synonymy).
1960 *Cancris indicus* (Cushman); Barker, p. 218, pl. 106, figs 6a–c.

Material examined: 23 specimens.

B. indica occurs frequently in several samples. The test is densely perforate, the pore diameter being 2 microns on both the dorsal and ventral sides. The wall is radiate in texture and the septal walls are single.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6377	0·54	0·31
CPC 6378	0·52	0·35

Occurrence: Figured specimens (CPC 6377 and 6378) from the sea cliff, 250 yards north of the L.M.S. Mission, Delena, Papua (lower Miocene, Burdigalian); other localities: 1d, 27, 28, 36.

B. indica is recorded from high in the lower Miocene (Burdigalian) to the Pliocene; it also occurs in Recent deposits.

Genus CANCRIS de Montfort, 1808

CANCRIS AURICULUS (Fichtel & Moll, 1798)
(Pl. 15, figs 1–5)

1798 *Nautilus auricula* Fichtel & Moll, var. 2, p. 108, pl. 20, figs a–c; var. 3, p. 110, pl. 20, figs d–f.
1921 *Pulvinulina auricula* (Fichtel and Moll); Cushman, p. 329, pl. 69, figs 3a–c.
1927*d* *Cancris auricula* (Fichtel and Moll); Cushman, p. 164, pl. 5, fig. 10,
1941*c* *Cancris auriculus* (Fichtel and Moll); LeRoy, p. 117, pl. 3, figs. 7–9, 16–18.
1942*b* *Cancris auriculus* (Fichtel and Moll); Cushman & Todd, p. 74, pl. 18, figs 1a–b, 2a–b, 3a–c, 4a–c, 5a–c, 6a–c, 7a–c, 8a–c, 9a–b, 10a–c, 11a–c; pl. 23, figs 6a–c.
1944*a* *Cancris auriculus* (Fichtel and Moll); LeRoy, p. 36, pl. 3, figs 4–9.
1956 *Cancris auricula* (Fichtel and Moll); Bhatia, p. 23, pl. 5, figs 5a–b.
1957 *Cancris auriculus* (Fichtel and Moll); Agip Mineraria, pl. 42, fig. 4.
1958 *Cancris auriculus* (Fichtel and Moll); Batjes, p. 148, pl. 10, figs 3a–c.
1959 *Cancris auriculus* (Fichtel and Moll); Graham & Militante, p. 91, pl. 13, figs 18a–b. (Synonymy).
1961 *Cancris auricula* (Fichtel and Moll); Bandy, p. 21, pl. 3, figs 6a–c.
1964 *Cancris auriculus* (Fichtel and Moll); LeRoy, p. 39, pl. 6, figs 23–24.

Material examined: 29 specimens.

There has been some confusion between *C. auriculus* and *C. oblongus* (Williamson) but the references given in the synonymy show the variation of the form which has come to be accepted as true *C. auriculus.* Cushman (1931) placed *oblongus* in the synonymy of *auriculus*, but Cushman & Todd (1942*b*) recognized *oblongus* as a valid species and placed *auriculus* of Cushman (1931) in synonymy. *C. oblongus* as figured by Cushman & Todd (1942*b*) has a narrow, elongate, somewhat oblong outline in side view, but in edge view resembles figures of *C. auriculus.* Barker (1960) considered that there is a possibility that the two forms figured by Brady (1884) represent two species rather than extremes in variability of *C. oblongus.*

The test of *C. auriculus* is densely perforate on both the dorsal and ventral sides. On the dorsal side the pores appear to be irregular in outline, and the diameter ranges from 2 to 6 microns; on the ventral side they are circular with a diameter of about 2 microns. The wall is radiate in texture and the septal walls are single.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6379	0·52	0·18
CPC 6380	0·49	0·17

Occurrence: Figured specimens (CPC 6379 and 6380) from the road cutting at the new residence, north of aerodrome, Madang, New Guinea (Pliocene); other locality: 1d.

C. auriculus has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

CANCRIS BODJONGENSIS (LeRoy, 1941)

(Pl. 15, figs 6–9)

1921 *Pulvinulina scabra* Cushman, p. 330, pl. 58, figs 3a–b (not of Brady).
1941*c* *Discorbis bodjongensis* LeRoy, p. 116, pl. 1, figs 9–11.
1941*b* *Discorbis bodjongensis* LeRoy; LeRoy, p. 82, pl. 3, figs 13–15.

Material examined: 26 specimens.

The present specimens agree well with the description given by LeRoy (1941*c*); a distinct, clear imperforate area is present on the lower part of the apertural face, the test is compressed, and the periphery is marked by an imperforate keel. A small lip extends over the umbilicus. This species cannot be referred to *Discorbis,* but shows the characteristic features of *Cancris* and is therefore placed in that genus.

The test, except for the imperforate area of the apertural face, is densely perforate, the pore diameter on the dorsal side ranging from 4 to 7 microns, and on the ventral side from 2 to 4 microns. The wall is radiate in texture and the septal walls are single. LeRoy (1941*c*) noted the resemblance between *C. bodjongensis* and the specimen figured by Cushman (1921) as *Pulvinulina scabra* Brady, which is here placed in the synonymy of *bodjongensis.*

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6381	0·47	0·18
CPC 6382	0·43	0·18

Occurrence: Figured specimens (CPC 6381 and 6382) from the 'Vaiviri Formation', Ipowoloe Creek, Hohoro area, Papua (Pliocene, locality 15b); other localities: 15e, 15f.

C. bodjongensis has been recorded as *Discorbis bodjongensis*, ranging from middle Miocene to Pliocene; it also occurs in Recent deposits.

Genus VALVULINERIA Cushman, 1926

VALVULINERIA JAVANA LeRoy, 1944

(Pl. 37, figs 16–20)

1944*b* *Valvulineria javana* **LeRoy, p. 88, pl. 7, figs 4–6.**

Material examined: 26 specimens.

Specimens figured by LeRoy (1941*b*) as *Valvulineria* aff. *araucana* var. *malagaensis* Kleinpell, and later (1944*a*) definitely as this species, are probably to be referred to *V. javana*, but were not mentioned by LeRoy (1944*b*). *V. malagaensis* Kleinpell (described by Kleinpell, 1938, as *V. araucana* var. *malagaensis*, but here considered to warrant specific rank) is a more inflated form with broad chambers on the dorsal side, and with the dorsal sutures less reflexed than in *javana*. The present specimens have a clear imperforate area around the umbilical margin; this feature was not mentioned by LeRoy in the description of *javana*, but the illustration of the holotype shows that it is present, and it also occurs on the specimens referred by LeRoy to *V. malagaensis.*

V. javana occurs frequently in a number of samples from Papua-New Guinea. Six or seven chambers are visible from the ventral side. The entire test is perforate, except near the umbilicus, the pore diameter being 3 to 4 microns; the wall is radiate in texture and the septal walls are single.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6383	0·48	0·24
CPC 6384	0·42	0·21

Occurrence: Figured specimen (CPC 6383) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); figured specimen (CPC 6384) from the sea-cliff below the L.M.S. Mission, Delena, Papua (lower Miocene Burdigalian); other localities: 12a, 12c, 14d.

I am not certain of the previous records of the specimens here referred to *V. javana*. They may have been recorded as *Valvulineria* sp. 3, occurring in the middle and upper Miocene, but comparison of the specimens is necessary to confirm this.

Family GLABRATELLIDAE Loeblich & Tappan, 1964

Genus BUENINGIA Finlay, 1939

BUENINGIA CREEKI Finlay, 1939
(Pl. 13, figs 6–11)

1939*a* *Bueningia creeki* Finlay, p. 122, pl. 14, figs 82–84.
1953 *Ruttenella butonensis* Keyzer, p. 280, pl. 4, figs 11–16 (not *Ruttenella* van den Bold, see *Lamarckinita*, nom.nov., Keyzer, 1955, p. 119).

Material examined: 50 specimens.

B. creeki occurs abundantly in one sample. The ventral surface is convex and the dorsal surface concave, with the chambers wholly involute on the ventral side and strongly involute on the dorsal. The aperture is dorsal, open on several chambers, with broad apertural lips. The test is finely perforate on both the dorsal and ventral sides, the pores being oval in outline with a diameter of 4 to 5 microns. The wall is radiate in texture and the septal walls are single; no internal structure is developed. Horizontal sections suggest that *Bueningia* is non-lamellar, the spiral wall being of constant thickness throughout. Successive chambers are separated by a distinct dark line, and it appears that each chamber is simply added on to the previous chambers, as in a non-lamellar form.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6385	0·66	0·42
CPC 6386	0·51	0·38

Occurrence: Figured specimens (CPC 6385 and 6386) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

No information is available on the stratigraphic range of *B. creeki* in Papua-New Guinea.

Genus PARRELLOIDES Hofker, 1956

Loeblich & Tappan (1964a) placed *Parrelloides* in the synonymy of *Cibicidoides* Thalmann, but this is not followed here. The wall texture of the type species of *Cibicidoides* was not determined, but it was stated that the similar species *C. proprius* has a granular wall. Reiss (1963) also noted a similarity between *Cibicidoides* and *Parrelloides*, again without reference to the wall texture of *Cibicidoides*, but indicating that this genus is bilamellid. Specimens of *Parrelloides hyalina* Hofker (here considered a synonym of *P. bradyi*, (Trauth)) obtained from 'Challenger' material have been examined; they have a radiate texture and are monolamellid. *Parrelloides* is therefore recognized as a valid genus, and is placed in the Planulininae.

Parrelloides was stated by Hofker to be closely related to *Planulina;* species referred by Hofker to *Parrelloides* included *Cibicides ungerianus* (d'Orbigny) and *C. wuellerstorfi* (Schwager). This does not take into account the difference in the nature of the septal wall between *ungerianus* and *wuellerstorfi* on one hand and *Parrelloides bradyi* on the other, a difference which in my opinion is sufficient to indicate that these species are not congeneric. In addition, the generic description of *Parrelloides* given by Hofker stated that the aperture is 'never extending back into the spiral suture'. However, the aperture of *bradyi* does extend over to the dorsal side, although it does not continue along the spiral suture; the aperture of *Cibicides cookei* Cushman & Garrett, which was also placed in *Parrelloides* by Hofker, extends along the spiral suture for about one-half the length of the last chamber. The aperture of both *ungerianus* and *wuellerstorfi* extends much further along the spiral suture.

The genus *Planulina* differs from *Parrelloides* in the nature of the septal wall, which is clearly double in *Planulina* and single in *Parrelloides*. In this respect, *ungerianus* and *wuellerstorfi* are closer to *Planulina* than to *Parrelloides*.

PARRELLOIDES BRADYI (Trauth, 1918)
(Pl. 11, figs 10–19)

1884 *Truncatulina dutemplei* Brady, p. 662, pl. 95, figs 5a–c (not of d'Orbigny).
1918 *Truncatulina bradyi* Trauth, p. 235.
1951*b* *Cibicides hyalina* Hofker, p. 359, figs 244, 245.
1960 *Cibicides bradyi* (Trauth); Barker, p. 196, pl. 95, figs 5a–c.
1964 *Eponides hyalinus* (Hofker); LeRoy, p. 37, pl. 7, figs 24–26.
1964 *Cibicidoides bradyi* (Trauth); Parker, p. 624, pl. 100, figs 19, 21–23.

Material examined: 161 specimens.

P. bradyi occurs abundantly in numerous samples from Papua-New Guinea. In addition to the fossil specimens, Recent specimens from the following localities have been examined:

1. 'Goldseeker' haul 228, 57° 59′ N., 10° 34′ W., west of St Kilda, at 1600 metres.
2. 'Atlantis' station 2993, 23° 24′ N., 80° 44′ W., at 580 fathoms.
3. 'Challenger' station 120, 80° 37′ S., 34° 28′ W., off Pernambuco, Brazil, at 675 fathoms.

Hofker (1951*b*) in proposing the species *Cibicides hyalina* stated that it may previously have been confused with *bradyi* and that his specimens showed a much higher spiral side. From an examination of the Recent specimens I consider that *hyalina* is a synonym of *bradyi* and that the present specimens from Papua-New Guinea are also to be referred to this species.

In the material from Papua-New Guinea, three groups of specimens (not necessarily to be interpreted as different generations) may be distinguished on the basis of external form of the test. The proloculus of the specimens has been measured and again three groups may be recognized, although there is some overlap in the proloculus size of two groups. Each group is here considered separately:

1. Proloculus generally ranging from 37 to 50 microns in diameter, one specimen with proloculus diameter of 58 microns. Test biconvex, circular in outline, periphery broadly rounded and slightly lobate over last chambers; ventral surface strongly convex, dorsal surface moderately to strongly convex. Chambers arranged in 3 to 3½ whorls, all visible from dorsal side, 5 to 7 visible from ventral side. Chambers on dorsal side long and

narrow, on ventral side triangular, increasing gradually in size as added. Sutures on dorsal side narrow, distinct, smooth, slightly curved and reflexed; on ventral side slightly depressed, straight, meeting at centre of test: test coarsely and densely perforate on dorsal side, except for proloculus; most specimens perforate on ventral side, pores occurring on outer part of wall, with central area imperforate: wall radiate in texture, septal walls single; no internal structure present. Aperture interiomarginal, peripheral, reaching to dorsal side but not extending along spiral suture.

2. Most commonly occurring type, proloculus ranging from 33 to 46 microns in diameter. Chambers arranged in 3 to 3½ whorls, dorsal surface flat or only slightly convex, ventral surface strongly convex. Shape of chambers and nature of sutures as described for specimens in group 1, 6 to 8 chambers visible from ventral side. Test coarsely perforate on dorsal side, only very rare specimens with pores on ventral side, confined to peripheral area of chambers. Aperture extending on to dorsal side and along spiral suture for up to one-half length of last chamber.

The specimen figured by Brady (1884) is probably of this type. Hofker (1951*b*) figured specimens with a strongly convex dorsal side, referred to the A_1 and A_2 generations. In edge view these resemble the specimens here placed in Group 1, but the recorded proloculus diameters are not the same. Barker (1960) noted that Hofker's figures did not bring out the resemblance between *hyalina* and *bradyi* referred to in the description of *hyalina*.

The size ranges of the proloculus of the specimens in groups 1 and 2 have a large overlap and it is difficult to assign some specimens with certainty to one or the other group. No clear distinction can be made on proloculus size alone and the difference of outline in edge view must also be considered.

3. Proloculus ranging from 12 to 25 microns in diameter, chambers arranged in 3½ to 4½ whorls. Test much larger than that of specimens in groups 1 and 2. Dorsal surface usually flat or slightly convex, two specimens observed with strongly convex dorsal surface. Chamber shape and nature of sutures as previously described, 7 to 9 chambers visible from ventral side. Later chambers becoming slightly evolute on ventral side, forming umbilical hollow. Test coarsely perforate on dorsal side, no specimens observed with pores on ventral side.

The proloculus diameter of these specimens is the same as that given by Hofker (1951*b*) for the A_1 generation, but except for the two specimens with a strongly convex dorsal side the present specimens differ in outline in edge view. Larger specimens from this group are similar in outline to *Cibicides robertsonianus* (Brady), but this species has longer, narrower chambers and many more chambers to a whorl. From the few specimens of *robertsonianus* that I have seen it appears different groups may be recognized similar to those for *bradyi*; *robertsonianus* is identical with *bradyi* in apertural characteristics, pore distribution, and wall texture, and in my opinion should also be referred to *Parrelloides*.

The pore diameter on the dorsal side of specimens from all three groups ranges from 4 to 8 microns; specimens of group 1 have a pore diameter of 3 to 4 microns on the ventral side.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6388	0·47	0·27
CPC 6389	0·45	0·28
CPC 6390	0·46	0·23

Occurrence: Figured specimens (CPC 6388 and 6389) from east of Amaimon, between the Gogol River and Amaimon, New Guinea (upper Miocene); figured specimen (CPC 6390) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 7a, 21, 30, 31, 38, 40.

P. bradyi seems to have been recorded under two generic names, specimens from group 3 being identified as *Cibicides* sp. 6 and those from groups 1 and 2 as *Eponides* sp. 1. Several of these records have been made from the same area, and the recorded stratigraphical ranges overlap. *Eponides* sp. 1 is recorded from middle Miocene to Pliocene and *Cibicides* sp. 6 from lower Miocene (Burdigalian) to upper Miocene. *P. bradyi* also occurs in Recent deposits.

Remarks: Bermudez (1949, pl. 17, figs 28–30) figured as *Eponides umbonatus* (Reuss) var. *multisepta* (Koch) a biconvex specimen which closely resembles specimens of *P. bradyi* from groups 1 and 2. Bermudez gave the recorded range of *E. umbonatus* var. *multisepta* in Cuba as upper Eocene to upper Oligocene, and recorded it from the middle Oligocene Sombrerito Formation of the Dominican Republic. On the formational equivalents given by Bermudez, this would now be regarded as Miocene.

Cushman (1934, pl. 17, figs 4a–c) figured as *Eponides umbonatus* var. *multisepta* (Koch) a strongly biconvex specimen which I consider to be referable to *Parrelloides bradyi*. However, it is not clear from Koch's (1926) original description and figures if his variety *multisepta* is a synonym of *bradyi*.

PARRELLOIDES SOENDAENSIS (LeRoy, 1941)
(Pl. 12, figs 1–7)

1941*c* *Cibicides soendaensis* LeRoy, p. 119, pl. 2, figs 1–3.

Material examined: 29 specimens.

P. soendaensis has been found in only one sample, but occurs abundantly. The number of chambers visible from the ventral side is usually 7, with rare specimens showing 8 chambers. The pore patterns of the dorsal and ventral surfaces are similar, the diameter generally ranging from 4 to 6 microns; the dorsal surface has a greater proportion of larger pores, rarely as large as 10 microns. The wall is radiate in texture and the septal walls are single; no internal structure is present.

The aperture is interiomarginal, a narrow slit beginning near the periphery on the ventral side and extending along the spiral suture, usually open on the last chamber only.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6393	0·42	0·19
CPC 6394	0·32	0·13
CPC 6395	0·40	0·15

Occurrence: Figured specimens (CPC 6393 to 6395) from the road cutting at new residence north of aerodrome, Madang, New Guinea (Pliocene); known only from this sample.

P. soendaensis has not been recorded previously from Papua-New Guinea.

Remarks: LeRoy's species is here referred to *Parrelloides*, again because of the radiate wall texture and single septa. Pores are more strongly developed on the ventral side than are those of other specimens here referred to *Parrelloides*. The aperture is similar to that of *P. depressus* sp.nov., but extends farther along the spiral suture than in *P. bradyi*.

PARRELLOIDES OKINAWAENSIS (LeRoy, 1964)
(Pl. 12, figs 8–14)

1964 *Cibicides okinawaensis* LeRoy, p. 44, pl. 9, figs 1–3.

Material examined: 27 specimens.

The present specimens agree well with the description given by LeRoy (1964) for the species *okinawaensis*, except for the number of chambers in the last whorl, 7 to 9 as against 9 to 10 given by LeRoy. Specimens from Papua-New Guinea have a radiate wall texture, and the septal walls are single; they are therefore here referred to *Parrelloides* rather than to *Cibicides*. The entire dorsal surface of the chambers is perforate, the pores rounded or irregularly oval, 3 to 6 microns in diameter. On the ventral side the early chambers of the last whorl lack pores, which later appear at the umbilical area, then spread over the entire chamber wall, the pore diameter being 3 to 4 microns. The aperture of *P. okinawaensis* extends farther along the spiral suture than does that of *P. bradyi*, the type species, but the apertural characteristics given in the original generic description would require little modification in order to accommodate species such as *P. okinawaensis*.

Dimensions:

	Maximum Diameter	Height
CPC 6397	0·45	0·16
CPC 6398	0·60	0·21
CPC 6399	0·40	0·16

Occurrence: Figured specimens (CPC 6397 to 6399) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other locality: 29.

P. okinawaensis is not known to have been recorded previously from Papua-New Guinea.

Family ASTERIGERINIDAE d'Orbigny, 1839

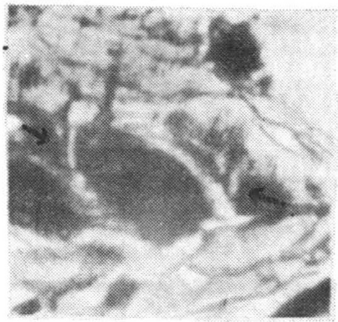
Genus ASTERIGERINA d'Orbigny, 1839

Ten Dam (1947) seems to have been the first to examine the internal structure of an asterigerinid foraminifer, working on species now placed in *Asterigerinoides*. He observed the aperture between the stellate and dorsal chambers, and discussed the relationship of the two chamber parts, stating that 'there is no communication between two of the dorsal chambers, except by way of a stellar chamber'. Brotzen (1948), presumably referring to *Asterigerina nørvangi*, reached the same conclusion. Hofker (1948) described the division into two chamber parts in *Asterigerinoides gurichi* (Franke), observed the opening between the two chamber parts, and first applied the term 'toothplate' to the dividing septum in each chamber.

In specimens of *Asterigerina carinata* from Cuba, the dividing septum is attached to the apertural face at the point where there is an abrupt change in direction. The septum then extends obliquely across the chamber, attached to the previous whorl and to the apertural face of the previous chamber above and about midway along the septal foramen. The opening between the dorsal and stellate chambers is formed immediately above the septal foramen, which remains open and could also function as a connexion between the two chamber parts. A narrow extension at the base of the dividing septum runs toward the marginal prolongation of the previous chamber; there is a small space between this extension of the septum and the floor of the chamber. A direct connexion exists between successive dorsal chambers and also between dorsal and stellate chambers, but none between successive stellate chambers. Whether or not there is direct connexion between the dorsal chambers depends on the position of the dividing septum. In both *Asterigerinoides lutetiana* (Ten Dam) and *Asterigerina nørvangi* Brotzen the dividing septum reaches the periphery and does not join the chamber septum, thus forming large stellate chambers and preventing any direct connexion between the dorsal chambers. In *A. carinata* the dividing septum reaches the chamber septum and direct connexion between the dorsal chambers is possible (see also Troelsen, 1954).

In *A. tentoria* from Papua the general structure of the dividing septum is the same as that in *A. carinata*; the basal extension of the septum is not as strongly developed in *A. tentoria* and does not reach to the marginal prolongation of the previous chamber. There is again a small space between the basal extension of the dividing septum and the floor of the chamber. Thin sections across the septum of *A. tentoria* show that it consists of two layers of shell material; this feature has not previously been reported in any species of *Asterigerina*.

Specimens of *Amphistegina* from 'Challenger' stations 172 and 187A, of the type referred by Barker (1960) to *A. lessonii*, also have a dividing septum similar to that of *Asterigerina carinata*. The basal extension of the septum does not reach the marginal prolongation of the previous chamber, and there is a large space between the extension and the chamber floor. The dividing septum again has two layers of shell material, and the opening between the dorsal and stellate chambers is immediately above the septal foramen. In specimens doubtfully referred to *Amphi-*



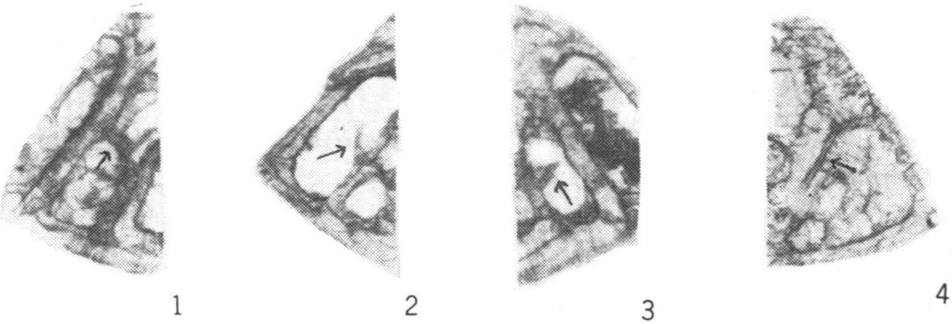
TEXT-FIGURE 10

Amphistegina lessonii **d'Orbigny; 'Challenger' station 187A, showing a bilamellid structure of the dividing septum, X122.**

stegina quoyi the features have not been clearly observed; the chambers are narrow and the dividing septum crosses the periphery of the test. I have not been able to observe the bilamellid structure of *Amphistegina* reported by Reiss (1958; 1963*b*).

Hofker (1956*b*) referred to a plate often covering the aperture, with large irregularly placed openings. This plate was stated to form the dividing septum between the normal and supplementary chambers, the latter being subsequently formed. In Hofker's view the toothplate therefore forms the distal wall of the protoforamen and the ventral wall of the supplementary chamber. Later (1959*b*) in a paper dealing with asterigerinid foraminifera Hofker recorded specimens in which the septum between the two chamber parts was not developed. In my opinion, the coarsely perforated plate, regarded by Hofker as a toothplate, and stated by him to close the aperture and form the septum between the two chamber parts, is in fact the apertural face with an interiomarginal aperture (see Hofker, 1959*b*, fig. 5). The two chamber parts are here considered to be formed at the same time; the double layer of shell material in the dividing septum may be explained by its being formed by a tight fold of the test wall.

Hofker (1959*a*, *b*) placed the genus *Nuttallides* Finlay in the synonymy of *Asterigerina*, but this is not followed here. I have not observed the secondary chambers reported by Hofker in any specimen of *Nuttallides trumpyi*. The internal partition of *Nuttallides* does not 'cut off' the ventral part of the chamber to form two chamber parts and the interpretation of the partition previously given (Belford, 1958) is maintained (see Text-fig. 11). The presence of two layers of shell material in the partition of *Nuttallides* has not been demonstrated, and the partition has a different position in the chamber from that of the dividing septum in *Asterigerina*. The aperture of *Nuttallides* is also different from that of *Asterigerina*, extending from the periphery to the umbilical boss, and lacking depressions at the peripheral and umbilical borders. Both *Asterigerina* and *Nuttallides* have a marginal prolongation of the chamber, but this feature is developed in several unrelated genera. Hofker (1959*b*) stated that I did not compare the internal partition of *Nuttallides* to that of *Asterigerina*. However, referring to the species described by Cushman & Siegfus (1935) as *Asterigerina crassaformis*, placed by Bermudez (1952) in *Nuttallides* and by Hofker (1956*a*) in *Asterigerinoides*, I stated 'vertical sections of *Nuttallides trumpyi* are very similar to the vertical section shown by Hofker (1956, text-fig. 66d), but the toothplate of *Nuttallides* does not extend completely across the chamber to form supplementary chambers'.



TEXT-FIGURE 11

Nuttallides trumpyi **(Nuttall), Aragon Formation, Mexico.**
1–3, CPC 6402–6404, showing internal partition, in figure 1 extending almost completely across chamber at point of origin; in figures 2 and 3, extending only partly across chamber, X100.
4, CPC 6405, section along partition, no bilamellid structure evident, X152.

Although I do not believe that *Nuttallides* is a synonym of *Asterigerina* it may well be that its relationships are with the asterigerinid foraminifera, as stated by Reiss (1958; 1960). In a previous paper (Belford, 1958) the taxonomic position of *Nuttallides* was suggested as being between *Alabamina* and *Epistomina*. From a consideration of wall texture, I now believe this opinion to be incorrect; *Alabamina* is a granular bilamellid, and *Epistomina* has an aragonitic test.

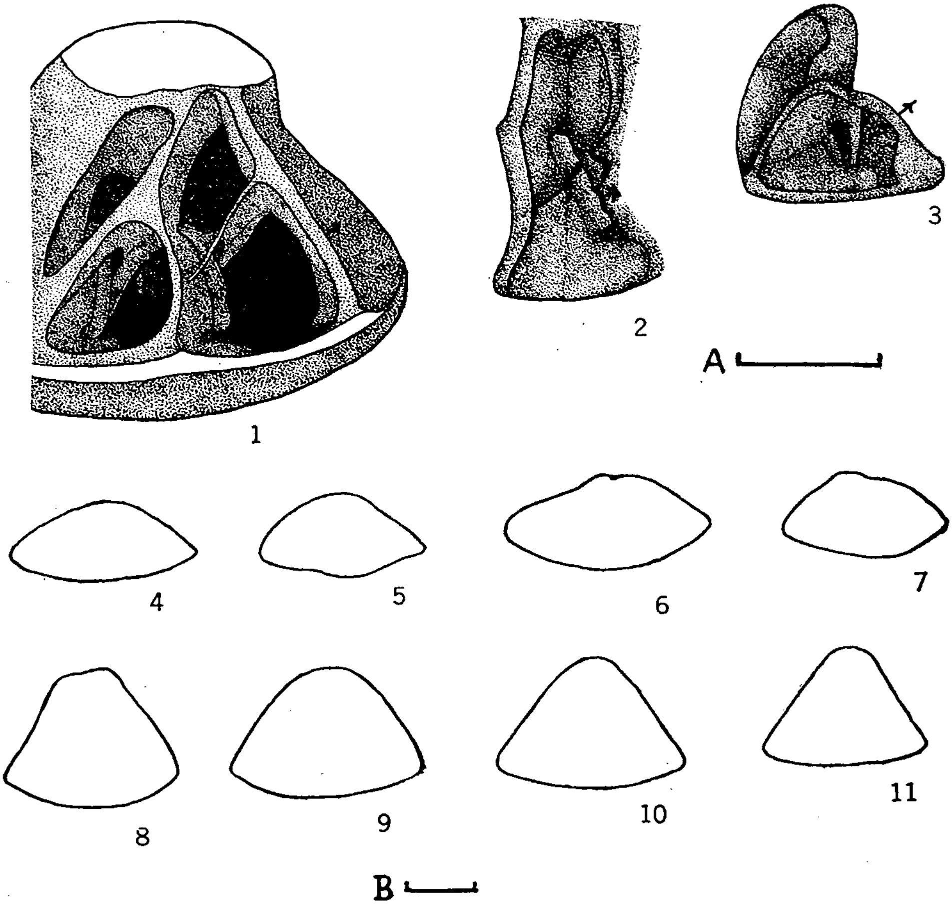
ASTERIGERINA TENTORIA Todd & Post, 1954
(Pl. 15, figs 15–21; text-fig. 12: 1–2, 8–11)

1954 *Asterigerina tentoria* Todd & Post, p. 562, pl. 201, figs 2a–c.

Material Examined: 35 specimens.

Abundant specimens referred to *A. tentoria* occur in one sample from Delena, Papua. The specimens also show some resemblance to that figured by Todd (1957, pl. 83, figs 7a-c) as *A. carinata*, particularly in side view.

Eight specimens of *A. carinata*, in a slide labelled 'Bermudez Station 1, La Chorrera, Havana, Cuba' have been measured; the ratio of maximum diameter to height is about 2. For Papuan specimens the same ratio has a value of about 1·5, and this value is also shown by *A. tentoria* on the measurements given by Todd & Post (1954). The Papuan specimens also differ from *A. carinata* in having a heavier test, smaller stellate chambers, and a less well-developed dividing septum. Both species have a perforate radiate test wall, with a similar pore pattern, the pore diameter ranging from 2 to 3 microns.



TEXT-FIGURE 12

1–2, 8–11, *Asterigerina tentoria* Todd & Post, locality 3. 1, CPC 6410, showing dividing septum, opening between two chamber parts, and extension at base of internal structure. 2, CPC 6410, showing attachment of dividing septum across septal foramen, small marginal prolongation of chamber and small depressions at peripheral and umbilical apertural margins. 8–11, outline drawings, edge view. 3–7, *Asterigerina carinata* d'Orbigny, Recent. Cuba. 3, CPC 6411, dividing septum. 4–7, outline drawings, edge view.

Each scale represents 0·25 mm.
Figures 1–3 to scale A.
Figures 4–11 to scale B.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6406	0·76	0·51
CPC 6407	0·60	0·43

Occurrence: Figured specimens (CPC 6406 and 6407) from the sea-cliff, 250 yards north of the L.M.S. Mission, Delena, Papua (lower Miocene, Burdigalian); found only in this sample.

Specimens here referred to *A. tentoria* have been recorded as *A. carinata*, occurring in the lower and middle Miocene.

Superfamily ROTALIACEA Ehrenberg, 1839

Family ROTALIIDAE Ehrenberg, 1839

Subfamily ROTALIINAE Ehrenberg, 1839

Genus AMMONIA Brünnich, 1772

The morphology of *Ammonia beccarii* has been investigated by Reiss & Merling (1958) and Cifelli (1962); my observations on the nature of the internal structure agree with those of Reiss & Merling. Cifelli recorded a structure which he termed the axial plate, occurring in all except the final chamber and separating the main part of the chamber from the umbilical area. There is no indication of such a structure in the present specimens. Cifelli noted that the axial plate corresponds to the 'toothplate' of Reiss & Merling, but did not consider this term to be appropriate; the internal structure is not a 'toothplate' as this term was originally defined. The internal structure of *A. beccarii* as I have seen it has the same form as that of *Pseudorotalia*, and has the same position in the chamber. In my opinion, it is formed in the same manner in both genera, that is, by a fold of the septal flap, and is here referred to as the 'septal siphon'.

Cifelli also stated that the septa of *A. beccarii* are single, but I do not agree with this. The septal flap of *beccarii* is difficult to detect, and is clearly developed only near the septal siphon: it wedges out rapidly toward the dorsal and ventral chamber margins. The dark line at the periphery marking the position of the septal flap is visible in illustrations given by Reiss & Merling, by Cifelli, and in this paper. Because of the single septa, Cifelli considered that *Ammonia* should not be placed in the Rotaliidae, but is more like genera referred to the Discorbidae; however, I prefer to include it in the Rotaliidae. The basic morphology of *Ammonia* is the same as that of *Pseudorotalia*, but is less complex. No canal systems are developed in *Ammonia*, and no indications of a double layer of shell material along the apertural face have been observed. Cifelli also recorded both radiate and granular wall structures in different parts of the test of the same specimen of *A. beccarii.* This does not hold for the present specimens, in which all parts of the test are radiate. Wood, Haynes, & Adams (1963) considered *A. beccarii* to be wholly radiate, and also detected two layers of shell material in the septa.

AMMONIA BECCARII (Linn., 1758)

(Pl. 19, figs 2–8)

1758 *Nautilus beccarii* Linnaeus, p. 710 (figured Plancus, p. 1, figs 1a–c; Gaultieri, pl. 19, figs h–h; i–i; *fide* Catalogue of Foraminifera, Ellis & Messina, 1940 et.seq.).
1928 *Rotalia beccarii* (Linné); Cushman, p. 104, pl. 15, figs 1, 2, 3a–c, 4a–c, 5a–c, 6a–c, 7a–c. (Synonymy).
1931 *Rotalia beccarii* (Linnaeus); Cushman, p. 58, pl. 12, figs 1, 2, 3a–c, 4a–c, 5a–c, 6a–c, 7a–c; pl. 13, figs 1a–c, 2a–c. (Synonymy).
1949 *Rotalia beccarii* (Linnaeus); Cushman, p. 47, pl. 9, figs 4a–c.
1952 *Streblus beccarii* (Linneo); Bermudez, p. 71, pl. 12, figs 2a–c.
1953 *Rotalia beccarii* (Linnaeus); Redmond, p. 726, pl. 76, figs 10a–c.
1957 *Streblus beccarii* (Linné); Todd, p. 278 (tab.), 283, 290 (tab.), 294, pl. 91, figs 3a–c.
1958 *Rotalia beccarii* (Linné); Batjes, p. 167, pl. 12, figs 10a–c.
1958 *Ammonia beccarii* (Linné); Reiss & Merling, pl. 1, figs 8–12; pl. 5, figs 8–9, 14.
1960 *Streblus beccarii* (Linné); Hofker, p. 255, pl. E, figs 134a–c.
1961 *Streblus beccarii* (Linné); Todd & Low, p. 21, pl. 2, figs 18–19.
1962 *Streblus beccarii* (Linné); Lange, p. 238, pl. 14, figs 11a–b.

Material examined: 51 specimens.

Cushman (1928) illustrated specimens showing the developmental stages of *A. beccarii.* Kaasschieter (1955) noted that specimens of *A. beccarii* from the Aquitanian and Burdigalian of south-western France showed the same range of variation as Cushman's specimens. Specimens from the present material resemble those illustrated by Cushman in figures 4 and 5; no specimens are as highly ornamented as those shown by Cushman in figures 6 and 7.

It is apparent from the literature that there is some difficulty in deciding on the specific limits of *A. beccarii* and related species. Most references to *beccarii* include the specimens figured by Brady (1884, pl. 107, figs 2–3) in synonymy, but Barker (1960) referred Brady's figure 2 to *Streblus beccarii* (Linnaeus) var. *koeboeensis* LeRoy, and figure 3 to *S.* cf. *catesbyanus* (d'Orbigny). The figure given by Graham & Militante (1959) for *beccarii* is very similar to the specimen shown in Brady's figure 2. These authors indicated the variation to be observed in specimens from the Philippine region with regard to the number of chambers in the last whorl and the position of the aperture.

Specimens from Papua-New Guinea referred to *A. beccarii* are biconvex, with a rounded periphery; the chambers are arranged in 2½ to 3½ whorls, with 6 to 8 chambers visible from the ventral side. A single umbilical boss is developed, but has not been observed on all specimens. Very few specimens have the last chamber intact, and apertural details are difficult to observe owing to adherent material; any aperture developed on the final chamber must be a very low interiomarginal opening. A well-developed umbilical aperture, referred to by Reiss & Merling (1958) as a 'labial aperture', opens along the umbilical margin of the chambers. In early chambers of the last whorl these apertures open under thickened imperforate umbilical chamber extensions, called lips by Reiss & Merling (1958), and considered by Hornibrook (1961) to be modified toothplates. There is no indication of the 'flap' or extension of the aperture referred to by Reiss & Merling, but it is evident that the septal foramen has been formed by resorption, as it is a large rounded interiomarginal opening midway between the periphery and the umbilicus. The septa on the ventral side are distinctly double only near the umbilicus, narrowing rapidly toward the periphery and appearing single. The septal flap in horizontal section is often marked only by a thin dark line against the apertural face of the previous chamber. Each chamber has a well developed septal siphon formed by a forward fold of the septal flap and situated immediately on the umbilical side of the septal foramen. This structure was regarded by Reiss & Merling (1958) as a toothplate, but it does not extend completely across the chamber between the septal foramen and the aperture and is not a toothplate as originally defined (Hofker, 1951*a*). Viewed from the periphery the septal siphon has the appearance of a tube inside the chamber, and it enables direct contact between the chamber and the interseptal space. The test is finely perforate on both dorsal and ventral sides, the pore diameter generally ranging from 0·6 to 1 micron, with rare pores having a diameter of 1 6 microns; the wall is radiate in texture.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6412	0·34	0·19
CPC 6413	0·32	0·18

Occurrence: Figured specimens (CPC 6412 and 6413) from the north-west flank of the Wira Anticline, Puri-Purari River area, Papua (upper Miocene, locality 13b); common in samples from this area.

A. beccarii has been recorded as *Rotalia beccarii*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

AMMONIA MACULOSA sp.nov.

(Pl. 19, figs 9–16)

Material examined: 58 specimens.

Diagnosis: A small trochoid species, generally equally biconvex; chambers arranged in 2½ to 3½ whorls, 6 to 7 visible from ventral side; dorsal sutures slightly curved, reflexed, ventral sutures radial or slightly reflexed; umbilicus filled with small pustules; aperture not observed.

Description: Test small, trochoid, circular in outline, periphery lobate in side view, broadly rounded in edge view. Usually equally biconvex, rare specimens with strongly convex dorsal surface and almost flat ventral surface. Chambers arranged in 2½ to 3½ whorls, increasing very slowly in size as added, 6 to 7 chambers visible from ventral side. Sutures on dorsal side broad, distinct, slightly curved, reflexed, on early whorls covered by secondary shell material, in last whorl slightly depressed; on ventral side narrow, depressed, radial or slightly reflexed, double near umbilicus, narrowing rapidly towards periphery and appearing single. Umbilicus large in relation to size of test, filled with numerous small, irregularly arranged pustules of shell material. Umbilical chamber margins and septal margins near umbilicus thickened and beaded with imperforate shell material. Apertural face of some specimens ornamented by short low ridges, which also occur along umbilical and sutural margins of chambers. Aperture not observed, if present a very low interiomarginal opening; septal foramen a small rounded interiomarginal opening midway between periphery and umbilicus. Test wall finely and densely perforate, pore diameter not determined, radiate in texture. Each chamber with small septal siphon formed by forward fold of septal flap, immediately on umbilical side of septal foramen. No umbilical or interseptal canal system developed.

Dimensions:

	Maximum Diameter	Height
Holotype	0·35	0·23
Paratype	0·32	0·20

Occurrence: Holotype (CPC 6416) and paratype (CPC 6417) from the road cutting at the new residence north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

A. maculosa sp.nov. has not been recorded previously from Papua-New Guinea.

Remarks: The holotype has the dorsal surface more strongly convex than the ventral and has 6 chambers visible from the ventral side. The paratype is evenly biconvex, also with 6 chambers visible from the ventral side.

Specimens of *A. maculosa* are infilled with matrix, making observation of details such as the aperture and the septal siphon difficult. The low ridges on the apertural face and on the umbilical and sutural margins of the chambers have been observed on few specimens. This is a type of ornament common in the Rotaliidae, and is thought to result from protoplasmic streaming. The septal flap of *A. maculosa* has not been clearly observed in any thin sections prepared and is represented only by a thin dark line against the apertural face of the previous chamber.

The species described by Cushman (1926*d*) as *Rotalia beccarii* (Linnaeus) var. *tepida* is similar to *A. maculosa*, but is a relatively more compressed form; *A. maculosa* also has a larger umbilicus with small pustules. The specimen figured by Cushman (1921) from the Recent of the Philippine area as *Rotalia beccarii* is very similar, particularly in ventral view, and may be referable to *A. maculosa*. *Rosalina inflata* Seguenza, referred by Hofker (1960) to *Streblus*, is also an inflated form, differing in the greater number of chambers in the last whorl and in having a larger umbilical area.

The specific name is from the Latin *maculosus*, spotted, referring to the umbilical pustules.

Ammonia supera sp.nov.

(Pl. 19, figs 17–19; Pl. 20, figs 1–4)

Material examined: 66 specimens.

Diagnosis: A trochoid species, dorsally slightly convex, ventrally strongly convex; chambers arranged in 3 to 3½ whorls, 7 to 8 visible from ventral side; dorsal sutures straight, slightly reflexed, ventral sutures radial; umbilicus wide, with several separate bosses; small murus reflectus formed; aperture interiomarginal.

Description: Test trochoid, circular in outline, periphery lobate in side view, broadly rounded in edge view. Dorsal surface slightly convex, thickened by deposits of clear shell material, ventral surface strongly convex. Chambers arranged in 3 to 3½ whorls, increasing very slowly in size as added, 7 to 8 visible from ventral side; sutures on dorsal side broad, straight, slightly reflexed, on early whorls covered by secondary shell material, slightly depressed on last whorl; on ventral side straight, radial, depressed, distinctly double near umbilicus, narrowing rapidly towards periphery, and appearing single. Umbilicus wide, open, with numerous small, irregularly distributed and separate umbilical bosses; umbilical ends of chambers and septal margins thickened and beaded with shell material. Apertural face near umbilicus drawn back towards proximal wall of chamber, attached to previous coil, forming small murus reflectus. Aperture interiomarginal, midway between periphery and umbilicus, in some specimens low and difficult to detect, in others clearly shown; umbilical apertures also developed. Septal foramen in same position as aperture, a large rounded opening formed partly by resorption. Test wall finely and densely perforate, pore diameter 0·6 to 1 micron, radiate in texture. Each chamber with well developed septal siphon, formed by fold of septal flap, situated immediately on umbilical side of septal foramen. No umbilical or septal canal system developed.

Dimensions:	Maximum Diameter	Height
Holotype	0·57	0·35
Paratype	0·56	0·34

Occurrence: Holotype (CPC 6421) from below the cliff at Maprik, Screw River, Sepik district, New Guinea (upper Miocene); paratype (CPC 6422) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 34, and also in samples from the Madang area, New Guinea, for which the exact locality is not known.

A. supera sp.nov. has been recorded as *Rotalia* sp. 4, ranging from upper Miocene to Pliocene.

Remarks: The septal flap of *A. supera* is distinct only near the umbilicus, where it swings forward to form the septal siphon in the chamber. Towards the periphery the parting between the septal flap and the apertural face of the previous chamber is very narrow and the septal flap wedges out approaching the umbilical surface of the previous whorl. In horizontal sections cut near dorsal side of the test the septal flap is detected only as a dark line at the periphery and no distinct double septa are shown.

The new species *supera* is referred to *Ammonia* because it lacks an umbilical and interseptal canal system, but the structure of the test is more complicated than that of *Ammonia beccarii*, and some features indicate a relationship with *Pseudorotalia*. The indentation of the apertural face is not shown by *A. beccarii*, but occurs in species of *Pseudorotalia*. The chambers of *A. supera* are not divided into two parts as in *Pseudorotalia*, and the occurrence of two layers of shell material in the apertural face has not been demonstrated; it also lacks a thickened peripheral margin. The development of multiple umbilical bosses in *A. supera* is an initial step towards the formation of an umbilical canal system, which would result if the umbilical bosses became fused at points along their margins.

A. supera is distinct from other described species of *Ammonia*, particularly in having a small murus reflectus.

The specific name is from Latin *superus*, over, above, referring to the more complex morphology, as compared with other species of *Ammonia*.

Genus Pseudorotalia Reiss & Merling, 1958

The genus *Pseudorotalia* was described in detail by Reiss & Merling (1958). My observations generally support those of Reiss & Merling, but I do not agree with their interpretation of some features, as indicated in the following discussion.

The septal siphon of *Pseudorotalia* has the appearance of a tube in the chamber. It is continuous with the septal flap, and is tightly folded in a dorso-ventral direction, the distal margin being recurved. In thin section it has a very distinctive appearance, which was referred to by Reiss & Merling (1958) as a 'pinion pattern'. The purpose of the septal siphon seems to be to permit communication between the chamber lumen and the interseptal canal system. When first formed the septal siphon has a large rounded opening directly to the surface of the chamber; on earlier chambers of the last whorl the opening is covered by secondary deposits of shell material and is indistinguishable from the openings of the umbilical canal system. Reiss & Merling (1958) clearly described the formation of the septal siphon, but regarded both it and the septal flap as being formed by the 'toothplate'.

In species of *Pseudorotalia* from Papua-New Guinea, the distal face of each chamber near the umbilicus is drawn inwards in a manner similar to that of a murus reflectus. This feature seems to have also been observed by Reiss & Merling (1958, p. 7) who stated, concerning the Rotaliidea, '. . . . the distal face of each chamber (and, therefore, of each septum) being strongly recurved at its innermost margin'. A morphological feature not previously recorded in *Pseudorotalia*, but clearly shown by the present specimens, is the presence of two layers of shell material along the apertural face, as in a bilamellid foraminifer. This inner layer does not seem to occur over the peripheral, dorsal, and ventral walls of each chamber, but its absence is not definitely established. One difficulty in observing this feature is the abrupt transition from the finely perforate chamber wall to the imperforate suture, clearly shown in a thin section illustrated (pl. 22, fig. 11). At the proximal border of the 'murus reflectus' the two layers diverge, the outer layer swinging forward to form the distal face of the umbilical part of the chamber ('umbilical cavity' of Reiss & Merling, 1958); the inner layer continues towards the proximal margin of the chamber and is apparently continuous with the septal flap. The inner lining which divides the chamber into a main chamber lumen and an 'umbilical cavity' was called by Reiss & Merling the toothplate, but is not this structure as originally defined (Hofker, 1951*a*). The two parts of the chamber are in contact through a small opening in the dividing wall, at its dorsal margin, and axially from the septal siphon in each chamber.

According to Reiss & Merling the genus *Pseudorotalia* has an anterior interiomarginal labial aperture open in the last-formed chamber only. However, they illustrated (pl. 5, fig. 15) a specimen which has a labial aperture open in the penultimate chamber. In the present specimens the labial aperture seems to be open throughout the test. In addition to the anterior labial aperture the 'umbilical cavity' of the younger chambers of many specimens also has a narrow interiomarginal opening against the umbilical bosses.

The 'labial aperture' defined by Reiss (1957) for members of the Globorotaliidae (Globotruncaninae) were said to 'represent a passage way for the protoplasmic mass to pass from the main aperture of the respective chambers to the outside'. They were stated to be any opening formed by free parts of the apertural lips. There is no resemblance between labial apertures as so defined and the openings in such genera as *Ammonia* and *Pseudorotalia* to which Reiss & Merling (1958) gave this name. Firstly, the lips are not apertural lips covering the primary aperture, but umbilical extensions of the chambers; secondly, the openings do not form passage ways permitting the protoplasmic mass from the primary aperture to reach the exterior of the test. The openings termed 'labial apertures' in *Pseudorotalia* are the apertures of the 'umbilical cavity', formed at the same time as the main chamber lumen, but separated from it. Reiss (1963) again used the term 'labial apertures' in this way, but also stated (p. 28) that the term is used 'to designate any opening formed beneath lips, within them or between them . . .'. The term 'apertural lips' was preferred to 'umbilical lips'.

PSEUDOROTALIA SCHROETERIANA (Parker & Jones, 1862)
(Pl. 20, figs 12–16; Pl. 21, figs 1–3)

1862 *Rotalia schroeteriana* Parker & Jones, p. 213, pl. 13, figs 7–9.
1884 *Rotalia schroeteriana* Parker & Jones; Brady, p. 707, pl. 115, figs 7a–c.
1927 *Rotalia schroeteriana* Parker et Jones; Hofker, p. 39, pl. 18, figs 1a–c, 2a–c, 3a–c, 4; pl. 19, figs 1–12; pl. 21, figs 1, 2, 7, 11, 13.
1958 *Pseudorotalia schroeteriana* (Parker & Jones); Reiss & Merling, p. 13, pl. 1, figs 15–17; pl. 2, fig. 1; pl. 5, fig. 15.
1960 *Streblus schroeterianus* (Parker & Jones); Barker, p. 238, pl. 115, figs 7a–c.

Material examined: At least 200 specimens.

P. schroeteriana, which occurs very abundantly in samples from Pliocene beds in the Hohoro area, Papua, has a flat or only slightly convex dorsal surface and strongly convex ventral surface. No specimens with the last chamber intact have been found, and the apertural details have not been observed. The septal foramen is an elongate narrow opening extending into the distal wall of each chamber midway between the periphery and the umbilicus. Each chamber has a well developed septal siphon situated immediately on the umbilical side of the septal foramen, and formed by a fold in the septal flap. The test is densely perforate, the pores being irregular in shape, with a diameter of about 2 microns; the wall is radiate in texture. The typical feature of the Rotaliidae, the secondarily formed septal flap, is clearly shown in horizontal section; the apertural face of each chamber has two layers of shell material.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6425	1·18	0·65
CPC 6426	1·06	0·58

Occurrence: Figured specimens (CPC 6425 and 6426) from the 'Vaiviri Formation', Ipowoloe Creek, Hohoro area, Papua (Pliocene, locality 15c); abundant in the Pliocene beds of this area.

P. schroeteriana has been recorded as *Rotalia schroeteriana*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

PSEUDOROTALIA CATILLIFORMIS (Thalmann, 1934)
(Pl. 21, figs 4–10)

1934 *Rotalia catilliformis* Thalmann, p. 437, pl. 11, figs 1–2, 3a–d.
1937 *Rotalia catilliformis* Thalmann; Yabe & Asano, p. 104, pl. 19, fig. 1.

Material examined: At least 150 specimens.

P. catilliformis is a large species distinguished by the convex dorsal surface and the flat or slightly concave ventral surface. The test is densely perforate, the pores being irregular in shape and only slightly larger than those of *P. schroeteriana*, with a diameter of 2 to 3 microns; the wall is radiate in texture. Other morphological details for *P. catilliformis* are as given for *P. schroeteriana*.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6430	2·32	1·00
CPC 6431	2·05	0·72

Occurrence: Figured specimens (CPC 6430 and 6431) from the 'Vaiviri Formation', Ipowoloe Creek, Hohoro area, Papua (Pliocene, locality 15d); abundant in the Pliocene beds of this area.

P. catilliformis has been recorded as *Rotalia catilliformis*, occurring doubtfully in the upper Miocene and in the Pliocene.

PSEUDOROTALIA GAIMARDI (d'Orbigny, 1906)

(Pl. 20, figs 5–11)

1826 *Rotalia (Turbinulina) gaimardi* d'Orbigny, p. 275, no. 46 (nom.nud).
1884 *Rotalia papillosa* Brady, p. 708, pl. 106, figs 9a–c.
1906 *Turbinulina gaimardi* d'Orbigny; Fornasini, p. 67, pl. 4, figs 1, 1a, 1b.
1915 *Rotalia papillosa* Brady; Cushman, p. 70, pl. 31, figs 1a–c.
1921 *Rotalia papillosa* Brady; Cushman, p. 347, pl. 72, figs 3a–b.
1934 *Rotalia (Turbinulina) gaimardi* d'Orbigny; Thalmann, p. 430, text-figs 1, 1a, 1b.
1941*a* *Rotalia papillosa* Brady; LeRoy, p. 40, pl. 2, figs 51–53.
1949 *Rotalia papillosa* Brady; Said, p. 38, pl. 4, figs 8a–b.
1956 *Streblus papillosus* Brady; Bhatia, p. 23, pl. 4, figs 1a–c, 2a–c.
1960 *Streblus gaimardi* (d'Orbigny); Barker, p. 218, pl. 106, figs 9a–c.

Material examined: 40 specimens.

P. gaimardi has the features of *Pseudorotalia* except that it lacks a well developed umbilical and interseptal canal system. The umbilical canal system of the present specimens is weakly developed, but no interseptal canal system has been observed. The margins of the sutures of early chambers of the last whorl are thickened, but beads of imperforate calcareous material bridging the sutures are not formed; in younger chambers the sutural margins are smooth and not thickened. This feature is well shown in the specimen figured by Brady (1884). The present specimens are biconvex, with an imperforate peripheral margin, large bosses in the umbilical area, and raised bands of imperforate calcareous material marking the spiral and septal sutures on the dorsal side. The apertural face has two layers of shell material, and near the umbilicus is drawn back towards the proximal chamber wall. The septal foramen and the septal siphon formed by the septal flap are similar to those of *P. schroeteriana*. The umbilical chamber part has a wide interiomarginal anterior aperture, and also openings against the umbilical bosses.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6434	1·27	0·73
CPC 6435	1·10	0·70

Occurrence: Figured specimens (CPC 6434 and 6435) from the creek near Wibiti I village, Maprik subdistrict, Sepik district, New Guinea (Pliocene); found only in this sample.

P. gaimardi has been recorded as *Rotalia gaimardi*, occurring in the upper Miocene and Pliocene; it also occurs in Recent deposits.

PSEUDOROTALIA PAPUANENSIS sp.nov.

(Pl. 21, figs 11–13; Pl. 22, figs 1–6)

Material examined: 84 specimens.

Diagnosis: A large, biconvex species with narrowly rounded periphery and margin of clear shell material; 13 to 18 chambers visible from ventral side; sutures straight, radial, beaded; umbilical area large, umbilical and interseptal canal system well developed; aperture not observed, septal foramen narrow, elongate.

Description: Test large, trochoid biconvex, periphery narrowly rounded, with distinct margin of clear shell material. Early chambers on spiral side obscured, later increasing very slowly in size as added, 13 to 18 visible from ventral side. Sutures on dorsal and ventral sides straight, radial, ornamented by small beads of clear shell material. Central part of dorsal side with large irregularly arranged bosses of imperforate shell material; wide umbilical area on ventral side, with large umbilical bosses, covered by imperforate extensions of umbilical chamber walls. Interseptal and umbilical canal systems well developed. Test wall finely and densely perforate except in umbilical area, pores irregular in outline, diameter 1·5 to 2·5 microns; radiate in texture. Apertural face with two layers of shell material, near umbilicus drawn back towards proximal chamber wall; outer layer forming distal wall of umbilical chamber part, inner layer continuing towards proximal margin, dividing chamber into two parts, apparently continuous with septal flap. Each chamber with a septal siphon immediately on axial side of septal foramen, formed by fold in septal flap; chamber parts connected by small opening at axial border of septal siphon, main chamber lumen also communicating with interseptal canal system. Apertural details not observed, septal foramen a long narrow opening into distal wall of each chamber, midway between periphery and umbilicus. Umbilical chamber part with wide interiomarginal anterior aperture and also narrow elongate openings against umbilical bosses.

Dimensions:

	Maximum Diameter	Height
Holotype	1·30	0·68
Paratype	1·57	0·85

Occurrence: Holotype (CPC 6438) and paratype (CPC 6439) from the 'Vaiviri Formation', Doabea Creek, Hohoro area, Papua (Pliocene, locality 15a); abundant in the Pliocene beds of this area.

P. papuanensis has been recorded as *Rotalia* sp. 1, occurring in the uppermost Miocene and the Pliocene.

Remarks: P. papuanensis differs from *P. schroeteriana* in the convex rather than flat dorsal surface, and in having a larger number of chambers in the last whorl; it differs from *P. catilliformis* in the convex rather than flat or concave ventral surface.

PSEUDOROTALIA sp. A
(Pl. 22, figs 7–11)

Material examined: 7 specimens.

Rare specimens found in samples from the Madang area, New Guinea, cannot be referred to any described species. The exact locality of the samples is not known, and for this reason, and also because of the small number of specimens available, the species is not described.

The specimens are large and almost spherical in outline, with 15 to 19 chambers visible from the ventral side. Other morphological details are as given for *P. schroeteriana*, but the doubling of the apertural face is very distinct, the laminae often being widely separated. The interseptal and umbilical canal systems are well developed.

Dimensions of figured specimen:	Maximum Diameter	Height
CPC 6444	1·60	1·18

Occurrence: Figured specimen (CPC 6444) from the Madang area, New Guinea, exact location unknown (upper Miocene).

P. sp. has not been recorded previously from Papua-New Guinea.

Remarks: The present specimens resemble some of those figured by Yabe & Asano (1937, pl. 19, fig.2) as *Rotalia alveiformis*, but the original figures of this species given by Thalmann (1934, pl. 11, figs 4–5) show a much higher dorsal side.

Superfamily ORBITOIDACEA Schwager, 1876

Family EPONIDIDAE Hofker, 1951

Genus NEOEPONIDES Reiss, 1960

NEOEPONIDES BERTHELOTIANUS (d'Orbigny, 1839)
(Pl. 17, figs 1–6)

1839*c* *Rotalina berthelotiana* d'Orbigny, p. 130, pl. 1, figs 31–33.
1884 *Pulvinulina berthelotiana*, d'Orbigny, sp.; Brady, p. 701, pl. 106, figs 1a–c.
1960 *Eponides berthelotianus* (d'Orbigny); Barker, p. 218, pl. 106, figs 1a–c.

Material examined: 8 specimens.

Specimens referred to *N. berthelotianus* occur only rarely. The dorsal surface is much more strongly convex than the ventral and the sutures on the ventral side are radial, thickening toward the centre, and meeting at the centre or with only a small umbilicus present. The test is finely perforate on both the dorsal and ventral sides, with a pore diameter of 2 to 3 microns; the wall is radiate in texture and the septal walls are double. Each chamber has a strong marginal prolongation with a deep inframarginal sulcus, and a small infundibulum is developed.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6447	1·03	0·65
CPC 6448	0·80	0·58

Occurrence: Figured specimens (CPC 6447 and 6448) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); other localities: 15e, 28.

N. berthelotianus has been recorded as *Eponides berthelotianus*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Neoeponides subornatus (Cushman, 1921)
(Pl. 17, figs 7–12)

1921 *Pulvinulina berthelotiana* d'Orbigny var. *subornata* Cushman, p. 333, pl. 70, figs 1a–c.
1941*a* *Eponides berthelotiana* (d'Orbigny) var. *subornatus* (Cushman); LeRoy, p. 39, pl. 2, figs 15–17.
1944*a* *Eponides berthelotiana* (d'Orbigny) var. *subornatus* (Cushman); LeRoy, p. 34, pl. 8, figs 38–40.
1944*b* *Eponides berthelotiana* (d'Orbigny) var. *subornatus* (Cushman); LeRoy, p. 89, pl. 5, figs 7–9.
1951 *Eponides subornatus* (Cushman); Asano, pt 14, p. 11, figs 85–87.
1960 *Eponides subornatus* (Cushman); Chang, p. 73, pl. 15, figs 3a–c.
1964 *Eponides subornatus* (Cushman); LeRoy, p. 38, pl. 7, figs 27–29.

Material examined: 17 specimens.

Specimens here referred to *N. subornatus* range from almost equally biconvex forms to those with a more convex dorsal surface. The sutures on the dorsal side are thickened and raised and on the ventral side narrow and depressed, but with a small raised area at the umbilicus. The marginal prolongation of the chambers, the inframarginal sulcus and the bilamellid septal walls indicate that this species is to be referred to the genus *Neoeponides*. The test is finely perforate, the pore diameter being 2 to 3 microns on both the dorsal and ventral sides, and the wall is radiate in texture.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6450	1·18	0·63
CPC 6451	1·14	0·59

Occurrence: Figured specimens (CPC 6450 and 6451) from a tributary of Kaukomba Creek, Lower Ramu-Atitau area, New Guinea (upper Miocene); other locality: 12a.

N. subornatus has been recorded as *Eponides berthelotianus* var. *subornatus*, from the Pliocene only; it also occurs in Recent deposits.

Neoeponides parantillarum (Galloway & Heminway, 1941)
(Pl. 17, figs 13–15; Pl. 18, figs 1–3)

1941 *Eponides parantillarum* Galloway & Heminway, p. 374, pl. 18, figs 1a–c.
1945 *Eponides parantillarum* Galloway and Heminway; Cushman & Todd, p. 54, pl. 9, figs 6a–c, 7.
1949 *Eponides parantillarum* Galloway and Heminway; Bermudez, p. 247, pl. 16, figs 49–51.
1953 '*Eponides*' *parantillarum* Galloway and Heminway; Redmond, p. 725, pl. 76, figs 7a–c.

Material examined: 12 specimens.

Specimens referred to *N. parantillarum* occur commonly in three samples. The sutures of *parantillarum* are greatly thickened towards the centre of the test and their umbilical margins form a heavy wall around the small but distinct open umbilicus. The test is finely perforate, the pores being 3 to 4 microns in diameter on both the dorsal and ventral sides. The wall is radiate in texture and the septal walls are double; a marginal prolongation of the chamber, a deep inframarginal sulcus and a small infundibulum are developed.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6453	1·15	0·70
CPC 6454	1·30	0·83

Occurrence: Figured specimens (CPC 6453 and 6454) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene); CPC 6453 from locality 1b, CPC 6454 from locality 1a; other locality: 1g.

N. parantillarum has been recorded as *Eponides parantillarum,* occurring in the middle and upper Miocene.

Subfamily PLANULININAE Bermudez, 1952

Genus PLANULINA d'Orbigny, 1826

As the genus *Cibicides* is here considered to be granular in texture, many species, such as *Rotalina ungeriana* d'Orbigny, should, in my opinion, be referred to the radiate bilamellid genus *Planulina.* The coiling and apertural characteristics of *Planulina ariminensis* d'Orbigny and *P. ungeriana* appear at first sight to differ greatly, but these differences are more apparent than real. *P. ariminensis* is a compressed species, evolute on both sides of the test to different degrees, and the aperture is on the less evolute side. In order to compare the apertural characteristics of these two species it is necessary to determine the dorsal and ventral sides of *P. ariminensis.* Glaessner (1945) did not distinguish between the dorsal and ventral sides of *Planulina,* or of any other genus placed by him in the Anomalininae. Cushman (1948) figured the aperture of *ariminensis* on the ventral side. Loeblich & Tappan (1962*c*) placed the aperture on the umbilical side, a term which in other trochoid genera is synonymous with ventral. The aperture of *P. ariminensis* is here considered to be on the dorsal side. Reiss (1958) illustrated a vertical section of *ariminensis* which shows that the aperture is on the apical side of the test and also that the opposite side is the more conical. As figured by Brady (1884) the apertural surface of *P. ariminensis* is perforate, and the opposite surface smooth. Parker (1964, p. 624) recorded coarse pores on both sides of adult specimens of *ariminensis*, and Loeblich & Tappan (1964*a*) figured a specimen perforate on both sides, the apertural surface being the more densely perforate. The criteria previously given (see pages 13–15) therefore indicate that the aperture is dorsally situated.

If the chambers on the more conical side of *P. ariminensis* were involute the result would be a test identical in development with that of *P. ungeriana,* with the aperture on the evolute dorsal side and with an involute ventral surface. It would appear that species such as *ariminensis* and *ungeriana* are similarly organized, with the aperture in the same relative position. The apparent differences are caused by the differing degree of compression of the test and by the extent to which the chambers approach the axis of coiling. As either side of the test may be involute or evolute the difference between *P. ariminensis* and *P. ungeriana* in the degree of involution of the ventral side cannot be taken to indicate that they are generically distinct. The species *Anomalina wuellerstorfi* Schwager, now generally placed in *Planulina*, is identical with *P. ungeriana* in the coiling of the test and the apertural characteristics.

PLANULINA WUELLERSTORFI (Schwager, 1866)

(Pl. 10, figs 1–6)

1866 *Anomalina wuellerstorfi* Schwager, p. 258, pl. 7, figs 105–107.
1884 *Truncatulina wuellerstorfi*, Schwager, sp.; Brady, p. 662, pl. 93, figs 9a–c (not fig. 8).
1915 *Truncatulina wuellerstorfi* (Schwager); Cushman, p. 34, text-figs 36a–c; pl. 12, figs 3a–c. (Synonymy).
1921 *Truncatulina wuellerstorfi* (Schwager); Cushman, p. 314, pl. 64, figs 1a–c.
1926 *Truncatulina wuellerstorfi* Schwager, mut.; Koch, p. 748, figs 24a–b.
1929*b* *Planulina wuellerstorfi* (Schwager); Cushman, p. 104, pl. 15, figs 1a–c, 2a–c.
1940 *Planulina wuellerstorfi* (Schwager); Coryell & Rivero, p. 337, pl. 44, figs 3a–c.
1941*a* *Cibicides wuellerstorfi* (Schwager); LeRoy, p. 46, pl. 1, figs 27–29.
1941*b* *Cibicides wuellerstorfi* (Schwager); LeRoy, p. 89, pl. 3, figs 7–9.
1944*b* *Cibicides wuellerstorfi* (Schwager); LeRoy, p. 93, pl. 6, figs 13–15.
1951*b* *Cibicides wuellerstorfi* (Schwager); Hofker, p. 350, figs 237a–k.
1951 *Planulina wuellerstorfi* (Schwager); Phleger & Parker, p. 33, pl. 18, figs 11a–b; pl. 19, figs 1a–b, 2a–b, 3a–b.
1951 *Planulina wuellerstorfi* (Schwager); Asano, pt 13, p. 15, figs 19–20.
1954 *Cibicides wuellerstorfi* (Schwager); Parker, p. 544, pl. 13, figs 3, 6.
1957 *Cibicides wuellerstorfi* (Schwager); Samaniego & Gonzales, p. 207, pl. 24, figs 8a–c.
1957 *Planulina wuellerstorfi* (Schwager); Todd, p. 279 (tab.), pl. 80, figs 7a–b.
1957 *Planulina wüllerstorfi* (Schwager); Agip Mineraria, pl. 50, fig. 7.
1960 *Planulina wuellerstorfi* (Schwager); Barker, p. 192, pl. 93, figs 9a–c.
1964 *Planulina wuellerstorfi* (Schwager); Ishiwada, pl. 8, figs 112a–b.
1964 *Cibicides wuellerstorfi* (Schwager); LeRoy, p. 45, pl. 8, figs 25–16.
1964 *Cibicidoides wuellerstorfi* (Schwager); Parker, p. 625, pl. 100, fig. 29.

Material examined: 45 specimens.

P. wuellerstorfi is abundant and widespread in the present samples. The test is plano-convex, with the chambers evolute on the dorsal side and wholly involute on the ventral side. The dorsal surface is coarsely perforate, the pore diameter being about 10 microns; pores do not occur on the ventral side of all specimens, and are finer than those on the dorsal side, occurring mainly near the umbilical area. The wall is radiate in texture and the septal walls are double.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6456	1·00	0·30
CPC 6457	0·85	0·28

Occurrence: Figured specimens (CPC 6456 and 6457) from the Nuru valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 11, 18, 27, 40.

P. wuellerstorfi has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Remarks: Planulina wuellerstorfi was referred by Hofker (1956*a*, p. 936) to the genus *Parrelloides*, but this is not accepted here. The type species of *Parrelloides*, *Truncatulina bradyi* Trauth, has single septa, whereas *Planulina wuellerstorfi* is bilamellid. Both species have a radiate wall structure, but differ in their apertural characteristics; the aperture of *Planulina wuellerstorfi* extends back over several chambers along the spiral suture, and in *Parrelloides bradyi* reaches to the spiral side but does not extend along the spiral suture.

PLANULINA UNGERIANA (d'Orbigny, 1846)

(Pl. 10, figs 7–13)

1846 *Rotalina ungeriana* d'Orbigny, p. 157, pl. 8, figs 16–18.
1915 *Truncatulina ungeriana* (d'Orbigny); Cushman, p. 36, text-figs 39a–c; pl. 17, figs 2a–c. (Synonymy).
1921 *Truncatulina ungeriana* (d'Orbigny); Cushman, p. 327, text-fig. 12; pl. 65, figs 3a–c.
1939 *Cibicides dorsopustulosus* LeRoy, p. 268, pl. 11, figs 1–3.
1941*a* *Cibicides dorsopustulosus* LeRoy; LeRoy, p. 47, pl. 1, figs 85–87.
1941*b* *Cibicides dorsopustulosus* LeRoy; LeRoy, p. 88, pl. 3, figs 4–6.
1944*a* *Cibicides dorsopustulosus* LeRoy; LeRoy, p. 42, pl. 2, figs 1–3; pl. 6, figs 7–9.
1944*b* *Cibicides dorsopustulosus* LeRoy; LeRoy, p. 93, pl. 6, figs 7–9.
1958 *Cibicides ungerianus* (d'Orbigny); Batjes, p. 152, pl. 9, figs 6a–c.
1964 *Cibicides dorsopustulosus* LeRoy; Huang, tab. 1, pl. 4, fig. 8.

Material examined: 30 specimens.

P. ungeriana is common in several samples. The distinctive pustules and small ridges in the central area of the dorsal side are well developed. The dorsal surface ranges from slightly to distinctly convex; the chambers are arranged in 2 to 2½ whorls, with 10 to 12 visible from the ventral side. Both dorsal and ventral walls of the test are perforate, the pore diameter on the dorsal side ranging from 10 to 12 microns, and on the ventral side from 4 to 5 microns. On the ventral side pores may be lacking on the early chambers of the last whorl, and if present are confined to the umbilical part of the chamber; on later chambers they occur over the entire chamber surface. The wall is radiate in texture and the septal walls are double; no internal structure is present.

The species described by LeRoy (1939) as *Cibicides dorsopustulosus* cannot be separated from *ungeriana* on any feature of the test. The variety described by Cushman (1921) as *Cibicides ungerianus* (d'Orbigny) var. *ornatus* also scarcely seems to warrant separate identity.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6459	0·60	0·21
CPC 6460	0·58	0·22

Occurrence: Figured specimens (CPC 6459 and 6460) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 1d, 41.

P. ungeriana has been recorded as *Cibicides ungerianus*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

PLANULINA PLANA sp.nov.
(Pl. 10, figs 14–19)

Material examined: 18 specimens.

Diagnosis: A compressed, plano-convex to concavo-convex species with narrowly rounded periphery; evolute on both sides of test; chambers arranged in 1½ to 2½ whorls, 8 to 9 in last whorl; sutures broad, distinct, curved; aperture interiomarginal, periphero-dorsal.

Description: Test compressed, oval in outline, plano-convex to concavo-convex, dorsal surface flat to concave, ventral surface convex; periphery with margin of clear shell material, slightly lobate in side view, narrowly rounded in edge view. Test evolute on both dorsal and ventral sides, chambers arranged in 1½ to 2½ whorls, increasing very slowly in size as added, 8 to 9 chambers in last whorl. Sutures on both dorsal and ventral sides broad, distinct, curved, usually smooth, depressed between last 2 or 3 chambers; spiral suture on ventral side slightly depressed. Test wall coarsely perforate on dorsal side, pore diameter not determined; on ventral side pores fine, sparse and irregularly distributed, at first usually at periphery, later over entire ventral chamber wall, but not observed on all specimens; radiate in texture. Septal walls double, no internal structure present. Aperture interiomarginal, periphero-dorsal, a low slit with narrow lip, extending along spiral suture on dorsal side.

Dimensions:

	Maximum Diameter	Height
Holotype	0·45	0·12
Paratype	0·42	0·10

Occurrence: Holotype (CPC 6463) and paratype (CPC 6464) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other locality: 30.

P. plana sp.nov. is not known to have been recorded previously from Papua-New Guinea. Several specimens referable to this species are in a slide from 'Challenger' station 185, at 155 fathoms, but the species was not figured by Brady (1884).

Remarks: Only 14 specimens of *P. plana* have been found, not all complete; no specimens have been broken for detailed examination of the pores. The inner lining of the septa in the one specimen section is very thin and visible only at high magnification.

P. plana is similar to *P. ariminensis* in the evolute coiling of the test on each side and in the less strongly perforate ventral side. These features, together with the radiate wall texture, bilamellid septal walls, and compressed test indicate that the new species *plana* is to be referred to *Planulina.*

P. plana is similar in dorsal view to *Cibicides catillus* Finlay; the sutures in *C. catillus* are very strongly reflexed and the description does not mention evolute coiling on both sides. *P. plana* also resembles *Cibicides floridanus* (Cushman) var. *cushmani* Barbat & Von Estorff in the compressed test and evolute coiling, but this variety has 12 to 13 chambers in the last whorl and is described as coarsely perforate, the figures showing the pores on both sides of the test. *Truncatulina depressa* d'Orbigny is also evolute but is a very compressed form perforate on both sides of the test.

The specific name is from the Latin *planus*, even flat, level, referring to the compressed test.

PLANULINA RETIA sp.nov.

(Pl. 11, figs 1–9; text-fig. 32: 4–5)

Material examined: 28 specimens.

Diagnosis: A trochoid plano-convex species with narrowly rounded periphery; evolute on dorsal side, usually involute on ventral; chambers in 1½ to 2 whorls, 6 to 7 visible from ventral side; sutures narrow, strongly curved, reflexed; surface with raised irregularly reticulate ornament; aperture interiomarginal, open on dorsal side.

Description: Test trochoid, plano-convex to concavo-convex, dorsal surface flat to concave, ventral surface convex, usually circular in outline, sometimes irregularly oval. Periphery narrowly rounded, with small margin of shell material, often not present on younger chambers. Test evolute on dorsal side, usually involute on ventral side, later chambers of some specimens becoming evolute. Chambers arranged in 1½ to 2 whorls, increasing slowly in size as added, 6 to 7 visible from ventral side of involute specimens. Sutures narrow, strongly curved, reflexed, usually smooth at first, later slightly to deeply depressed; early sutures on dorsal side raised on rare specimens. Surface of test, particularly early chambers of last whorl, with raised irregularly reticulate ornament. Test wall perforate on both dorsal and ventral sides, pore diameter 8 to 10 microns; radiate in texture. Septal walls double, no internal structure present.

Aperture a narrow interiomarginal slit extending back over several chambers along spiral suture on dorsal side.

Dimensions:

	Maximum Diameter	Height
Holotype	0·59	0·17
Paratype A	0·52	0·17
Paratype B	0·81	0·21

Occurrence: Holotype (CPC 6466) and paratypes A and B (CPC 6467 and 6468) from east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene, locality 7a); other localities: 21, 29.

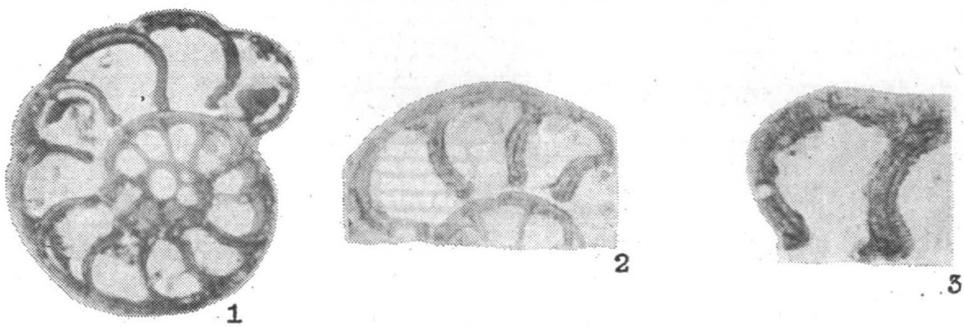
Planulina retia sp.nov. has been record as *P.* sp. 1, ranging from lower Miocene (Burdigalian) to upper Miocene.

Remarks: Planulina retia sp.nov. resembles *Cibicides lobatulus* (Walker & Jacob), but is a more compressed species with narrower chambers and strongly reflexed sutures. One specimen of *C. lobatulus* figured by Brady (1884, pl. 93, fig. 4) has a strong reticulate ornament, but *P. retia* does not have the raised sutures shown by this specimen. *P. retia* differs from *P. ariminensis*, the type species, in being perforate on the ventral side, but has the other morphological features of *Planulina*, such as the compressed test, radiate wall, bilamellid septa and apertural characteristics.

The specific name is the Latin *retia*, a net, referring to the ornament of the test.

Genus HYALINEA Hofker, 1951

Hofker (1951*b*) recorded a spiral canal in *H. balthica*, with the ventral foramina opening into it to form a simple umbilical canal system. This led Hofker to suggest that *Hyalinea* is either an altered *Rotalia* or an advanced form of *Streblus* (=*Ammonia* of this paper). Papua-New Guinea specimens of *H. balthica*, and Recent specimens from the Atlantic that have been examined, have the aperture opening towards the umbilical area in the later chambers, with a narrow lip. The tubular ventral extensions of the earlier chambers, regarded by Hofker as a simple umbilical canal system, appear to be merely the remnants of the ventral umbilical apertures, covered by later shell laminae. They do not open to the surface, and I cannot detect a spiral canal. Hofker also recorded interseptal canals in large tests; this is confirmed in that the septa of both Recent and fossil specimens are double. However, as may be seen from the thin sections illustrated, the structure is bilamellid, not rotaliid.



TEXT-FIGURE 13

1–3, *Hyalinea balthica* (Schroeter), 'Goldseeker' Fry Net haul 8209, station 9, 61° 34′ N., 02° 04′ E at 330 metres, 1, X 68; 2, X 100; 3, X 115. 1, CPC 6471; 2–3, CPC 6472. Showing the bilamellid structure.

HYALINEA BALTHICA (Gmelin, 1791)

(Pl. 14, figs 1–8; text-fig. 13: 1–3)

1782 'Ammonshörner der Ostsee', Schroeter, p. 120.
1783 'Das platte Ammonshorn aus der Ostsee', Schroeter, p. 20, pl. 1, fig. 2.
1791 *Nautilus balthicus* Gmelin, p. 3370.
1884 *Operculina ammonoides* Brady, p. 745, pl. 112, figs 1a–b, 2 (not of Gronovius).
1931 *Anomalina balthica* (Schroeter); Cushman, p. 108, pl. 19, figs 3a–c. (Synonymy).
1949 *Anomalina balthica* (Schroeter); Boomgaart, p. 148, pl. 14, fig. 7.
1950 *Operculina balthica* (Schroeter); Parr, p. 375, pl. 15, fig. 18.
1951*b* *Hyalina baltica* (Schroeter) [sic]; Hofker, p. 508, figs 345 (tab.), 346, 347a–d, 348a–c.
1951 *Anomalina balthica* (Schroeter); Asano, pt 13, p. 14, figs 6–7.
1952 *Hofkerinella balthica* (Schroeter); Bermudez, p. 74.
1957 *Anomalina balthica* (Schroeter); Agip Mineraria, p. 49, fig. 5.

1957 *Anomalina balthica* Schroeter; Samaniego & Gonzales, p. 206, pl. 24, figs 7a–b.
1959 *Anomalina balthica* (Schroeter); d'Onofrio, p. 179, pl. 2, fig. 11.
1959 *Hyalinea balthica* (Schroeter); Parker, p. 275, pl. 4, fig. 39.
1960 *Hyalinea balthica* (Schroeter); Barker, p. 230, pl. 112, figs 1a–b, 2.
1960 *Hofkerinella baltica* (Schroeter) [sic]; Hofker, p. 255, pl. F, figs 137a–c. (Synonymy).
1963 *Anomalina balthica* (Schroeter); Decima, p. 89, pl. 1, fig. 17.
1964 *Hayalinea balthica* (Schroeter) [sic]; Huang, tab. 1, pl. 3, fig. 6.
1964 *Anomalina balthica* (Schroeter); Ishiwada, pl. 8, fig. 111.
1964 *Hyalinea balthica* (Schroeter); LeRoy, p. 44, pl. 9, figs 34–36.

Material examined: 91 specimens.

H. balthica has been found abundantly in several samples. The test is finely perforate, the pore diameter being 0·6 to 1 micron; the wall is radiate in texture. Other morphological details have already been given.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6473	0·35	0·13
CPC 6474	0·32	0·10

Occurrence: Figured specimens (CPC 6473 and 6474) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 13a, 13b, 14d, 30.

Hyalinea balthica has been recorded as *Anomalina balthica,* occurring in the upper Miocene and Pliocene; it also occurs in Recent deposits.

Genus EPONIDES de Montfort, 1808

The following six species are referred to generically as '*Eponides*', as I do not at present know of any genus in which they may be satisfactorily placed. Redmond (1949), Hofker (1950), and Reiss (1960) commented on the status of the genus *Eponides,* and Loeblich & Tappan (1962*a*) selected a neotype; obviously none of the six species under discussion can be referred to *Eponides.* Their relationships are not clear, but because of their radiate texture and bilamellid septa they are here placed in the Planulininae. The primary aperture is interiomarginal and extends to the dorsal side; '*Eponides*' *margaritiferus* (Brady) also has additional smaller openings on the dorsal side. An umbilical aperture may be developed, but is not a constant feature; one species, '*Eponides*' *subhaidingeri* (Parr), has no indication of such an aperture, and in other species it occurs on very few specimens. A small murus reflectus has been observed on all species except '*E.*' *crassilabrus* sp. nov.

'EPONIDES' PRAECINCTUS (Karrer, 1868)

(Pl. 16, figs 1–6)

1868 *Rotalia praecincta* Karrer, p. 189, pl. 5, fig. 7.
1884 *Truncatulina praecincta* Karrer, sp.; Brady, p. 667, pl. 95, figs 1a–c, 2a–c, 3.
1915 *Truncatulina praecincta* (Karrer); Cushman, p. 39, pl. 26, figs 2a–c. (Synonymy).
1941*a* *Eponides praecinctus* (Karrer); LeRoy, p. 39, pl. 1, figs 66–68.
1941*b* *Eponides praecinctus* (Karrer); LeRoy, p. 83, pl. 3, figs 25–27.
1941*c* *Eponides praecinctus* (Karrer); LeRoy, p. 116, pl. 2, figs 22–24.
1944*a* *Eponides praecinctus* (Karrer); LeRoy, p. 34, pl. 2, figs 31–33.
1944*b* *Eponides praecinctus* (Karrer); LeRoy, p. 89, pl. 5, figs 4–6.
1951 *Eponides praecinctus* (Karrer); Asano, pt 14, p. 11, figs 80–82.
1960 *Cibicides praecinctus* (Karrer); Barker, p. 196, pl. 95, figs 1a–c, 2a–c, 3.

Material examined: 28 specimens.

'*E.*' *praecinctus* is a distinctive species, common and widespread in the Indo-Pacific region. The early chambers on the dorsal side are obscured by imperforate shell material, and the spiral suture is thickened. On the ventral side the sutures are broad and raised, particularly on the early chambers of the last whorl, on the last one or two chambers becoming narrower and smooth, or even slightly depressed. The test is perforate on both the dorsal and ventral sides, the pore diameter being 6 to 7 microns, and the wall is radiate in texture; the septal walls are double. The aperture is a narrow interiomarginal slit extending to the dorsal side, where it is open on the last chamber only. Very few specimens have an umbilical aperture. A small but distinct murus reflectus is developed.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6477	1·00	0·64
CPC 6478	0·77	0·60

Occurrence: Figured specimens (CPC 6477 and 6478) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); other locality 28.

'*E.*' *praecinctus* has been recorded as *Eponides praecinctus*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

'EPONIDES' MARGARITIFERUS (Brady, 1881)
(Pl. 18, figs 11–16)

1881 *Truncatulina margaritifera* Brady, p. 66.
1884 *Truncatulina margaritifera* Brady; Brady, p. 667, pl. 96, figs 2a–c.
1915 *Truncatulina margaritifera* Brady; Cushman, p. 40, fig. 43; pl. 17, fig. 1.
1921 *Truncatulina margaritifera* Brady; Cushman, p. 319, pl. 65, figs 1a–c; pl. 74, figs 1a–c.
1941*a* *Eponides margaritiferus* (Brady); LeRoy, p. 40, pl. 3, figs 110–112.
1941*b* *Eponides margaritiferus* (Brady); LeRoy, p. 83, pl. 3, figs 28–30.
1960 *Cibicides margaritiferus* (Brady); Barker, p. 198, pl. 96, figs 2a–c.
1964 *Cibicides margaritiferus* (Cushman); Ishiwada, pl. 8, figs 117a–b.
1964 *Eponides margaritiferus* (Brady); LeRoy, p. 37, pl. 7, figs 19–21.

Material examined: 23 specimens.

'*E.*' *margaritiferus* is a commonly occurring and widespread species in the younger Tertiary rocks of Papua-New Guinea and throughout the Indo-Pacific region. The present specimens show apertural characteristics which do not appear to have been reported previously for the species. In addition to the normal interiomarginal aperture there is a small, narrow umbilical aperture with a distinct lip, open on the last two or three chambers. On the dorsal side narrow apertures occur along the spiral suture, open at the most on only the last three chambers, the position on earlier chambers being marked by a narrow spiral groove, which is finally obscured by the thickened spiral suture. Small openings have also been observed on the dorsal side along the sutures between the chambers, but are variable, occurring on as many as the last four chambers, but generally being restricted to the last one or two chambers; some specimens do not show these openings. A small distinct depression occurs in the apertural face immediately on the umbilical side of the interiomarginal ventral aperture, associated with a small murus reflectus.

All specimens show the characteristic ornament of the species, the sutures being heavily beaded, particularly on the dorsal side and the early chambers on the ventral side. The test is coarsely perforate, the pore diameter on both dorsal and ventral sides generally ranging from 8 to 10 microns; in one specimen examined the pore index is 6 to 8 microns. The wall is radiate in texture and the septal walls are double.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6480	1·55	0·66
CPC 6481	1·45	0·65

Occurrence: Figured specimens (CPC 6480 and 6481) from east of Atemble, Lower Ramu-Atitau area, New Guinea (Pliocene); other localities: 27, 29, 35.

'*E.*' *margaritiferus* has been recorded as *Eponides margaritiferus*, ranging from middle Miocene to Pliocene; it also occurs in Recent deposits.

'Eponides' labricrassus sp.nov.

(Pl. 18, figs 4–10)

Material examined: 25 specimens.

Diagnosis: A trochoid, biconvex species, with rounded periphery; umbilicus usually open; early dorsal chambers obscured, 8 to 12 visible from ventral side; dorsal sutures slightly curved, ventral sutures curved with sharp bend near umbilicus; no internal structure observed; aperture interiomarginal, extending to spiral suture, rarely also umbilical.

Description: Test trochoid, biconvex, circular in top view, periphery rounded in edge view with small margin of imperforate shell material not developed on younger chambers. Usually with small umbilical hollow, with very thick margin of imperforate shell material, umbilicus rarely closed, with smooth boss. Early chambers on dorsal side obscured by large area of imperforate shell material, later chambers visible for about last 1½ whorls, increasing only slowly in size as added, 8 to 12 visible from ventral side. Spiral suture on dorsal side thickened, slightly raised, chamber sutures smooth, slightly curved, at first broad, later narrow; sutures on ventral side curved, some with sharp bend near umbilicus. Test wall perforate on both sides, pore diameter on dorsal side 6 to 8 microns, on ventral side 4 to 6 microns; radiate in texture. Septal walls double, no internal structure observed. Aperture an interiomarginal slit, with narrow lip, extending for short distance along spiral suture, usually open on last chamber only, sometimes also on penultimate chamber; very rare specimens with narrow umbilical aperture, open on last chamber only.

Dimensions:

	Maximum Diameter	Height
Holotype	1·10	0·69
Paratype A	1·03	0·60
Paratype B	0·96	0·67

Occurrence: Holotype (CPC 6483) and paratypes A and B (CPC 6484 and 6485) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene); holotype and paratype A from locality 1b, paratype B from locality 1g; known only from these two samples.

'Eponides' labricrassus sp.nov. has been recorded as *Eponides* sp. 3, occurring in the middle and upper Miocene.

Remarks: The holotype and paratype B have a small umbilical hollow, in paratype B surrounded by a very thick rim of shell material; paratype A has a closed umbilicus. The sutures of the paratypes are strongly raised near the umbilicus, but in the holotype are only slightly raised, or smooth throughout.

'Eponides' labricrassus sp.nov. differs from *'E.' suturicrassus* sp.nov. in having a rounded rather than sharply angled periphery, more elongate, narrow chambers on the dorsal side, a smaller peripheral margin of shell material, and in generally lacking an umbilical aperture. *'E.' labricrassus* also apparently lacks a murus reflectus.

The specific name is from the Latin *labrum*, lip or brim, and *crassus*, thick, fat, referring to the thick umbilical border.

'EPONIDES' SUTURICRASSUS sp.nov.

(Pl. 18, figs 17–21; Pl. 19, fig. 1)

Material examined: 18 specimens.

Diagnosis: A trochoid biconvex species with narrowly rounded periphery; small umbilical hollow; early dorsal chambers obscured, 11 to 13 visible from ventral side; dorsal sutures slightly curved, ventral sutures almost radial, curved near umbilicus; apertures multiple on dorsal and ventral sides; small murus reflectus developed.

Description: Test trochoid, biconvex, with ventral surface more strongly convex, circular in outline. Periphery in side view lobate, with small margin of imperforate shell material, in edge view narrowly rounded. Central part of dorsal side with boss of imperforate shell material obscuring early chambers; ventral side with small umbilical hollow, ranging from narrow and shallow to open and deep. Chambers of about last two whorls visible from dorsal side, 11 to 13 visible from ventral side, increasing slowly in size as added. Spiral suture on dorsal side thickened, slightly raised, chamber sutures slightly curved, on earlier chambers raised, later narrow, smooth. Sutures on ventral side broad, almost radial, with strong curvature near umbilicus, smooth near periphery, increasingly raised toward centre of test, meeting to form thickened margin around umbilical hollow. Surface of test, except for raised sutures, smooth. Test wall coarsely perforate on both dorsal and ventral sides, pore diameter usually 8 to 10 microns, but showing some variation, falling to 6 microns on some specimens; radiate in texture. Septal walls double. Apertures multiple, on ventral side interiomarginal, with broad lip, extending over to dorsal side, and also small narrow umbilical apertures opening into umbilical hollow; on dorsal side rare specimens with small openings along sutures between chambers, open for last one or two chambers only. Small murus reflectus developed.

Dimensions:

	Maximum Diameter	Height
Holotype	1·12	0·06
Paratype	1·12	0·70

Occurrence: Holotype (CPC 6487) and paratype (CPC 6488) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1g); other localities: 1a, 1d.

From slides that I have seen it appears that specimens here described as '*Eponides*' *suturicrassus* sp.nov. have been included in the records of '*E.*' *margaritiferus*; the total stratigraphical range of '*E.*' *suturicrassus* is not known.

Remarks: '*Eponides*' *suturicrassus* sp.nov. is clearly congeneric with '*E.*' *margaritiferus*. Specifically *suturicrassus* differs from *margaritiferus* in its less compressed test, lack of pustulose ornament, more open umbilicus and greater thickening of the sutures around the umbilical margin. These two species have a similar pore pattern and pore index; the possibilities that *suturicrassus* is either a smooth form of *margaritiferus*, the lack of ornamentation reflecting some environmental influence, or is one generation of *margaritiferus*, have been considered. Horizontal sections do not support the suggestions that *margaritiferus* and *suturicrassus* are different generations of the same species, but the effect of environmental influence cannot be determined. The two forms have not been found together in any of the available samples. However, the observed differences between them are considered to be too great to be attributed to intra-specific variation.

The specific name is from the Latin *sutura*, a seam and *crassus*, thick, fat, referring to the thickened sutures.

'EPONIDES' SUBHAIDINGERI (Parr, 1950)

(Pl. 16, figs 7–13)

1884 *Truncatulina haidingeri* Brady, p. 663, pl. 95, figs 7a–c (not of d'Orbigny).
1950 *Cibicides subhaidingeri* Parr, p. 364, pl. 15, figs 7a–c.
1957 *Eponides haidingeri* (Brady, non. d'Orbigny); Agip Mineraria, pl. 40, fig. 6.
1960 *Cibicides subhaidingeri* Parr; Barker, p. 196, pl. 95, figs 7a–c.
1962 *Cibicides subhaidingeri* Parr; McKnight, p. 130, pl. 23, figs 151a–b.

Material examined: 32 specimens.

Specimens of '*E.*' *subhaidingeri* from 'Challenger' station 185, and also in a slide labelled 'Anchor mud, H.M.A.S. Moresby, N.W. of Bathurst Island, 40 fathoms', have been examined. Specimens from one locality in New Guinea (17) are identical in every way with the Recent forms; at other localities, particularly in Papua, the specimens are larger and have a slightly heavier ornament, with broader sutures and deposits of imperforate shell material in the umbilical area. I do not consider these to be specifically distinct from *subhaidingeri*. The test is coarsely perforate, with the pores circular in outline and those on the dorsal side larger than those on the ventral. One specimen from locality 17 has a pore diameter of 10 microns on the dorsal side, and in another specimen it is 6 to 7 microns; the pore pattern of the two specimens is identical. The pore diameter on the dorsal side of specimens from Papua is 8 to 10 microns. On the ventral side the pore diameter is more uniform, being 4 to 6 microns on all specimens. The wall is radiate in texture and the septal walls are double; a small murus reflectus is developed. No specimen has been observed to have an umbilical aperture.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6490	0·76	0·42
CPC 6491	0·74	0·44
CPC 6492	0·53	0·29

Occurrence: Figured specimens (CPC 6490 and 6491) from the 'Doabea Formation', Ipowoloe Creek, Hohoro area, Papua (Pliocene, locality 15b); figured specimen (CPC 6492) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); other localities: 1d, 15e, 27.

'E.' subhaidingeri has been recorded as *Cibicides* sp. 3, ranging from middle Miocene to Pliocene; it also occurs in Recent deposits.

'EPONIDES' sp. cf. 'E.' SUBHAIDINGERI (Parr, 1950)
(Pl. 16, figs 14–22)

Material examined: 11 specimens.

Rare specimens from two samples are similar to *'E.' subhaidingeri* (Parr) but have a much more convex dorsal surface. They resemble closely in shape of the test the species *Eponides haidingeri* (d'Orbigny) var. *pacifica* (Cushman), a form which Parr (1950) noted to be close to *subhaidingeri*. *Eponides* sp. A of LeRoy (1941*a*) is also similar in outline, as are the specimens figured by Cushman (1931) as *E. umbonata* (Reuss). Cushman (1915) recorded specimens as *Truncatulina haidingeri* (d'Orbigny); the present specimens are very similar to Cushman's text figure, adapted from d'Orbigny's type figure. However, Cushman also refigured (pl. 13, figs 1a-c) the specimens illustrated by Brady, which were referred by Parr (1950) to *subhaidingeri*.

The pore diameter on the dorsal side is again variable, in one specimen ranging from 4 to 6 microns and in another being 8 microns. On the ventral side the pores are finer, the diameter being 4 microns. The wall is radiate in texture and the septal walls are double.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6494	0·83	0·43
CPC 6495	0·84	0·45
CPC 6496	0·51	0·28

Occurrence: Figured specimens (CPC 6494 and 6496) from the creek north of Ibab village, Wewak subdistrict, Sepik district, New Guinea (upper Miocene); figured specimen (CPC 6495) from Forsayth Plantation, Mushu Island, Sepik district, New Guinea (Pliocene); found only in the two samples.

No previous records of specimens of this type from Papua-New Guinea are known.

Family CIBICIDIDAE Cushman, 1927

Subfamily CIBICIDINAE Cushman, 1927

Genus Cibicides de Montfort, 1808

Differing opinions have been expressed concerning the morphology of the genus *Cibicides* and also its generic definition and affinities (see Brotzen, 1942, p.21 *et seq.*; Hofker, 1951*b*, p. 342 *et seq.*; 1956*a*, p. 935; 1956*b*, p. 114; and comments by Reiss, 1958, p. 68; 1959; 1963).

In the present study Recent specimens conspecific with those figured by Brady (1884) as *Truncatulina refulgens* have been examined from the following localities:

1. 'Goldseeker' haul 97, station 21A, 60° 02′ N., 03° 10′ W., from 105 metres.
2. 'Goldseeker' haul 118, cold area, Faroe Channel, 60° 31′ N., 03° 53′ W., from 505 metres.
3. 'Goldseeker' haul 211, cold area, Faroe Channel 59° 59′ N., 06° 38′ W., from 505 metres.
4. 'Goldseeker' fry net haul 8209, station 9, 61° 34′ N., 02° 04′ W., from 330 metres.

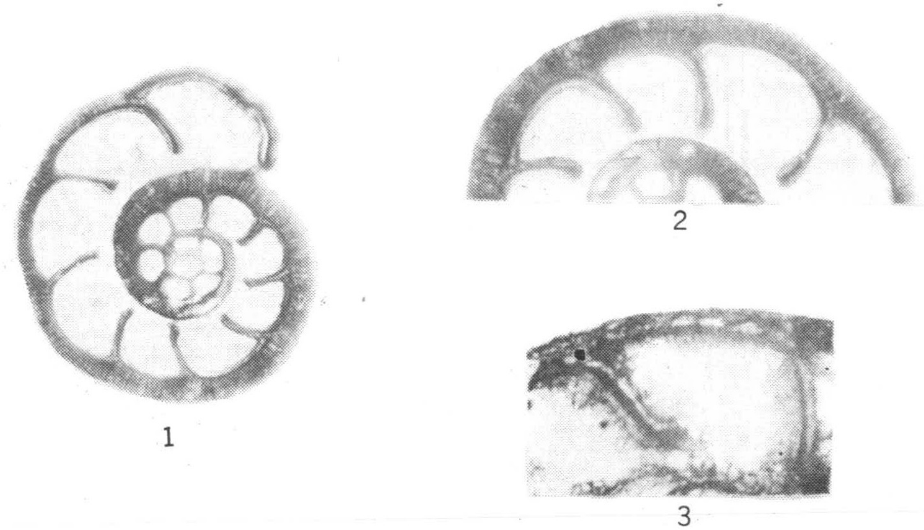
Papua-New Guinea specimens here referred to as *Cibicides* sp. cf. *C. refulgens* are much smaller than those from these four localities, but are similar in the outline of the test, the sinuous ventral sutures and the slightly evolute ventral chambers, to the specimen illustrated by Brady (1884, pl. 92, fig. 7).

In addition, I have examined specimens from a bore on Wreck Island, Queensland, conspecific with specimens referred by Cushman (1942*b*) to *C. refulgens*; these were provided by Mr A. R. Lloyd of the Bureau of Mineral Resources. The bilamellid septal walls and the pore patterns of the Recent 'Goldseeker' specimens and the Wreck Island specimens are illustrated (Text-figure 14; Text-figure 15, figures 1–2, 8–10).

The wall texture of *C. refulgens* was investigated by Wood (1949) and stated to be granular; Wood & Haynes (1957) corrected this and stated that in thin section the wall is radiate, the individual crystals apparently being larger than usual. Hofker (1956*a*) and Reiss (1959) stated that *Cibicides* is granular, although Hofker also referred to fine arenaceous grains embedded in the shell substance; I have not seen these. The observations by Reiss were made on species other than *C. refulgens*, Loeblich & Tappan (1962*c*, 1964) recorded a radiate test and bilamellid septa in *C. refulgens*; Reiss (1959) also observed a bilamellid structure, but Hofker (1956*a*, 1957) stated that the septal walls are single.

Examination of small fragments of the wall indicates that all the available specimens have typical granular texture, with sutured grains: the septa are bilamellid. In thin section the 'Goldseeker' specimens have a thick spiral suture with a seemingly radiate texture, caused by the perforation of the test. Petrological examination suggests that the wall consists of larger grains with an essentially radiate arrangement, and small grains between them with other orientations. The result is that complete extinction does not occur at any point along the wall of the test, although a slight shadow can be seen to pass along the wall as the stage is rotated. Reiss

(1959) observed that the size of the granules in species referred by him to *Cibicides* was heterogeneous, but considered this to be apparently due to diagenetic processes. These processes could scarcely have affected Recent specimens.



TEXT-FIGURE 14

1–2 CPC 6498 *Cibicides refulgens* **Montfort, 'Goldseeker' haul 118, cold area, Faroe Channel, 60° 31′ N., 03° 53′ W., at 505 metres, showing bilamellid septa and radiate appearance due to pores. 1, X 49; 2, X 70.**

3 CPC 6499 *Cibicides* **sp.cf.** *C. refulgens* **Montfort, from a bore on Wreck Island, Queensland, at 614–625 feet, showing bilamellid septa. X 191.**

Wood's (1949) original division into granular and radiate wall texture was largely on fragments of the shell wall, and not on thin sections. A radiate wall texture gives a pseudouniaxial interference figure, and a comparison between the appearance of fragments of the wall of *C. refulgens* and of a true radiate species shows that there must be a difference in texture. I have not been able to obtain an interference figure from the wall of *C. refulgens*, even in conoscopic light. Thin sections of true radiate specimens show complete extinction of the wall, in contrast to the appearance of thin section of *C. refulgens*. The opinion that the wall of *C. refulgens* is granular in structure, or at least is not truly radiate, is supported by the difference between the x-ray diffraction charts obtained from *C. refulgens*, and also from undoubted radiate species; this has been discussed previously.

The occurrence of small irregularly arranged grains among larger radiate grains might suggest that the wall of *Cibicides refulgens* is agglutinated. However, the smaller grains do not appear to be only a cementing medium for the larger grains, as no definite boundaries between them can be detected in ordinary light. They can be detected only by their petrological characteristics.

C. refulgens shows a wall texture similar to that of *Gyroidina* (compare the thin sections of *C. refulgens* in Text-figure 14 and of *Gyroidina torula* sp.nov. in Plate 28, figure 19); both genera are also bilamellid. On these features *Gyroidina* and *Cibicides* appear to be closely related. However, *Cibicides* is an attached genus and the two genera differ in their apertural characteristics; *Gyroidina* also has an infundibulum.

CIBI IDES sp. cf. C. REFULGENS Montfort, 1808

(Pl. 23, figs 1–6; Text–fig. 15: 3–10)

1808 *Cibicides refulgens* Montfort, p. 123, fig. p. 122.

Material examined: 26 specimens.

Small conical specimens compared with *C. refulgens* have been found commonly in one sample. The specimens are very small, with the dorsal surface flat or slightly concave and the ventral surface strongly convex but varying in height. The peripheral margin has a thickened edge of clear shell material, extending into a narrow keel which never becomes as wide as that on the specimens figured by Brady (1884, Pl. 92, figs 7–9); in this respect the specimens are the same as those figured by Todd & Low (1960, Pl. 262, figs 14a-c). The sutures are smooth, on the dorsal side broad and slightly curved, on the ventral side narrow and sinuous, as in Brady's specimens. The test is coarsely perforate on the dorsal surface, but on the ventral surface pore distribution is irregular; on some specimens no ventral pores can be observed, while others have fine pores on the later chambers, confined to the the area near the umbilicus. The interiomarginal aperture has a broad lip and extends along the spiral suture on the dorsal side. No internal structure is present.

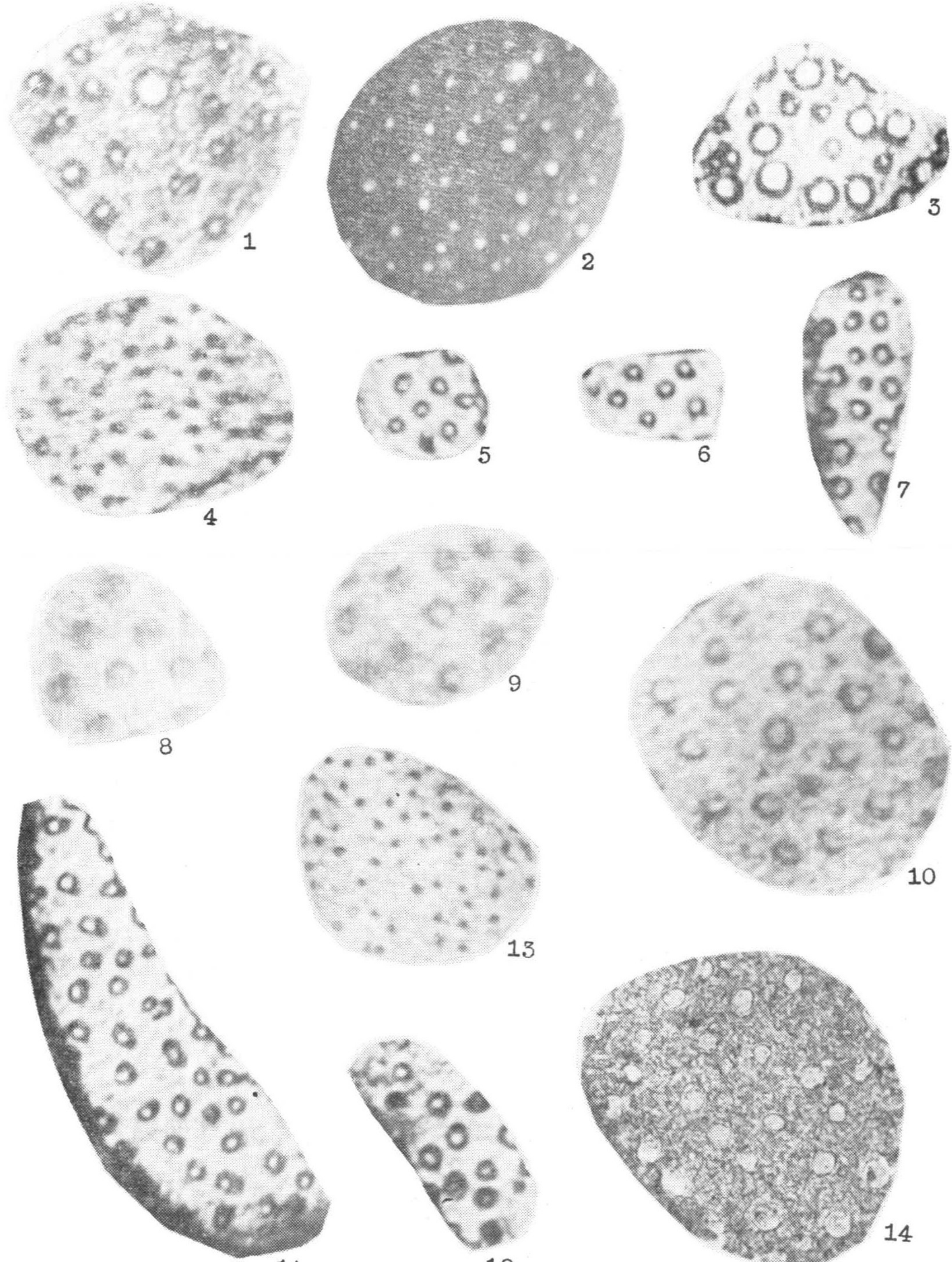
The pore diameter on the dorsal side of Papua-New Guinea specimens is usually about 4 microns; one fragment from the dorsal surface of one specimen has a group of several larger pores with a diameter of 10 microns. Pores on the dorsal surface of the 'Goldseeker' specimens also generally have a diameter of 4 microns, and only one larger pore with a diameter of 10 microns has been observed. Wreck Island bore specimens have a pore diameter from 6 to 8 microns. On the ventral surface the 'Goldseeker' specimens are densely perforate, with a pore diameter from 2 to 4 microns. The pore diameter of those specimens from Papua-New Guinea which develop pores on the ventral side ranged from 2 to 4 microns. Specimens from the Wreck Island bore are more coarsely perforate, with a pore diameter from 6 to 8 microns.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6500	0·39	0·23
CPC 6501	0·37	0·21

Occurrence: Figured specimens (CPC 6500 and 6501) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

C. refulgens has been recorded from lower Miocene (Burdigalian) to upper Miocene; it also occurs in Recent deposits.


1
2
3
4
5
6
7
8
9
10
11
12
13
14

CIBICIDES TENUIMARGO (Brady, 1884)

(Pl. 23, figs 7–9; Text-fig. 15: 11–13)

1884 *Truncatulina tenuimargo* Brady (part), p. 662, pl. 93, figs 3a–c (not figs 2a–c).
1960 *Cibicides tenuimargo* (Brady); Barker, p. 192, pl. 93, figs 3a–c.
1964 *Cibicides tenuimargo* (Brady); LeRoy, p. 44, pl. 8, figs 30–32.

Material examined: 6 specimens.

Two species were figured under this name by Brady (1884) and the specific name *tenuimargo* was restricted by Finlay (1940) to the specimen illustrated by Brady in figure 3. Specimens referred to *C. tenuimargo* occur rarely in only one of the present samples. A distinct thin peripheral keel is present on all specimens and five to six chambers are visible from the ventral side. All specimens observed have a large globular proloculus with the following chambers arranged in $1\frac{1}{2}$ to 2 whorls. The pore diameter on the dorsal side is 4 to 6 microns; on the ventral side the occurrence of pores is variable: some specimens do not show pores; others are finely and densely perforate, particularly on the later chambers. The pore pattern is almost identical with that of the specimens referred to *C. refulgens*, except that the larger pores of *refulgens* have not been observed. The septal walls are bilamellid, but the structure is not clearly shown; the wall is granular in texture, with thin sections showing a radiate arrangement of some grains. A small interiomarginal aperture is developed at the periphery and extends along the spiral suture on the dorsal side.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6511	0·47	0·21

Occurrence: Figured specimen (CPC 6511) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

C. tenuimargo is not known to have been recorded previously from Papua-New Guinea.

TEXT-FIGURE 15

Pores, all figures X 500

1–2 *Cibicides refulgens* **Montfort, 'Goldseeker' haul 97. 60° 02′ N., 03° 10′ W. CPC 6503, dorsal side; 2, CPC 6504, ventral side.**

3–7 *Cibicides* **sp.cf.** *C. refulgens* **Montfort, locality 27. 3, CPC 6505; 4, CPC 6506; 5–6, CPC 6507; 7, CPC 6508.**

8–10 *Cibicides* **sp.cf.** *C. refulgens* **Montfort, from a bore on Wreck Island, Queensland, at 614–625 feet. 8–9, CPC 6509, dorsal side; 10, CPC 6510, ventral side.**

11–13 *Cibicides tenuimargo* **(Brady), locality 27. 11–12, CPC 6513, dorsal side; 13, CPC 6514, ventral side.**

14 CPC 6669 *Heterolepa mediocris* **(Finlay), locality 21, dorsal side.**

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family CAUCASINIDAE N. K. Bykova, 1959

Subfamily FURSENKOININAE Loeblich & Tappan, 1961

Genus FURSENKOINA Loeblich & Tappan, 1961

The erection of the genus *Fursenkoina* for *Virgulina* d'Orbigny, 1826 (not Bory de St Vincent, 1823) was criticized by Todd (1963) and commented on by Hofker (1963*a*). However, as pointed out by Loeblich & Tappan (1964*b*), pending a petition to the International Commission on Zoological Nomenclature for the suppression of *Virgulina* Bory de St Vincent, and a ruling by the Commission, a new name is needed to replace *Virgulina* d'Orbigny. The generic name *Fursenkoina* must therefore be used at this time. Harman (1964), and an editorial note to a paper by Hofker (1963*b*), considered *Cassidella* (attributed to Thalmann, 1952, but here considered to be due to Hofker, 1951) to be the next available name to replace *Virgulina* d'Orbigny; Reiss (1963*b*) placed *Cassidella* in the synonymy of *Virgulina* (= *Fursenkoina*). However, Loeblich & Tappan (1964*b*) regarded *Cassidella* and *Fursenkoina* as distinct genera.

FURSENKOINA SCHREIBERSIANA (Czjzek, 1848)

(Pl. 9, figs 18–21)

1848 *Virgulina schreibersiana* Czjzek, p. 147, pl. 13, figs 18–21.
1937 *Virgulina schreibersiana* Czjzek; Cushman, p. 13, pl. 2, figs 11, 12a–b, 13, 14a–b, 15a–b, 16a–b, 17a–d, 18, 19a–b, 20a–b. (Synonymy).
1942*a* *Virgulina schreibersiana* Czjzek; Cushman, p. 12, pl. 4, figs 1a–c.
1949 *Virgulina schreibersiana* Czjzek; Boomgaart, p. 110, pl. 9, fig. 5.
1959 *Virgulina schreibersiana* Czjzek; Graham & Militante, p. 90, pl. 13, figs 14a–b. (Synonymy).
1960 *Virgulina schreibersiana* Czjzek; Subbotina, Pischvanova, & Ivanova, p. 79, pl. 6, figs 4, 5a–b.
1964 *Virgulina schreibersiana* Czjzek; LeRoy, p. 33, pl. 3, fig. 14.

Material examined: 37 specimens.

F. schreibersiana is abundant in the Papua-New Guinea material. The early part of the test is rounded, and the chambers appear to be arranged in a spiral, with three or more chambers to a whorl. Closer examination shows that the early chambers have a highly twisted biserial arrangement, the twisting being lost in the upper part of the test. Loeblich & Tappan (1957) noted that the genus *Virgulina* (= *Fursenkoina*) has been erroneously regarded as having a triserial chamber arrangement at the base and stated that the type species, *V. squammosa* d'Orbigny, has a twisted biserial development. The test of *F. schreibersiana* in the Papua-New Guinea samples is very finely perforate, the pore diameter ranging from 1·2 to 1·6 microns; the wall is granular in texture. Each chamber has a narrow closely folded toothplate beginning within the trough of the previous toothplate and attached to its outer margin; the upper part of the free edge forms a small tooth at the outer apertural border.

Dimensions of figured specimens:	Length	Maximum Width
CPC 6515	0·95	0·28
CPC 6516	0·81	0·26

Occurrence: Figured specimens (CPC 6515 and 6516) from the south-east flank of the Wira Anticline, Puri-Purari River area, Papua (upper Miocene); other localities: 1f, 1g, 13d, 27, 32.

F. schreibersiana has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Remarks: The specimens here referred to *F. schreibersiana* are of the type illustrated by Cushman (1937). Hofker (1951*b*, p. 268) believed that the specimens figured by Cushman were not referable to *schreibersiana,* and that the species had not been sufficiently well described by Czjzek (1848) to enable it to be recognized. However, Cushman (1937) figured topotypes which agree very well with the original figure given by Czjzek. The figures of *schreibersiana* given by Hofker (1951*b*) show a very inflated form quite unlike the figures of Czjzek, some specimens having an initial spine. The wall of the specimens was stated by Hofker to be 'hyaline', a term which he used as synonymous with radiate. At this time, Hofker believed that *Virgulina* (= *Fursenkoina*) was a radiate genus, and erected the genus *Cassidella* for similar forms with a granular wall. However, *Virgulina,* as shown by the type species *V. squammosa* d'Orbigny, is granular (see Wood, 1949; Loeblich & Tappan, 1957). Later (1956*a*, *b*) Hofker placed *Cassidella* in the synonymy of *Virgulina* and proposed a new genus *Stainforthia* for the radiate species. The specimens referred by Hofker (1951*b*) to *V. schreibersiana* are probably to be placed in *Stainforthia.* Brady (1884) also illustrated specimens as *Virgulina schreibersiana.* Cushman (1932) noted that Brady's figures are not typical, and that he has been followed by many later authors. The specimens illustrated by Brady on plate 52, figures 1 and 3 were referred by Chapman & Parr (1937*b*) and Barker (1960) to *Virgulina davisi;* the specimen shown in figure 2 was doubtfully referred by Barker to *Cassidella pacifica* Hofker (see discussion by Barker, 1960). Wood (1949) found the specimen shown in figure 3 to be radiate in texture; it seems reasonable to assume that all the specimens illustrated by Brady are radiate and therefore more correctly referable to *Stainforthia.*

Genus SIGMAVIRGULINA Loeblich & Tappan, 1957

SIGMAVIRGULINA TORTUOSA (Brady, 1881)

(Pl. 9, figs 22–23; Text-fig. 1–9)

1881 *Bulimina (Bolivina) tortuosa* Brady, p. 57.
1884 *Bolivina tortuosa* Brady; Brady, p. 420, pl. 52, figs 31–32 (not figs 33–34).
1937 *Bolivina tortuosa* Brady; Cushman, p. 133, pl. 17, figs 11, 12a–b, 13a–b, 14–16, 17a–b, 18a–b, 19. (Synonymy).
1942*a* *Bolivina tortuosa* Brady; Cushman, p. 20, pl. 7, figs 1a–b. (Synonymy).
1945 *Bolivina tortuosa* Brady; Cushman & Todd, p. 44, pl. 7, fig. 6. (Synonymy).
1949 *Bolivina tortuosa* Brady; Bermudez, p. 195, pl. 12, fig. 45.
1951*b* *Bolivina tortuosa* Brady; Hofker, p. 75, figs 39a–d.
1953 *Bolivina tortuosa* (Brady); Redmond, p. 721, pl. 75, figs 14a–b.
1956*b* *Bolivina tortuosa* Brady; Hofker, p. 61, pl. 6, figs 22–29.
1957*a* *Sigmavirgulina tortuosa* (Brady); Loeblich & Tappan, p. 227, pl. 73, figs 1a–c, 2; text-fig. 30.
1957 *Bolivina tortuosa* Brady; Todd & Bronnimann, p. 34, pl. 8, fig. 24.
1959 *Sigmavirgulina tortuosa* (Brady); Graham & Militante, p. 87, pl. 13, figs 6, 7a–b. (Synonymy).
1960 *Sigmavirgulina tortuosa* Brady; Barker, p. 108, pl. 52, figs 31–32.

Material examined: 23 specimens.

S. tortuosa, which is common throughout the Indo-Pacific area, occurs in several of the present samples. The granular wall of the test and the twisted sigmoiline chamber development indicate that *S. tortuosa* has closer relationships to the Caucasinidae than to the Bolivinitidae. The toothplate begins within the septal foramen and has a small fold along the free edge, forming a small tooth in the aperture. The wall of the early part of the test is thickened by secondary deposition of shell material, and the early biserial chambers have a single row of coarse pores along the base of the chamber; the last one or two pairs of biserial chambers have a thinner wall, with the pores spreading over the entire chamber surface.

Dimensions of figured specimen:	Length	Maximum Width
CPC 6517	0·36	0·21

Occurrence: Figured specimen (CPC 6517) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1f); other localities: 1a, 3, 4, 5, 12b, 12c, 27.

S. tortuosa has been recorded as *Bolivina tortuosa*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Family CASSIDULINIDAE d'Orbigny, 1839

Genus CASSIDULINA d'Orbigny, 1826

CASSIDULINA LAEVIGATA d'Orbigny, 1826

(Pl. 24, figs 1–4; Text-fig. 16: 1–2)

1826 *Cassidulina laevigata* d'Orbigny. p. 282, pl. 15, figs 4–5, 5 bis.
1921 *Cassidulina laevigata* d'Orbigny; Cushman, p. 171, pl. 31, fig. 7.
1922*a* *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman, p. 124, pl. 25, figs 6–7.
1930 *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman; Cushman, p. 58, pl. 11, figs 7a–b.
1933 *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman; Cushman & Cahill, p. 32, pl. 12, figs 3a–c.
1938 *Cassidulina laevigata* var. *carinata* Cushman; Kleinpell, p. 333, pl. 8, figs 11a–b.
1948 *Cassidulina laevigata* d'Orbigny; Renz, p. 125, pl. 9, figs 9a–b.
1950 *Cassidulina neocarinata* Thalmann, p. 44.
1951 *Cassidulina laevigata* d'Orbigny; Phleger & Parker, p. 27, pl. 14, figs 6a–b.
1951 *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman; Phleger & Parker, p. 27, pl. 14, figs 7a–b.
1954 *Cassidulina laevigata* d'Orbigny; Parker, p. 536, pl. 11, fig. 2.
1954 *Cassidulina neocarinata* Thalmann; Parker, p. 536, pl. 11, fig. 3.
1955 *Cassidulina laevigata* d'Orbigny; Walton, p. 1004, pl. 104, figs 2, 7.
1958 *Cassidulina laevigata* d'Orbigny; Nørvang, p. 38, pl. 9, figs 27a–c, 28a–b, 29a–b, 30a–b, 31a–b.
1959 *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman; Graham & Militante, p. 109, pl. 18, figs 7a–b.
1959 *Cassidulina laevigata* d'Orbigny; Dieci, p. 84, pl. 7, fig. 7.
1962 *Cassidulina laevigata* d'Orbigny; McKnight, p. 127, pl. 21, figs 140a–b.
1964 *Cassidulina laevigata carinata* Cushman; Ishiwada, pl. 7, fig. 97.

Material examined: 65 specimens.

Nørvang (1958) found that most specimens of *C. laevigata* from the Iceland region possessed a thin carina, and considered that the presence or absence of a carina is a matter or normal variation only. In the Papua-New Guinea samples very few specimens lacking a carina have been found; there is no difference in wall texture or internal structure between carinate and non-carinate forms, and Nørvang's opinion is followed here. Specimens of *C. laevigata* from Papua-New Guinea cannot be distinguished from specimens identified by Dr Nørvang, in a slide forwarded by him for inclusion in the collection of the Bureau of Mineral Resources and labelled 'S. W. F. Torskoy (Biol. st. Herdla) 350–400 m, 29–8–1932'.

The test is finely and densely perforate and is granular in texture; the pore diameter has not been determined. Internally, each chamber has a narrow edge along the upper margin of the aperture, formed by infolding of the apertural face and not connected to the septal foramen. Hofker (1951*b*) described and figured a different internal structure in *C. laevigata*. Externally, Hofker's specimens appear identical with those from Papua-New Guinea, and the discrepancy in observations is at present unexplained; my observations of the internal structure agree with those of Nørvang (1958).

Dimensions of figured specimens:

	Maximum Diameter	Thickness
CPC 6519	0·40	0·18
CPC 6520	0·36	0·15

Occurrence: Figured specimens (CPC 6519 and 6520) from east of Yekimbolje village, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localities: 26, 30, 38.

C. laevigata has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Remarks: Phleger, Parker, & Peirson (1935) considered that neither *Cassidulina carinata* Silvestri nor *C. neocarinata* Thalmann shows much resemblance to *C. laevigata*. *C. laevigata* was stated to have a more rounded apertural face and a very small aperture, set at an angle and lacking the plate-like tooth. One specimen figured by Brady (1884, Pl. 54, fig. 3) was referred to *C. carinata*, but Barker (1960) questioned this determination and considered that the two specimens which Brady had referred to *C. laevigata* should be compared with *C. neocarinata*. Both specimens have the same apertural characteristics and both have a keel; the aperture is the same as that of the specimens of *C. laevigata* figured by Nørvang (1958), who also showed the variation in the development of the apertural tooth. The specimen figured by Phleger & Parker (1951) as *C. laevigata* var. *carinata* Cushman and that figured by Phleger, Parker, & Peirson as *C. carinata* Silvestri differ only in the shape of the aperture, and this difference falls within the variation figured by Nørvang.

It is not possible to collect topotypic material of *C. laevigata*, and consequently identification of this species depends on the original specimen and figure of d'Orbigny. The type figure shows a compressed test, with a sharply angled periphery; apertural details are not clearly shown. Common usage has established *C. laevigata* as a compressed species with an elongate aperture, with or without a peripheral keel. The type figure of *C. neocarinata* does not show the apertural characteristics, but other published figures show an aperture of the type figured by Nørvang for *C. laevigata*. It seems to me that Nørvang's observations on the variability of the peripheral keel are conclusive, and I therefore agree with his interpretation of *C. laevigata* and his conclusions regarding the specimens separated by Cushman (1922*a*) as the variety *carinata*. The distribution chart published by Parker (1954, p. 551) supports the observations of Nørvang. This chart shows the ranges of carinate and non-carinate forms, identified by Parker as *C. neocarinata* and *C. laevigata* respectively, coinciding almost exactly with scattered occurrences of non-carinate forms extending into shallower water, and absent between 350 and 1000 feet. The carinate forms are consistently the more abundant down to 1000 feet; occurrences of both forms below that depth are scattered.

CASSIDULINA DELICATA Cushman, 1927
(Pl. 24, figs 5–10; Text-fig. 16: 3–4)

1927*d* *Cassidulina delicata* Cushman, p. 168, pl. 6, fig. 5.
1929*a* *Cassidulina delicatula* Cushman (sic); Cushman, p. 101, pl. 14, figs 12a–b.
1930 *Cassidulina delicata* Cushman; Cushman & Moyer, p. 61, pl. 8, fig. 16.
1948 *Cassidulina delicata* Cushman; Renz, p. 125, pl. 9, figs 10a–b.
1948 *Cassidulina delicata* Cushman; Cushman & Stevenson, p. 65, pl. 10, fig. 20.
1953 *Cassidulina delicata* Cushman; Bandy, p. 176, pl. 25, figs 4a–c.
1954 *Cassidulina delicata* Cushman; Cushman, Todd, & Post, p. 365, pl. 90, fig. 25.
1955 *Cassidulina delicata* Cushman; Walton, p. 1004, pl. 103, figs 28–29.
1956 *Cassidulina delicata* Cushman; Pierce, p. 1300, pl. 139, figs 10a–b.
1961 *Cassidulina delicata* Cushman; Bandy, p. 21, pl. 4, figs 13a–b.
1964 *Cassidulina delicata* Cushman; Ishiwada, pl. 7, fig. 95.

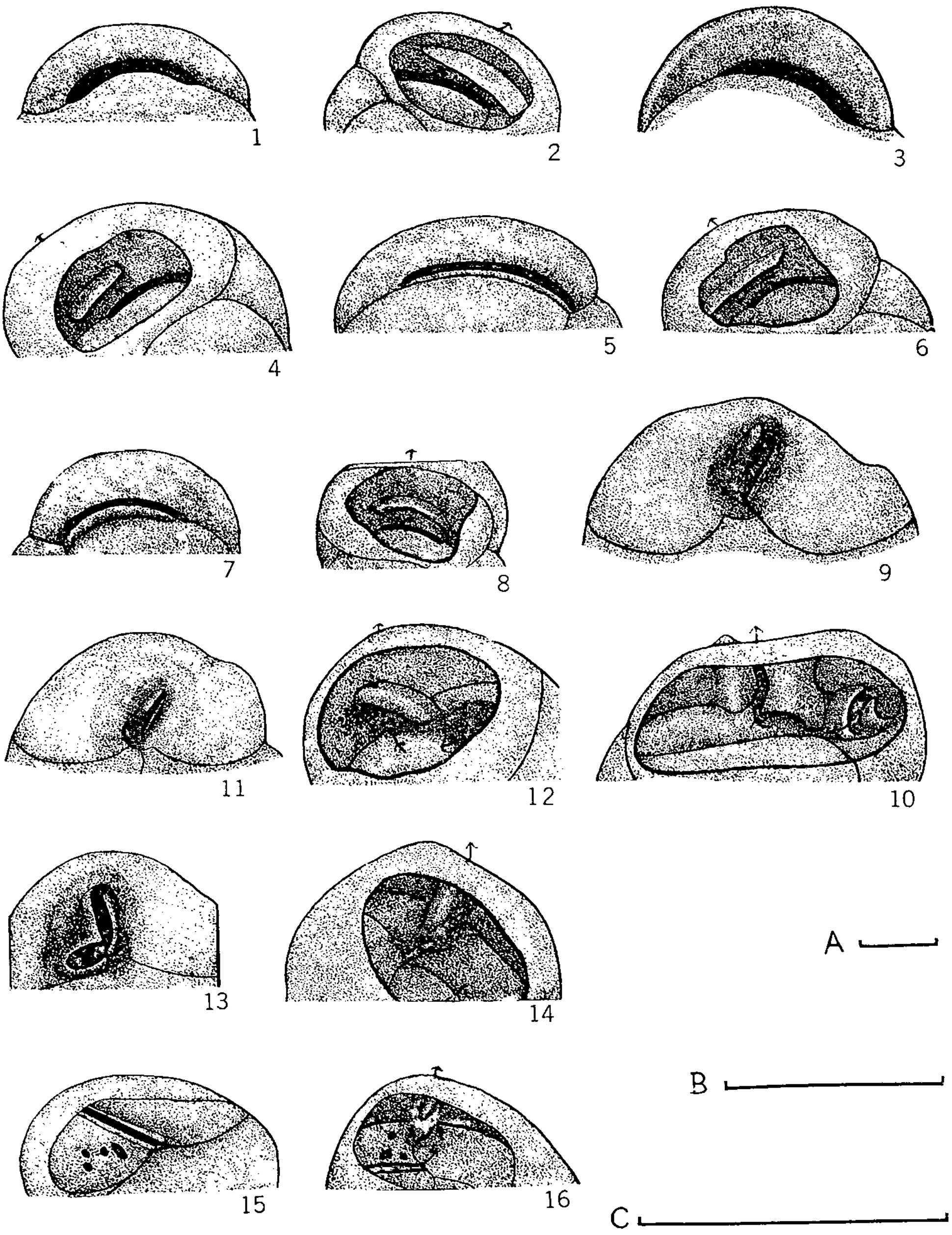
Material examined: 35 specimens.

C. delicata has been found in only one sample, but specimens are abundant. Specimens with four pairs of chambers visible are the more common, and closely resemble the holotype; the very few specimens with three pairs of chambers visible are more inflated but are otherwise identical. Rare specimens show faint striations along the apertural margin, but these are not as strongly developed as on the specimen figured by Cushman, Todd, & Post (1954). The test is finely and densely perforate and is granular in texture; the pore diameter has not been determined. A small internal ledge occurs above the aperture in each chamber, formed by infolding of the apertural face, and not connected with the septal foramen.

TEXT-FIGURE 16

1–2	**CPC 6521**	*Cassidulina laevigata* **d'Orbigny, locality 27. 1, aperture; 2, toothplate.**
3–4	**CPC 6524**	*Cassidulina delicata* **Cushman, locality 31. 3, aperture; 4, toothplate.**
5–6	**CPC 6530**	*Cassidulina quasisulcata* **sp.nov., locality 27. 5, aperture; 6, toothplate.**
7–8	**CPC 6527**	*Cassidulina sulcata*, **sp.nov., locality 27. 7, aperture; 8, toothplate.**
9–10	**CPC 6537**	*Globocassidulina ornata* **(Cushman), locality 40. 9, aperture; 10, toothplate.**
11–12	**CPC 6540**	*Globocassidulina gemma* **(Todd), locality 21. 11, aperture; 12, toothplate.**
13–14	**CPC 6543**	*Globocassidulina oriangulata* **sp.nov., locality 30. 13, aperture; 14, toothplate.**
15–16	**CPC 6546**	*Globocassidulina oribunda* **sp.nov., locality 21. 15, aperture; 16, toothplate.**

Each scale represents 0·25 mm.
Figures 15–16 to scale A.
Figures 1–2, 5–14 to scale B.
Figures 3–4 to scale C.


1
2
3
4
5
6
7
8
9
11
12
10
13
14
A
B
15
16
C

Dimensions of figured specimens:	Maximum Diameter	Minimum Diameter	Width
CPC 6522	0·29	0·24	0·15
CPC 6523	0·26	0·20	0·13

Occurrence: Figured specimens (CPC 6522 and 6523) from west of Yangoru, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); known only from this sample.

C. delicata has not been recorded previously from Papua-New Guinea.

CASSIDULINA SULCATA sp.nov.
(Pl. 24, figs 11–14; Text-fig. 16: 7–8)

Material examined: 40 specimens.

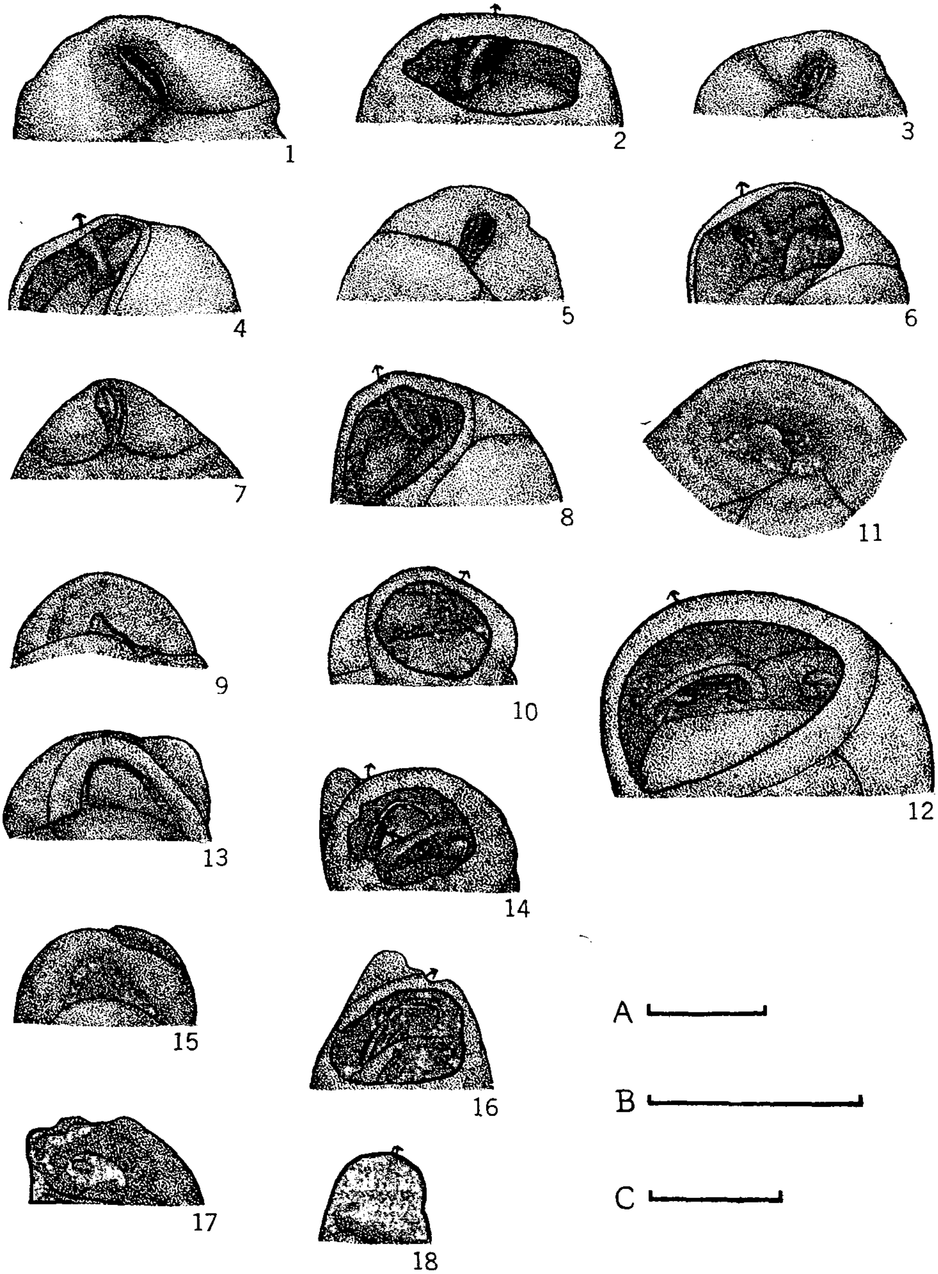
Diagnosis: A compressed species, elongate oval in outline, periphery rounded; sutures narrow, slightly depressed; ornamented by fine shallow irregularly distributed grooves, also occurring on apertural face; aperture narrow, interiomarginal; each chamber with narrow internal flap over aperture.

Description: Test elongate oval in side view, compressed, coiled biserial, periphery rounded; biserial chambers only slightly overlapping at periphery, four or five pairs forming last coil. Sutures narrow, distinct, slightly depressed, very slightly curved. Surface of test with few short very fine shallow irregularly distributed grooves, running from sutures and also from peripheral margin of aperture. Apertural face ornamented by series of fine shallow parallel grooves, extending out from aperture, varying in strength of development in different specimens. Test wall finely and densely perforate, pore diameter not determined, thin, granular in texture. Aperture a long narrow curved interiomarginal slit; each chamber with narrow internal ledge above aperture, formed by infolding of apertural face and not connected with septal foramen.

TEXT-FIGURE 17

1–2	**CPC 6550**	*Globocassidulina subglobosa* **(Brady), 'Challenger' station 120. 1, aperture; 2, toothplate.**
3–4 **5–6**	**CPC 6551** **CPC 6552**	*Globocassidulina subglobosa* **(Brady), locality 21. 3, 5, aperture; 4, 6, toothplate.**
7–8	**CPC 6558**	*Globocassidulina oblonga* **(Reuss), locality 30. 7, aperture; 8, toothplate.**
9–10	**CPC 6561**	*Globocassidulina crassa* **(d'Orbigny), locality 21. 9, aperture; 10, toothplate.**
11–12		*Globocassidulina murrhyna* **(Schwager), locality 21. 11, CPC 6564, aperture; 12, CPC 6565, toothplate.**
13–14	**CPC 6252**	*Cassidulinoides inflatus* **(LeRoy), locality 40. 13, aperture; 14, toothplate.**
15–16		*Cassidulinoides seranensis* **Germeraad, locality 27. 15, CPC 6255, aperture; 16, CPC 6256, toothplate.**
17–18		*Cassidulinoides bradyi* **(Norman), locality 27. 17, CPC 6248, aperture; 18, CPC 6249, toothplate.**

Each scale represents 0·25 mm.
Figures 1–6 to scale A.
Figures 7–10, 17–18 to scale B.
Figures 11–16 to scale C.


1
2
3
4
5
6
7
8
11
9
10
12
13
14
15
16
17
18
A
B
C

Dimensions:

	Maximum Diameter	Minimum Diameter	Width
Holotype	0·32	0·24	0·12
Paratype	0·30	0·24	0·13

Occurrence: Holotype (CPC 6525) and paratype (CPC 6526) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); known only from this sample.

C. sulcata is not known to have been previously recorded from Papua-New Guinea.

Remarks. The ornament of the test distinguishes *C. sulcata* from other similar species. In general appearance it may be grouped with species such as *C. delicata* Cushman and *C. orientalis* Cushman, which are also compressed forms with an oval to rectangular outline, and with the same type of internal structure.

The specific name is from the Latin *sulcus,* furrow or groove, referring to the ornament of the test.

CASSIDULINA QUASISULCATA sp.nov.

(Pl. 24, figs 15–18; Text-fig. 16: 5–6)

Material examined: 26 specimens.

Diagnosis: A compressed species, circular in outline, periphery narrowly rounded to angular; sutures narrow, depressed; ornamented by fine shallow grooves at apertural margins; aperture narrow, interiomarginal; each chamber with narrow internal flap above aperture.

Description: Test compressed, coiled biserial, circular in outline, with lobate periphery in side view, in edge view narrowly rounded to angular; biserial chambers only slightly overlapping at periphery, four or five pairs forming last coil. Sutures narrow, distinct, slightly depressed, curved. Surface of test with short fine shallow grooves radiating from inner margin of aperture, sometimes also at peripheral margin, well developed on last chamber, not always visible on earlier chambers; apertural face smooth. Test wall finely and densely perforate, pore diameter not determined, thin, granular in texture. Aperture a long narrow curved interiomarginal slit; each chamber with narrow internal ledge above aperture, formed by infolding of apertural face, not connected with septal foramen.

Dimensions:

	Maximum Diameter	Width
Holotype	0·33	0·16
Paratype	0·31	0·15

Occurrence: Holotype (CPC 6528) and paratype (CPC 6529) from Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); known only from this sample.

C. quasisulcata sp.nov. is not known to have been recorded previously from Papua-New Guinea.

Remarks: *C. quasisulcata* occurs in the same sample as *C. sulcata*. Both species have shallow grooves on the test, but they are differently distributed on each species, and *C. quasisulcata* lacks grooves on the apertural face. The two species also differ in chamber shape and the outline of the test.

C. quasisulcata is referable to the species group of which *C. laevigata* may be regarded as the central type; these species are characterized by a compressed circular test with carinate or angular periphery, thin finely perforate granular walls, and an internal ledge above the aperture.

Genus Favocassidulina Loeblich & Tappan, 1957

Loeblich and Tappan (1957*a*) regarded the honeycomb secondary ornament of *Favocassidulina* as the only difference between this genus and *Cassidulina*. As compared with the type species of *Cassidulina*, *C. laevigata* d'Orbigny, *favus* is more tightly coiled, the chambers are narrower, elongate, and more strongly overlapping, and the internal structure, though similarly situated in both genera, is a thin fragile ledge in *laevigata* and a low, rounded, and thickened internal margin to the aperture in *favus*. However, the main difference as far as my observations are concerned is in the wall texture, granular in *Cassidulina* and radiate in *Favocassidulina*. The observed radiate wall texture would place *Favocassidulina* more correctly in the Islandiellidae, but because of the uncertainty regarding this feature it is here retained in the Cassidulinidae.

The *Favocassidulina* lineage may have begun in the Eocene, with the appearance of such species as *Pulvinulinella cancellata* Cushman & Bermudez. Another species with reticulate ornament, possibly referable to *Favocassidulina*, is *Cassidulina elegantissima* Cushman. This has yet to be confirmed by examination of the wall texture and internal structure of these species.

Favocassidulina favus (Brady, 1877)

(Pl. 26, figs 28–31; Text-fig. 18: 6)

1877 *Pulvinulina favus* Brady, p. 535.
1884 *Pulvinulina favus* Brady; Brady, p. 701, pl. 104, figs 12a–b, 13a–b, 14–16.
1926*c* *Cassidulina favus* (Brady); Cushman, p. 70. (Synonymy).
1957*a* *Favocassidulina favus* (Brady); Loeblich & Tappan, p. 230, pl. 73, figs 7, 8, 9a–b, 10, 11.
1960 *Favocassidulina favus* Brady; Barker, p. 214, pl. 104, figs 12a–b, 13a–b, 14–16.

Material examined: 31 specimens.

F. favus occurs in only one of the Papua-New Guinea samples. The chambers as seen in thin section are very low and elongate; the internal structure is reduced to a thickening along the margin of the narrow elongate aperture. The entire wall of the last chamber, except for the proximal part in rare specimens, is free of the honeycomb ornament, and not only the area around the aperture as in the specimens figured by Loeblich & Tappan (1957). Differing opinions have been published concerning the wall texture of *favus*. Wood (1949) recorded the texture as radiate, but Loeblich & Tappan considered it to be granular, from a re-examination of four specimens from 'Challenger' stations. The wall texture of the present specimens is radiate, and is clearly shown by both fragments of the wall and thin sections. The test is finely perforate, the pore diameter ranging from 1·2 to 1·6 microns.

Dimensions of figured specimens:	Maximum Diameter	Width
CPC 6531	0·66	0·43
CPC 6532	0·62	0·38

Occurrence: Figured specimens (CPC 6531 and 6532) from one mile south of the Kumil River, Lower Ramu-Atitau area, New Guinea (upper Miocene); found only in this sample.

F. favus has been recorded as *Cassidulina favus*, ranging from middle to upper Miocene; it also occurs in Recent deposits.

Genus GLOBOCASSIDULINA Voloshinova, 1960

Included here are globular non-keeled species differing in their apertural characteristics and internal structures. The genus *Globocassidulina* (s.s.) includes only species with a tripartite aperture and lacking apertural toothplate (*fide* Loeblich & Tappan, 1964*a*). Loeblich & Tappan referred *Cassidulina oblonga* Reuss to *Globocassidulina*; specimens from Papua-New Guinea here referred to *G. oblonga* have a distinct toothplate. A different structure is shown by *G. murrhyna* (Schwager), which has a broad internal ledge above the aperture, in the same position as that of *Cassidulina laevigata*, but larger and heavier. The globular enrolled biserial forms of the Cassidulinidae require further detailed examination to distinguish and evaluate the different morphological types.

GLOBOCASSIDULINA ORNATA (Cushman, 1927)

(Pl. 24, figs 19–21; Text-fig. 16: 9–10)

1927*d* *Cassidulina subglobosa* Brady var. *ornata* Cushman, p. 167, pl. 6, fig. 6.

Material examined: 31 specimens.

Specimens referred to *G. ornata* occur abundantly in one sample and rarely in others. All specimens have the characteristic irregularly reticulate ornament except on the last chamber. The difference between the apertural characteristics and toothplates of Cushman's variety *ornata* and those of *C. subglobosa* Brady are considered to be sufficiently large to justify raising *ornata* to specific rank. Cushman (1934, p. 132) stated that the variety *ornata* does not seem to occur with the typical form, and may be of specific value.

The test of *G. ornata* is finely perforate, but the pore diameter has not been determined; the wall is granular in texture. A large narrowly folded toothplate is formed by infolding of the apertural face, attached to the previous apertural face near the outer margin of the septal foramen. The free edge is smooth, forming a narrow curved tooth in the broad aperture, which has a large lip along the inner margin.

Dimensions of figured specimens:	Maximum Diameter	Width
CPC 6535	0·42	0·34
CPC 6536	0·47	0·37

Occurrence: Figured specimens (CPC 6535 and 6536) from Pagansop village north-north-east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 21, 30.

G. ornata has been recorded as *Cassidulina subglobosa* var. *ornata*, ranging from middle Miocene to Pliocene; it also occurs in Recent deposits.

GLOBOCASSIDULINA GEMMA (Todd, 1954)
(Pl. 24, figs 22–25; Text-fig. 16: 11–12)

1954 *Cassidulina gemma* Todd, p. 366, pl. 90, figs 26–27.

Material examined: 20 specimens.

Rare specimens referred to *G. gemma* have been found in several of the present samples. Their appearance in front view is identical with that of the holotype and paratype, with the greatest width across the last pair of chambers. The species is described as having about six pairs of chambers forming the last whorl, but the holotype and paratype do not appear to have this number; the Papua-New Guinea specimens have three pairs of chambers visible. The present specimens also have numerous low striations around the apertural margin; this feature is indistinctly shown in the figures given by Todd but is not mentioned in the description. The specimen figured by LeRoy (1941*b*, Plate 6, figures 16–17) as *Cassidulina subglobosa* is in my opinion wrongly attributed and is most probably referable to *Globocassidulina gemma*. This specimen also shows the striations along the apertural margin.

The test is finely perforate and the wall is granular in texture; the pore diameter has not been determined. Each chamber has a toothplate formed by a narrow fold of the apertural face, attached at the base to the apertural face of the previous chamber and extending almost to the septal foramen, with the free edge forming an elongate tooth in the aperture. A small lip is developed along the inner apertural margin.

Dimensions of figured specimens:	Maximum Diameter	Width
CPC 6538	0·46	0·38
CPC 6539	0·51	0·42

Occurrence: Figured specimen (CPC 6538) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); figured specimen (CPC 6539) from Pagansop village, north-north-east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 31, 38, 40.

I have seen specimens from Papua-New Guinea which have been referred to *Cassidulina murrhyna* Schwager, but are identical with those here placed in *Globocassidulina gemma*. These two species have some similarity in outline of the test, but the chamber arrangement, apertural characteristics, and internal structure are quite different. It is not possible at this time to determine the vertical range of *G. gemma* in Papua-New Guinea.

GLOBOCASSIDULINA ORIANGULATA sp.nov.

(Pl. 25, figs 1–5; Text-fig. 16: 13–14)

Material examined: 41 specimens.

Diagnosis: A globose species with usually four pairs of chambers in last coil; sutures narrow, smooth, slightly curved; surface smooth; aperture trifid, with large triangular lip at outer margin; each chamber with narrowly folded internal structure reaching to septal foramen.

Description: Test globose, coiled biserial, circular in side view, oval in front view, periphery smooth or very slightly lobate. Usually four pairs of chambers in last coil, increasing very slowly in size as added. Sutures narrow, distinct, smooth, slightly curved; surface of test smooth. Test wall finely perforate, pore diameter not determined, granular in texture. Aperture narrow, trifid, in depression in apertural face, with large triangular lip attached to outer margin and narrow lip along basal margin. Each chamber with narrowly folded toothplate formed by fold of apertural face, extending to margin of septal foramen, free edge forming narrow elongate tooth in aperture.

Dimensions:

	Maximum Diameter	Minimum Diameter	Width
Holotype	0·37	0·32	0·31
Paratype	0·38	0·31	0·32

Occurrence: Holotype (CPC 6541) and paratype (CPC 6542) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 13b, 18, 27, 30, 31, 38, 40.

Some specimens which have been referred in unpublished reports to *Cassidulina subglobosa* are here referred to *Globocassidulina oriangulata* sp.nov.; but which records of *subglobosa* refer to *oriangulata* cannot be determined at this time.

Remarks: The trifid aperture of *G. oriangulata* resembles that of specimens referred by Nørvang (1958) to *Cassidulina subglobosa.* However, *G. oriangulata* has a well-developed toothplate and differs also in the outline of the test and the chamber shape. Other species with a trifid aperture, such as *G. crassa,* are more compressed than *G. oriangulata* and as far as is known lack a definite toothplate.

The specific name is from the Latin *oris,* mouth, opening, and *angulus,* corner, bend, referring to the shape of the aperture.

GLOBOCASSIDULINA ORIBUNDA sp.nov.

(Pl. 25, figs 6–10; Text-fig. 16: 15–16)

Material examined: 17 specimens.

Diagnosis: A large almost spherical species with 4 to 5 pairs of chambers in last coil; sutures narrow, smooth, undulating, surface smooth; aperture narrow, elongate, with smaller openings in apertural face; each chamber with small low internal structure.

Description: Test large, coiled biserial, almost spherical, with slightly lobate periphery. Four to five pairs of chambers in last coil, increasing only slowly in size as added. Sutures narrow, distinct, smooth and undulating, surface of test smooth. Test wall finely perforate, thick, granular in texture; pore diameter not determined. Aperture narrow elongate, extending obliquely into apertural face, with narrow lip along inner margin; also one to four smaller openings, possible supplementary apertures, in apertural face, in some specimens with slightly thickened margin. Each chamber with small, low, tightly folded toothplate formed by fold in apertural face, not reaching to septal foramen and attached to previous apertural face near smaller openings; free edge forming narrow elongate tooth in aperture.

Dimensions:

	Maximum Diameter	Width
Holotype	0·88	0·86
Paratype	0·61	0·65

Occurrence: Holotype (CPC 6544) and paratype (CPC 6545) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other locality: 40.

G. oribunda is not known to have been recorded previously from Papua-New Guinea.

Remarks: G. oribunda sp.nov. is distinguished from other large spherical species such as *Cassidulina pacifica* Cushman, by the undulating sutures and also by the apertural characteristics. No other described species of *Cassidulina* is known to have the smaller openings in the apertural face shown by *Globocassidulina oribunda.*

The specific name is from the Latin *oris*, mouth, opening, and *bundus*, increased quality, tendency toward, referring to the numerous openings in the apertural face.

Globocassidulina subglobosa (Brady, 1881)

(Pl. 25, figs 11–16; Text-fig. 17: 1–6; Text-fig. 18: 1–4)

1881 *Cassidulina subglobosa* Brady, p. 60.
1884 *Cassidulina subglobosa* Brady; Brady, p. 430, pl. 54, figs 17a–c.
1925 *Cassidulina subglobosa* Brady; Cushman, p. 54, pl. 8, figs 48–50.
1929*a* *Cassidulina subglobosa* Brady; Cushman, p. 100, pl. 14, figs 11a–b.
1951*b* *Cassidulina subglobosa* Brady; Hofker, p. 289, figs 196a–c, 197a–b, 198a–e, 199a–4.
1951 *Cassidulina subglobosa* Brady; Phleger & Parker, p. 27, pl. 14, figs 11–12.
1953 *Cassidulina subglobosa* Brady; Drooger, p. 140, pl. 24, fig. 13.
1954 *Cassidulina subglobosa* Brady; Cushman, Todd, & Post, p. 367, pl. 90, figs 30–32.
1960 *Cassidulina subglobosa* Brady; Barker, p. 110, pl. 54, figs 17a–c.
1964 *Cassidulina subglobosa* Brady; Parker, p. 624, pl. 99, fig. 29.

Material examined: 25 specimens.

Four specimens of *G. subglobosa* from 'Challenger' station 120, off Pernambuco, have been examined. The aperture of all specimens is the same as that of the holotype, a narrow elongate opening extending obliquely into the apertural face. A small lip is present on the basal margin of the aperture and a narrow tooth extends along its length near the opposite border. There is no indication of a tripartite aperture as figured by Nørvang (1958) in specimens identified as *Cassidulina subglobosa.* Each chamber has a well developed toothplate formed by the infolding of the apertural face, straight, narrowly folded, and pillar-like, extending to the border of the septal foramen. The free edge forms the elongate tooth in the aperture. No toothplate is shown by the specimens Nørvang figured as *Cassidulina subglobosa,* and these seem to be a different species.

Many specimens from Papua-New Guinea have the broad outline of the holotype; others are more oval in outline, approaching the shape of a specimen figured by Phleger & Parker (1951, Pl. 14, fig. 11). The more slender specimens have a larger and more elongate aperture than is usual in the broad form, but the internal structure and chamber shape of both types are identical. The toothplate of the Papua-New Guinea specimens has the same narrow pillar-like shape as that of the 'Challenger' specimens. The test of both fossil and Recent specimens is finely perforate, with an identical pore pattern, the pore diameter ranging from 1 to 1·5; the wall is granular in texture.

Dimensions of figured specimens:	Maximum Diameter	Width
CPC 6547	0·48	0·49
CPC 6548	0·56	0·45
CPC 6549	0·55	0·45

Occurrence: Figured specimens (CPC 6547 to 6549) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); found only in this sample.

Some specimens which have been referred in unpublished reports to *G. subglobosa* have a tripartite aperture different from that of the 'Challenger' specimens and in my opinion are not to be referred to *subglobosa.* They are described in this paper as *G. oriangulata* sp.nov.

G. subglobosa has been recorded as *Cassidulina subglobosa* from lower Miocene (Burdigalian) to upper Miocene, but as more than one species is involved in these records the correct range is not known; it also occurs in Recent deposits.

GLOBOCASSIDULINA OBLONGA (Reuss, 1850)
(Pl. 26, figs 1–4; Text-fig. 17: 7–8)

1850 *Cassidulina oblonga* Reuss, p. 376, pl. 48, figs 5a–b, 6a–b.
1925 *Cassidulina oblonga* Reuss; Cushman, p. 55, pl. 9, figs 19–22.
1958 *Cassidulina oblonga* Reuss; Nørvang, p. 35, pl. 8, fig. 17 (given in plate as *C. globosa* Reuss).

Material examined: 64 specimens.

Brady (1884) placed *oblonga* Reuss in the synonymy of *C. crassa* d'Orbigny, and Marks (1951) also considered the two species to be synonymous; these views are based on observed variation in external features. Cushman (1925) and Nørvang (1958) recognized the two species as valid.

Specimens from Papua-New Guinea referred to *G. oblonga* differ considerably from those placed in *crassa* in that they have a distinct toothplate formed by a fold in the apertural face; this fold is attached to the previous chamber and extends to a point near the base of the septal foramen, with a free edge forming a small tooth in the aperture. I have not observed the tripartite aperture recorded by Nørvang (1958) for *oblonga*. The wall of the test in the present specimens is finely perforate and is granular in texture.

Topotype specimens of *G. crassa* and *G. oblonga* must be compared to determine whether or not the two species are synonymous; in particular, information is required on the toothplate, if any, in such specimens. Meanwhile, specimens from Papua-New Guinea of the type figured are referred to *G. oblonga*.

Dimensions of figured specimens:	Maximum Diameter	Minimum Diameter	Width
CPC 6556	0·40	0·29	0·21
CPC 6557	0·35	0·26	0·20

Occurrence: Figured specimens (CPC 6556 and 6557) from west of Yangoru, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localities: 27, 30, 40.

G. oblonga has been recorded as *Cassidulina oblonga* from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

GLOBOCASSIDULINA CRASSA (d'Orbigny, 1839)

(Pl. 26, figs 5–9; Text-fig. 17: 9–10)

1839*b* *Cassidulina crassa* d'Orbigny, p. 56, pl. 7, figs 18–20.
1884 *Cassidulina crassa* d'Orbigny; Brady, p. 429, pl. 54, figs 4a–c, 5a–c.
1925 *Cassidulina crassa* d'Orbigny; Cushman, p. 54, pl. 8, figs 37–39.
1929*a* *Cassidulina crassa* d'Orbigny; Cushman, p. 100, pl. 14, figs 10a–b.
1930 *Cassidulina crassa* d'Orbigny; Cushman, p. 58, pl. 11, figs 6a–b.
1938 *Cassidulina crassa* d'Orbigny; Kleinpell, p. 331, pl. 12, figs 8a–b.
1949 *Cassidulina crassa* d'Orbigny; Cushman, p. 49, pl. 10, figs 2a–c.
1951 *Cassidulina crassa* d'Orbigny; Phleger & Parker, p. 26, pl. 14, figs 4a–b.
1953 *Cassidulina crassa* d'Orbigny; Todd, p. 5, pl. 2, figs 9a–b.
1958 *Cassidulina crassa* d'Orbigny; Nørvang, p. 36, pl. 8, figs 20a–c, 21a–c, 22a–c, 23a–c; pl. 9, figs 24a–c, 25a–c.
1960 *Cassidulina crassa* d'Orbigny; Barker, p. 110, pl. 54, figs 4a–c, 5a–c.

Material examined: 30 specimens.

Specimens of *C. crassa* from Papua-New Guinea are identical with topotype specimens from the Falkland Islands, in the collection of the Bureau of Mineral Resources. The specimens show a trifid aperture as figured by Nørvang (1958) and some also have a shallow groove leading from the aperture to the periphery. The wall of the test is finely perforate and is granular in texture, but the pore diameter has not been determined. Internally, each chamber has a low ridge along the upper margin of the aperture, formed by an inward fold of the apertural face, not reaching to the septal foramen.

Some figured specimens, such as those illustrated by Brady (1884) and Phleger & Parker (1951), show a very elongate aperture, but seem to fall within the range of variation given by Nørvang (1958). A tripartite aperture, or at least a groove in the apertural face, is shown by the specimen illustrated by Brady in figure 4.

Dimensions of figured specimens:	Maximum Diameter	Minimum Diameter	Width
CPC 6559	0·24	0·19	0·15
CPC 6560	0·22	0·19	0·13

Occurrence: Figured specimens (CPC 6559 and 6560) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 21, 31.

Specimens identified as *Cassidulina crassa* (?) have been recorded from middle Miocene to Pliocene.

GLOBOCASSIDULINA MURRHYNA (Schwager, 1866)
(Pl. 26, figs 10–13; Text-fig. 17: 11–12; Text-fig. 18: 5)

1866 *Sphaeroidina murrhyna* Schwager, p. 250, pl. 7, fig. 97.
1940 *Cassidulina cuneata* Finlay, p. 456, pl. 63, figs 62–66.
1946 *Cassidulina moluccensis* Germeraad, p. 72, pl. 2, figs 29–32.

Material examined: 39 specimens.

The biserial arrangement of the chambers is not mentioned in the original description of *G. murrhyna* by Schwager (1866), but the biseriality is evident from the type figure, which is an oblique side view. The aperture of the species is large, with a lip attached to the inner margin; this lip would, if well developed, leave a slit-like aperture such as was figured by Schwager. Comparison of the descriptions and figures given by Schwager (1866) and Germeraad (1946) leaves little doubt that both were dealing with the same species. The specimen figured by Cushman (1921) as *Cassidulina subglobosa* is at least very similar to *murrhyna* if not in fact referable to this species. Specimens of *G. cuneata* (Finlay) from a sample of Awamoan age collected between Whangara Beach and Tolaga Bay, New Zealand, have been examined, and also topotypes forwarded by Dr N. de B. Hornibrook of the New Zealand Geological Survey. The specimens have the same chamber arrangement and apertural characteristics as *G. murrhyna*, and also have a broad internal ledge above the aperture. In my opinion, *G. cuneata* is a synonym of *G. murrhyna*. Finlay noted that the New Zealand specimens had usually been identified as *murrhyna*, but referred to the 'produced beak-like last chamber' shown in the original figure of *murrhyna*. This appearance results from the oblique side view illustrated, and specimens of *G. cuneata* in the same orientation have the same appearance.

The specimen figured by Cushman & Todd (1945) as *Cassidulina murrhyna* is quite unlike the present specimens referred to that species, and more closely resembles specimens here placed in *G. subglobosa* (Brady). Cushman (1934, p. 131) recorded, but did not figure, *Cassidulina murrhyna*, and described this species as being 'much more pointed' in comparison with *C. subglobosa* Brady. Chapman (1915, p. 20) also recorded *C. murrhyna* (given as *C. nurrhyna*), but did not figure any specimens.

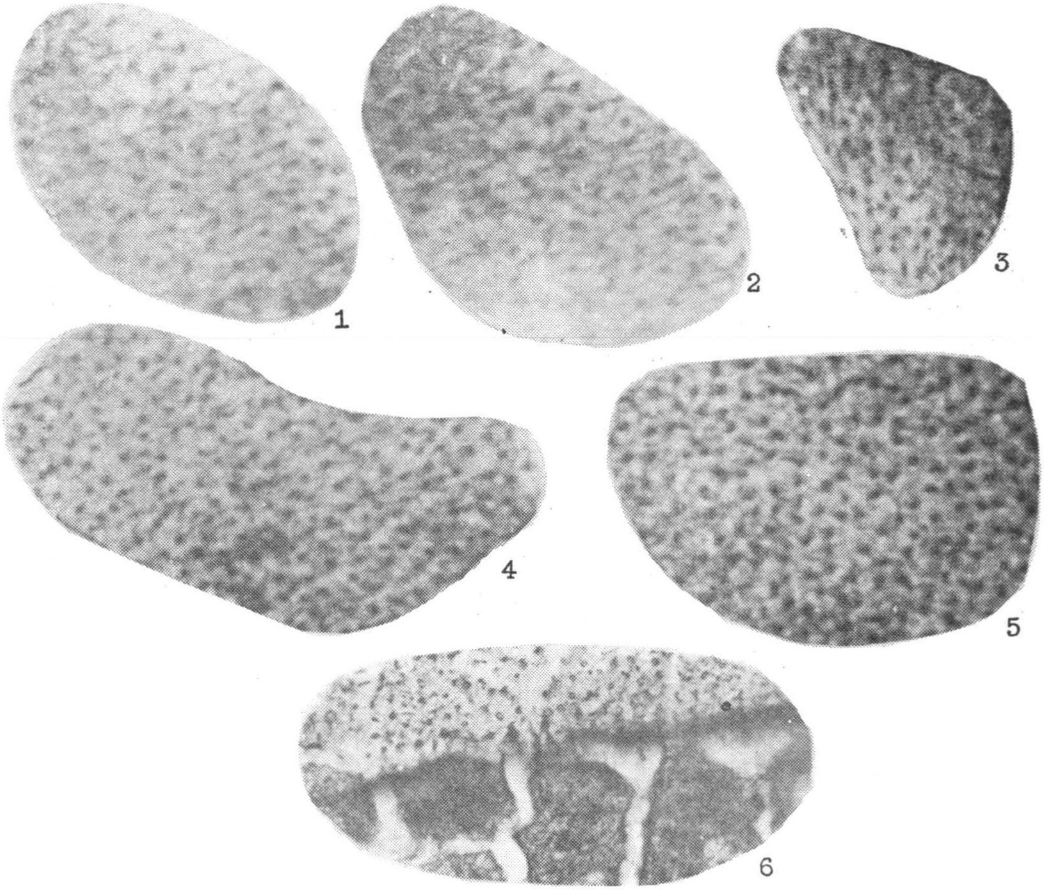
G. murrhyna occurs in several of the present samples. The test is finely perforate, but the pore diameter has not been determined; the wall is granular in texture. The apertural face is folded inwards to form a very broad ledge above the aperture, attached to the previous chamber but not reaching the septal foramen.

Dimensions of figured specimens:

	Maximum Diameter	Width
CPC 6562	0·45	0·38
CPC 6563	0·43	0·37

Occurrence: Figured specimens (CPC 6562 and 6563) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 27, 31, 38, 40.

G. murrhyna has been recorded as *Cassidulina murrhyna* from lower Miocene (Burdigalian) to upper Miocene. However, some specimens which have been referred to *murrhyna* are in my opinion *G. gemma* (Todd). It is not possible at this time to check all the reported occurrences of *G. murrhyna* to determine if the vertical range given is correct.



TEXT-FIGURE 18

Pores, all figures X 500

1–2	**CPC 6553**	*Globocassidulina subglobosa* **(Brady), 'Challenger' station 120.**
3–4	**CPC 6554 and CPC 6555**	*Globocassidulina subglobosa* **(Brady), locality 21.**
5	**CPC 6566**	*Globocassidulina murrhyna* **(Schwager), locality 21.**
6	**CPC 6534**	*Favocassidulina favus* **(Brady), locality 42.**

Globocassidulina bicornis (Brady, 1888)
(Pl. 25, figs 17–18)

1888 *Ehrenbergina bicornis* Brady, p. 5, pl. 1, figs 3a–b.

Material examined: 7 specimens.

Rare specimens of this distinctive species occur in one sample from Papua. Usually only one spine is developed at each side of the test, along the axis of coiling, but one specimen found has two spines. Preservation of the specimens is poor, the chambers being infilled, and it has not been possible to examine the finer details of the test. The aperture is similar to that of *Ehrenbergina*, an elongate slit parallel to the periphery, but the species is completely enrolled and not uncoiled as are species of *Ehrenbergina*.

Dimensions of figured specimen:

	Width (incl. spines)	Maximum Diameter
CPC 6567	0·95	0·45

Occurrence: Figured specimen (CPC 6567) from east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); found only in this sample.

G. bicornis has been recorded as *Cassidulina bicornis*, ranging from lower Miocene (Burdigalian) to upper Miocene. The records of this species from Papua are the only occurrences known to me away from Fiji.

Family NONIONIDAE Schultze, 1854

Subfamily CHILOSTOMELLINAE Brady, 1881

Genus Allomorphina Reuss, 1849

Allomorphina pacifica Hofker, 1951
(Pl. 30, figs 14–16)

1884 *Allomorphina trigona* Brady, p. 438, pl. 55, figs 24–26 (not of Reuss).
1951*b* *Allomorphina pacifica* Hofker, p. 138, figs 86a–f.
1960 *Allomorphina pacifica* Hofker; Barker, p. 112, pl. 55, figs 24–26.

Material examined: 7 specimens.

Rare specimens referred to *A. pacifica* occur in one sample. The internal structures called by Brotzen (1948, p. 128) 'septum inferior', 'pars reflecta' and 'crista', and figured by him in *A. halli* Jennings, are present in specimens of *A. pacifica*. The 'crista' is very low and narrow and is difficult to detect; the line of attachment of this feature may be observed externally. The 'septum inferior' is directed more to the umbilical margin of the septal foramen than is the case in *A. halli*; this structure is curved and is concave towards the aperture. The septal foramina are not divided into two openings as described by Brotzen (1948) for *A. halli*. The wall is granular in texture, but no pores have been observed.

Dimensions of figured specimen:

	Maximum Diameter	Height
CPC 6568	0·28	0·10

Occurrence: Figured specimen (CPC 6568) from Forsayth Plantation, Mushu Island, Sepik district, New Guinea (Pliocene); found only in this sample.

A. pacifica has been recorded as *A. trigona* Reuss, ranging from lower Miocene (Burdigalian) to upper Miocene; it also occurs in Recent deposits.

Genus QUADRIMORPHINA Finlay, 1939

The genus *Quadrimorphina* was originally defined as having four chambers to a whorl. The holotype of the species *Valvulineria laevigata* Phleger & Parker, here referred to *Quadrimorphina*, has between four and five chambers per whorl, as do all the Papua-New Guinea specimens examined. The number of chambers per whorl is not a generic feature, and on this basis there can be only a subjective distinction between *Quadrimorphina* and *Rotamorphina* Finlay. *Rotamorphina cushmani* Finlay, the type species of *Rotamorphina*, was described as deeply umbilicate, and in this feature differs from *Valvulina allomorphinoides* Reuss, the type species of *Quadrimorphina*. The chambers of *Quadrimorphina* increase rapidly in size and the final chamber forms a greater proportion of the test than it does in *Rotamorphina*. Parker (1954; 1958) referred *laevigata* to the genus *Rotamorphina*, comparing it to a species which she described as *Rotamorphina? involuta*. The features of these two species are in my opinion closer to *Quadrimorphina* than to *Rotamorphina*.

Phleger, Parker, & Peirson (1953) noted that *laevigata* has usually 5 chambers, and sometimes 4 or 6 in the adult whorl. They stated that the distinction between *Quadrimorphina* and *Rotamorphina* seems a rather arbitrary one, and that future investigation may lead to a combination of the two. Cushman & Todd (1949) discussed the genera *Quadrimorphina* and *Rotamorphina*, and considered that *Rotamorphina* is not related to the Allomorphininae, but is a synonym of *Valvulineria*. The difference between the *Allomorphina* and *Quadrimorphina* apertures was pointed out. The apertural difference between *Quadrimorphina* and *Rotamorphina* is clear, and is of more importance in separating these genera than the number of chambers to a whorl. However, I also consider that the granular wall of *Rotamorphina* justifies its separation from the radiate genus *Valvulineria*.

A more serious objection to the assignment of *laevigata* to the genus *Quadrimorphina* is the apparent absence of a definite internal structure. However, the test of this species is very fragile, and any internal structure may not have survived in the fossil specimens. Troelsen (1954, p. 470) observed faint traces of an internal partition in *Q. laevigata*. *Allomorphina* is another possible genus, but the question of whether or not it has an internal structure is not settled. At the present time I consider that *Quadrimorphina* is the most satisfactory generic assignment for *laevigata* and other species of this kind.

QUADRIMORPHINA LAEVIGATA (Phleger & Parker, 1951)
(Pl. 37, figs 21–25)

1951 *Valvulineria laevigata* Phleger & Parker, p. 25, pl. 13, figs 11a–b, 12a–b. (Synonymy).
1954 *Rotamorphina laevigata* (Phleger & Parker); Parker, p. 537, pl. 11, figs 10–11.

Material examined: 7 specimens.

Q. laevigata has been found only very rarely in samples from Papua-New Guinea. The figures published by Phleger & Parker show only dorsal and ventral views, but the species was described as having a broadly rounded periphery, as do the present specimens. The Papuan-New Guinea specimens are identical with specimens in a slide from 'Challenger' station 120, 80° 37′ S., 34° 28′ W., off Pernambuco, Brazil, at a depth of 675 fathoms, and also to specimens from an 'Endeavour' sample, 50 miles south-west of Cape Martin, South Australia, at 850 fathoms. The species was not figured by Brady, and was not recorded by Chapman (1915; 1941) or by Chapman & Parr (1937*a*), who examined Recent samples from the south-eastern and southern areas of Australia.

The test of the present specimens is very finely perforate, but the pore diameter has not been determined; the wall is granular in texture and the septal walls are single. The 'Challenger' specimens also have granular walls. No internal structure has been observed.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6569	0·31	0·16
CPC 6570	0·32	0·20

Occurrence: Figured specimen (CPC 6569) from east of Yekimbolje village, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); figured specimen (CPC 6570) from west of Yangoru, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other locality: 25.

Q. laevigata has not been recorded previously from Papua-New Guinea.

Genus ROTAMORPHINA Finlay, 1939

Loeblich & Tappan (1964a) placed *Rotamorphina* in the synonymy of *Valvulineria*, which has a radiate wall texture. Reiss (1958; 1963*b*) recorded a granular wall for *Rotamorphina*, which in the later paper was placed in the synonymy of *Quadrimorphina*. The synonymy of *Rotamorphina* with *Quadrimorphina* is not accepted here, and on the basis of the granular wall texture recorded by Reiss *Rotamorphina* is also considered be distinct from *Valvulineria*. I have examined the wall of a specimen of *Rotamorphina minuta* Finlay forwarded by N. de B. Hornibrook of the New Zealand Geological Survey, and it appears to be granular; unfortunately, the specimen is infilled with calcite, and this conclusion cannot be regarded as definite.

ROTAMORPHINA MINUTA (Schubert, 1904)

(Pl. 37, figs 11–15)

1884 *Discorbina rugosa* part, Brady, p. 652, pl. 91, figs 4a–c (not pl. 87, figs 3a–c) (not of d'Orbigny).
1904 *Discorbina rugosa* (d'Orbigny) var. *minuta* Schubert, p. 420.
1954 *Valvulineria minuta* Parker, p. 527, pl. 9, figs 4–6.
1960 *Valvulineria rugosa* (d'Orbigny) var. *minuta* (Schubert); Barker, p. 188, p. 91, figs 4a–c.

Material examined: 23 specimens.

R. minuta occurs commonly in one sample from New Guinea, and rarely in others. Short, thick projections of imperforate shell material attached to the umbilical apertural margin of each chamber extend over the wide deep umbilicus. The number of chambers visible from the ventral side ranges from 7 to 8. The test is very finely perforate, but the pore diameter has not been determined. The wall is granular in texture and the septal walls are single; no internal structure has been observed. Identical specimens, also with granular walls, occur in a slide from U.S.S. 'Hydrographer' station 37, 29° 25′ N., 86° 53′ W., off Pensacola, Florida, at a depth of 1602 feet.

Specimens of *R. minuta* are also present in a slide from an 'Endeavour' dredging, 50 miles south-west of Cape Martin, South Australia, at 850 fathoms. Earlier papers dealing with samples from the south and south-east coast of Australia, for example Chapman (1941) and Chapman & Parr (1937*a*), did not record this species.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6571	0·33	0·19
CPC 6572	0·29	0·16

Occurrence: Figured specimens (CPC 6571 and 6572) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 18, 40.

R. minuta has not been recorded previously from Papua-New Guinea.

Remarks: The coiling of the test, apertural characteristics, and granular wall texture place *minuta* in the genus *Rotamorphina*. The vertical range of *Rotamorphina* must be extended to the Recent; Finlay (1939) regarded it as an Upper Cretaceous genus.

There is no observable difference between the illustrations of the holotype and paratype of the species described by Parker (1954) as *Valvulineria minuta*, and the figures of Brady's specimen (1884). Parker did not investigate the wall structure of her species *minuta*, but considering the wide distribution now known for the species *Rotamorphina minuta* (Schubert), there is little doubt that Parker was dealing with the same species.

Subfamily NONIONINAE Schultze, 1854

Genus Florilus de Montfort, 1808

Florilus incisus (Cushman, 1926)

(Pl. 31, figs 5–7)

1926*b* *Nonionina incisa* Cushman, p. 90, pl. 13, figs 13a–c.
1939 *Nonion incisum* (Cushman); Cushman, p. 15, pl. 4, figs 6a–b.
1964 *Nonion incisum* (Cushman); Rau, p. 16, pl. 5, figs 9a–b.

Material examined: 51 specimens.

F. incisus has been found abundantly in samples from one area, but is otherwise rare. The specimens have deep umbilici, with the characteristic heart-shaped apertural face, and 11 to 12 chambers in the outer whorl. The sutures are deeply depressed around the umbilical margin, but are otherwise only slightly depressed. Some specimens are slightly papillate at the umbilical margin of the later chambers, as in *F. boueanus* (d'Orbigny), but the umbilici are never filled. *F. costiferus* (Cushman) is also similar, but has a more angulate periphery and more chambers in the outer whorl.

The test is very finely perforate, the pore diameter being about 1 micron; the wall is granular in texture and the septal walls are single.

Dimensions of figured specimens:	Length	Breadth	Thickness
CPC 6573	0·48	0·38	0·24
CPC 6574	0·45	0·32	0·21

Occurrence: Figured specimens (CPC 6573 and 6574) from the south-west flank of the Wira Anticline, Puri-Purari River area, Papua (upper Miocene, locality 14b); also known from other samples in this area, and from locality 15f.

F. incisus has been recorded as *Nonion incisum* from lower Miocene (Burdigalian) to Pliocene.

FLORILUS ELONGATUS (d'Orbigny, 1852)

(Pl. 31, figs 8–12)

1826 *Nonionina elongata* d'Orbigny, p. 128 (294). (nom.nud.)
1852 *Nonionina elongata* d'Orbigny, p. 155.
1904 *Nonionina elongata* d'Orbigny; Fornasini, pl. 3, figs 4, 4a.
1939 *Nonion elongatum* (d'Orbigny); Cushman, p. 11, pl. 3, figs 4a–b, 5a–b, 6.
1957 *Nonion elongatum* (d'Orbigny); Samaniego & Gonzales, p. 198, pl. 21, figs 7a–b.

Material examined: 12 specimens.

Specimens from Papua-New Guinea are identical with those figured by Cushman (1939), with the exception of the smaller number of chambers in the outer whorl, 11 to 12 as against 12 to 16 in topotype specimens. *F. elongatus* has been found in only one sample, but occurs abundantly. The test is very finely perforate, but the pore diameter has not been determined; the wall is granular in texture and the septal walls are single.

Dimensions of figured specimens:	Length	Breadth	Thickness
CPC 6575	0·36	0·24	0·15
CPC 6576	0·38	0·28	0·18
CPC 6577	0·41	0·31	0·19

Occurrence: Figured specimens (CPC 6575 to 6577) from road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

F. elongatus has not been recorded previously from Papua-New Guinea. *F. scaphus* (Fichtel & Moll) is recorded from several areas, ranging from lower Miocene (Burdigalian) to Pliocene. This species is in outline somewhat similar to *F. elongatus* but has unornamented umbilici; specimens here referred to *F. elongatus* may perhaps be included in the records of *F. scaphus*.

FLORILUS SUBTURGIDUS (Cushman, 1924)

(Pl. 31, figs 13–15)

1924 *Nonionina subturgida* Cushman, p. 47, pl. 16, fig. 2.
1939 *Nonion subturgidum* (Cushman); Cushman, p. 25, pl. 6, figs 29a–b.
1959 *Nonion subturgidum* (Cushman); Graham & Militante, p. 72, pl. 11, figs 3a–b.

Material examined: 8 specimens.

Rare, very small specimens of *F. subturgidus* have been found in one sample. All specimens have the characteristic final chamber extending the full length of the test, and there are 8 to 9 chambers in the outer whorl. The test is very finely perforate, but the pore diameter has not been determined; the wall is granular in texture and the septal walls are single.

Dimensions of figured specimens:	Length	Breadth	Thickness
CPC 6578	0·35	0·22	0·15
CPC 6579	0·30	0·18	0·12

Occurrence: Figured specimens (CPC 6578 and 6579) from road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

F. subturgidus has been recorded as *Nonionella? subturgida*, ranging from lower Miocene (Burdigalian) to Pliocene.

Genus NONIONELLA Cushman, 1926

NONIONELLA AMPLILABRATA sp.nov.

(Pl. 31, figs 16–20)

Material examined: 36 specimens.

Diagnosis: A small trochoid species, broadly rounded in edge view; chambers arranged in about $1\frac{1}{2}$ whorls, 8 to 9 in last whorl; sutures narrow, slightly curved, very slightly depressed; umbilicus covered by large lip; aperture interiomarginal.

Description: Test small, trochoid, oval in outline, periphery smooth in side view, broadly rounded in edge view. All chambers visible from dorsal side, 8 to 9 from ventral side. Chambers arranged in about $1\frac{1}{2}$ whorls, increasing rapidly in height but slowly in width as added. Sutures on both dorsal and ventral sides narrow, distinct, slightly curved, very slightly depressed. Umbilicus covered by large extension of final chamber, joining suture between penultimate and last chamber in sharp angle. Test wall very finely perforate, pore diameter not determined, granular in texture; septal walls single. Aperture a narrow interiomarginal slit on ventral side.

Dimensions:	Length	Breadth	Height
Holotype	0·28	0·18	0·11
Paratype	0·25	0·16	0·11

Occurrence: Holotype (CPC 6580) and paratype (CPC 6581) from road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); known only from this sample.

Nonionella amplilabrata sp.nov. has been recorded as *N.* sp. 2, occurring only in the Pliocene.

Remarks: N. amplilabrata resembles *N. turgida* (Williamson), but the final chamber of *amplilabrata* does not overlap the previous chambers as strongly as in *turgida*. The umbilical extension of the chamber is also smaller in *amplilabrata* than in *turgida* and is more strongly projecting over the umbilicus, with an angular junction with the suture between the penultimate and last chambers. Some specimens of *amplilabrata* have the umbilical chamber extension broken away.

N. amplilabrata is also similar to *N. auris* (d'Orbigny), particularly as figured by Drooger (1953), but the sutures of the later chambers of *amplilabrata* are not as strongly curved and the test is more upright; the umbilical chamber extension of *amplilabrata* is also proportionately larger. As figured by Cushman (1939) *auris* is a rounded inflated species with strongly curved sutures, and the umbilical extension of the last chamber does not completely cover the umbilicus.

The specimens figured by Goodwin & Thomson (1954) as *Nonionella miocenica* Cushman resemble *N. amplilabrata* in the nature of the umbilical extension of the chamber, but *amplilabrata* is a more compressed species with more upright coiling. As figured by Cushman (1939) *miocenica* is a more tightly coiled and thicker species than *amplilabrata*.

The specific name is from the Latin *amplus*, large and *labrum*, lip, referring to the large umbilical chamber extension.

NONIONELLA sp. A

(Pl. 31, figs 21–23)

One specimen only of a compressed trochoid species has been found, lacking the umbilical extension of the chamber, but otherwise referable to *Nonionella*; the extension has probably been broken during preservation. The test is oval in outline, with the periphery slightly lobate in side view and rounded in edge view. Nine chambers are visible from the ventral side and the sutures are curved and depressed; the aperture is a narrow interiomarginal slit on the ventral side.

I am not able to refer this specimen to any described species.

Dimensions of figured specimen:	Length	Breadth	Height
CPC 6582	0·34	0·25	0·11

Occurrence: Figured specimen (CPC 6582) from road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); found only in this sample.

No specimens of this type have been recorded previously from Papua-New Guinea.

Family ALABAMINIDAE Hofker, 1951

ALABAMINA TUBULIFERA (Heron-Allen & Earland, 1914)

(Pl. 27, figs 1–6; Text-fig. 22: 6)

1914 *Truncatulina tubulifera* Heron-Allen & Earland, p. 710, pl. 52, figs 37–40.
1951*b* *Alabamina tubulifera* (Heron-Allen et Earland); Hofker, p. 392, figs 271a–g; 272a–d, 273.
1954 *Epistominella tubulifera* (Heron-Allen and Earland); Cushman, Todd, & Post, p. 365, pl. 90, figs 20a–b.
1957 *Epistominella tubulifera* (Heron-Allen and Earland); Todd, p. 274 (tab.), 276, 278 (tab.), 283, 292 (tab.), pl. 84, figs 6a–c; pl. 92, figs 1a–c.
1959 *Epistominella tubulifera* (Heron-Allen and Earland); Graham & Militante, p. 110, pl. 18, figs 8a–b.
1964 *Epistominella tubulifera* (Heron-Allen & Earland); Huang, tab. 1, pl. 3, figs 1a–c, 2a–c.

Material examined: 27 specimens.

A. tubulifera occurs at several localities; the specimens show one feature which has not been described for the species, a distinct ridge on the ventral chamber wall parallel to and in front of the aperture, concealing to some extent the apertural opening. An indication of this ridge is shown on the ventral view of the holotype given by Heron-Allen & Earland (1914). Most specimens are smooth on the ventral side, but some have rows of pores along the sutures, occasionally forming tubular projections. Some specimens also have coarse pores in the wall of the later chambers, near the periphery, which may be developed into tubular projections. I have not observed pores of two sizes on the dorsal side, as figured by Hofker (1951*b*).

As pointed out by Hofker, the tubular projections ('wallets') surrounding the coarse pores on the dorsal side are formed after the chamber on which they occur; they appear only on chambers of the last whorl. No specimens found have any indication of tubular projections on the last chamber; there is here only a coarsely perforate area confined to the distal half of the dorsal chamber wall. The projections begin as a raised wall surrounding this porous area. On the earlier chambers of the last whorl the raised wall is more strongly developed until finally fusion occurs at several points, giving the appearance of coarse tubular projections. In the central area of the dorsal side single tubular extensions of chambers appear, extending through the thickened shell material and opening to the dorsal surface.

I agree with Hofker in assigning *tubulifera* to the genus *Alabamina*. The chambers have a distinct marginal prolongation and there is a peripheral depression in the plane of coiling associated with an infundibulum identical with that of species referred to *Alabamina*. The test is very finely perforate, the pore diameter being about 1 micron, and the wall is granular in texture, as in *Alabamina*. The genus *Epistominella* was stated by Reiss (1958) to have a radiate wall. I have not been able to demonstrate clearly that the septal walls of *Alabamina tubulifera* are bilamellid.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6583	0·45	0·23
CPC 6584	0·39	0·19

Occurrence: Figured specimens (CPC 6583 and 6584) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 1d, 3, 17, 31.

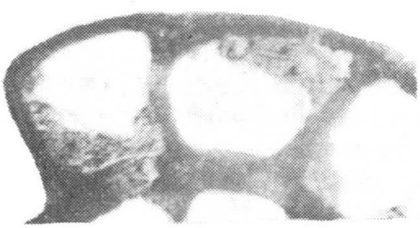
A. tubulifera has been recorded as *Eponides tubulifera*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Genus GYROIDINA d'Orbigny, 1826

Recent specimens from the North Atlantic, undoubtedly conspecific with specimens identified in numerous publications as *Gyroidina orbicularis* d'Orbigny have been examined. The wall is granular in texture, and is very finely perforate, the pore diameter being about 1 micron. The septal walls are double, a feature clearly observed only by examination of thin sections under reflected light. Reiss (1958;

95044—(7)

1959) recorded double septal walls in *Rotalina nitida* Reuss, the type species of *Gyroidinoides*, and later (1960) mentioned the possibility of *Gyroidinoides* being a synonym of *Gyroidina*, summarizing the views of other workers on the relationship of these genera. Smout (1956) did in fact observe double septal walls in *Gyroidina*, as he stated (p. 338) that the wall in section '. . . often appears to be triple, with a dark layer between two lighter ones'. The recognition of double septal walls in *Gyroidina orbicularis* removes one possible method of distinguishing between *Gyroidina* and *Gyroidinoides*; the original distinction, based on the open umbilicus and apertural lips of *Gyroidinoides*, cannot be maintained. *Gyroidina orbicularis* has both an umbilicus and a pseudoumbilicus as defined by Reiss (1960), although the pseudoumbilicus is much narrower than that of *nitida* and of other species of *Gyroidina*. An umbilical aperture is also shown by *G. orbicularis*, at least in the last chamber, and there is a small apertural and umbilical lip. Loeblich & Tappan (1964*a*, pp. C750, C753) stated that *Gyroidinoides* has a continuous aperture from the periphery to the umbilicus, and that *Gyroidina* has a primary interiomarginal aperture at the middle of the apertural face, with a small secondary umbilical aperture. A small extension of the lip dividing the aperture into two parts has been observed on both Recent and fossil specimens of *G. orbicularis*, but it is not a constant feature, and is not considered here to be of generic significance. Of nine Recent specimens observed, two have a divided aperture; the proportion is higher in fossil specimens, and at one locality (39) about 60 per cent. of the specimens have a divided aperture. Another species, here described as *Gyroidina torulus* sp.nov., has a continuous aperture on the final chamber, but three specimens have been observed to have a divided septal foramen. Internally, *Gyroidina orbicularis* has a small infundibulum, observed both in dissected specimens and in horizontal sections. Upper Cretaceous (upper Campanian) specimens from the *Belemnitella mucronata* zone, referred by Marie (1941) to *Gyroidina* aff. *nitida*, also have a distinct infundibulum.


1


2

TEXT-FIGURE 19

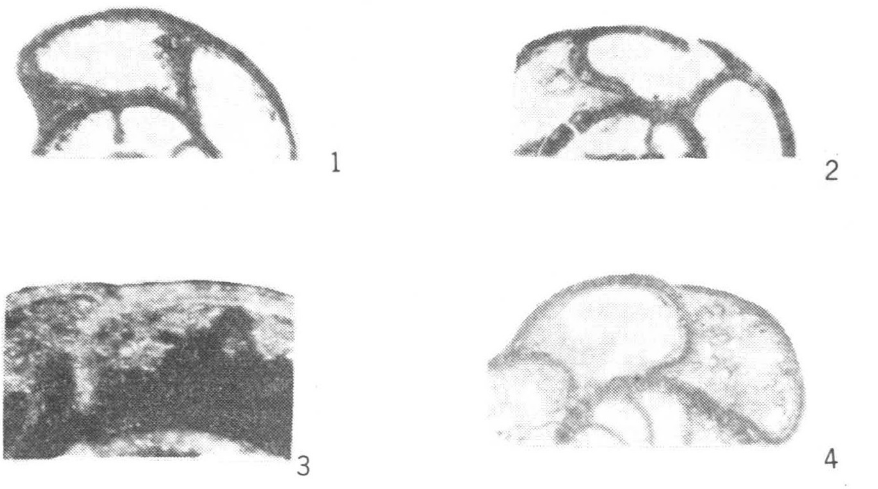
1–2 CPC 6588 *Gyroidina orbicularis* **d'Orbigny, from 'Goldseeker' haul 135, 61° 34′ N., 02° 04′ E., at 370 metres. 1, photographed in transmitted light, bilamellid structure not shown, X172. 2, photographed in reflected light, bilamellid structure clearly shown, X172.**

No infundibulum has previously been recorded in *Gyroidina* or *Gyroidinoides*, although published figures and observations indicate that it is present at least in *Gyroidinoides*. Smout (1956, p. 338) stated that *Alabamina*, *Gyroidina*, and *Gyroidinoides* do not have obvious toothplates. Hofker (1951*b*, p. 389) recorded a toothplate in *Alabamina*, but stated (pp. 15, 389) that it is obliterated in *Gyroidina*; it is obvious that Hofker regarded the 'infundibulum' of Brotzen (1948) as a toothplate.

Later (1956*a*, p. 944; 1957, p. 391) Hofker stated that internal toothplates have never been found in *Gyroidinoides*, but observed (1956*a*) a 'turning-in of the dorsal part of the apertural face', which clearly describes the method of formation of the infundibulum. Some sections of *Gyroidinoides nitida* illustrated by Reiss (1959, Plate 1, figures 5–6) also clearly show the infundibulum.

It is concluded here that the differences between *orbicularis* and *nitida* are merely differences of degree, with no taxonomic significance; *Gyroidinoides* is therefore considered to be a synonym of *Gyroidina*. This conclusion differs from that of Hofker (1951*b*, p. 399), who stated that these genera have no real relation with each other. Later, however, Hofker (1957, p. 377) referred both *Gyroidina* and *Gyroidinoides* to the family Alabaminidae.

The infundibulum now known to occur in the genus *Gyroidina*, the granular wall, and the apertural characteristics are here considered to indicate a relationship between this genus and *Alabamina*. The one morphological feature which cannot be definitely stated to be the same in both genera is the nature of the septal walls. Reiss (1958, 1960) examined specimens of *Alabamina wilcoxensis* Toulmin, the type species, from the Wilcox Formation of Alabama and the lower Eocene of Israel. The septa were stated to be single and the genus was placed in the superfamily Monolamellidea. Specimens of *A. australis australis* Belford and *A. australis obscura* Belford from the Upper Cretaceous of Western Australia have double septal walls. Should the type species of *Alabamina* prove to have double septal walls, other morphological features, such as the more strongly developed infundibulum, deep



TEXT-FIGURE 20

1–2 CPC 6589–6590 *Alabamina australis obscura* **Belford, Gingin Chalk, Upper Cretaceous, Western Australia, showing infundibulum; both X112.**

3 CPC 6591 *Alabamina australis australis* **Belford, Toolonga Calcilutite, Upper Cretaceous, Murchison River area, Western Australia. Photographed in reflected light, showing bilamellid structure. X222.**

4 CPC 6592 *Gyroidina noda* **Belford, Toolonga Calcilutite, Upper Cretaceous, Murchison River area, Western Australia, showing bilamellid septa and infundibulum. X94.**

peripheral depression, distinct marginal prolongation, and closed umbilicus, still enable a distinction to be made between *Alabamina* and *Gyroidina*. However, the differences are probably not of more than subgeneric significance.

This conclusion supports the views of Hofker (1951*b*, p. 390) who placed *Gyroidina* in the family Alabaminidae and later (1957, p. 377) also included *Gyroidinoides* in this family. Reiss (1960) also suggested that *Alabamina* may have to be included in *Gyroidina*, or relegated to subgeneric status. Hofker (1951*b*) derived *Gyroidina* from *Alabamina*, but this is not supported by the relative time of appearance of the two genera. Smout (1956) considered that records of *Gyroidina* (not including *Gyroidinoides*) could not be substantiated below the Turonian; with the inclusion of *Gyroidinoides* in the synonymy of *Gyroidina* this latter genus ranges from at least the Cenomanian. The earliest known occurrence of a species of *Alabamina* is in the Santonian. Present knowledge of stratigraphical occurrences therefore suggests that *Alabamina* is derived from *Gyroidina*.

GYROIDINA ORBICULARIS d'Orbigny, 1826

(Pl. 27, figs 7–14; Text-fig. 19: 1–2; Text-fig. 21: 1–5)

1826 *Gyroidina orbicularis* d'Orbigny, p. 278, model No. 13.
1884 *Rotalia orbicularis* d'Orbigny; Brady, p. 706, pl. 115, figs 6a–c (not p. 1107, figs 5a–c).
1915 *Rotalia orbicularis* d'Orbigny; Cushman, p. 68, text-figs 62a–c; pl. 29, figs 3a–c. (Synonymy).
1931 *Gyroidina orbicularis* d'Orbigny; Cushman, p. 37, pl. 8, figs 1a–b, 2a–b.
1951 *Gyroidina orbicularis* d'Orbigny; Phleger & Parker, p. 22, pl. 11, figs 11a–b, 12a–b.
1951 *Gyroidina orbicularis* d'Orbigny; Asano, pt 14, p. 8, figs 61–62.
1952 *Gyroidina orbicularis* (d'Orbigny); Bermudez, p. 49, pl. 6, figs 2a–c.
1954 *Gyroidina orbicularis* d'Orbigny; Parker, p. 528, pl. 9, figs 13, 18.
1960 *Gyroidina orbicularis* d'Orbigny; Barker, p. 238, p. 115, figs 6a–c.
1964 *Gyroidina orbicularis* d'Orbigny; Huang, tab. 1, pl. 4, figs 9a–b.
1964 *Gyroidina orbicularis* (d'Orbigny); Ishiwada, pl. 6, figs 88a–b.

Material examined: 80 specimens.

G. orbicularis occurs abundantly in several samples. The test is very finely and densely perforate, the pore diameter being about 1 micron. The wall is granular in texture and the septal walls are double, this structure being shown clearly by observation of thin sections under reflected light. A distinct infundibulum is developed, but is not as large as that of *Alabamina*. A small depression in the apertural face is associated with the infundibulum, but no distinct marginal prolongation is formed at the periphery.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6593	0·54	0·38
CPC 6594	0·55	0·37
CPC 6595	0·48	0·29

Occurrence: Figured specimens (CPC 6593 to 6595) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 17, 20, 25, 28, 36, 37.

Specimens of the type figured have been recorded as *Gyroidina orbicularis*, ranging from middle Miocene to Pliocene; they occur also in Recent deposits.

Remarks: The references given in the synonymy illustrate the variation of specimens of the type now generally accepted as representing *G. orbicularis.* Barker (1960) referred the specimen figured by Brady (1884) to *Gyroidinoides altiformis* (R. E. & K. C. Stewart). However, in my opinion, Brady's specimen does not agree with either the description or the original figure of *altiformis.* I have seen specimens of *G. altiformis* from the Pico Formation (upper Pliocene) of the Los Angeles Basin, California, which are plano-convex, with strongly oblique and raised dorsal sutures and a large umbilicus. Brady's specimen is distinctly biconvex, with the dorsal sutures not as oblique as those of *G. altiformis,* and the umbilicus smaller. The Papua-New Guinea specimens are identical with specimens from 'Goldseeker' haul 135, station 9, 61° 34′ N., 02° 04′ E., at 370 metres, and these in turn agree with Brady's figure, except that none has as large an umbilicus as indicated for that specimen. They also agree very closely with the figure given by Fornasini for *Gyroidina laevigata* d'Orbigny (*fide* Catalogue of Foraminifera). Barker (1960) quoted Fornasini as stating that *G. laevigata* and also *G. laevis* d'Orbigny are variations of *G. orbicularis.* The Papua-New Guinea specimens also resemble the specimen figured by Coryell & Rivero (1940, Pl. 43, figs 20, 28) as *Gyroidina laevis* d'Orbigny. Parker (1959) stated that *G. orbicularis* lacks a channelled spiral suture on the outer whorl, but Phleger & Parker (1951, p. 22) recorded this feature, which was said to be absent from young forms. Larger specimens from Papua-New Guinea have a channelled spiral suture on the last chambers; this is not caused by any change in the spiral suture itself, but is due to an extended dorsal margin of the last chambers reaching above the suture. I do not regard it as a specific feature.

GYROIDINA ACUTA Boomgaart, 1949

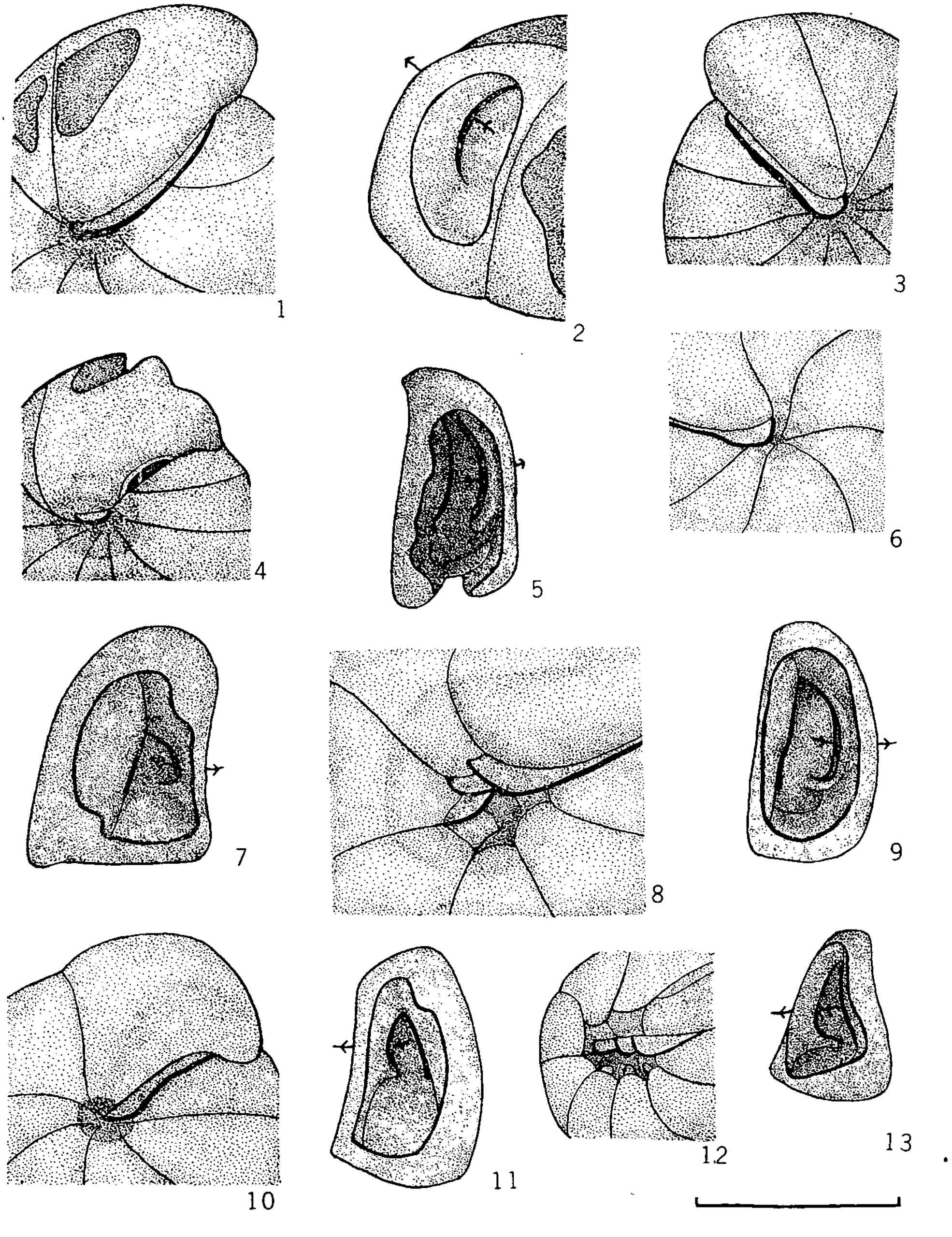
(Pl. 28, figs 1–9; Text-fig. 21: 6–7)

1941*b* *Gyroidina soldanii* LeRoy, p. 83, pl. 4, figs 19–21 (not of d'Orbigny).
1949 *Gyroidina neosoldanii* Brotzen var. *acuta* Boomgaart, p. 125, pl. 14, figs 1a–c.

Material examined: 28 specimens.

G. acuta has been found abundantly in one sample and rarely in another. Most specimens agree well with the figures given by Boomgaart (1949) but in some the later chambers move away from the dorsal side. Both an umbilicus and a narrow deep pseudoumbilicus are developed; the aperture is umbilical-extraumbilical, with small distinct umbilical lips. The test is very finely and densely perforate, the pore diameter being about 1 micron. The wall is granular in texture and the septal walls are double. An infundibulum is present, associated with a shallow depression in the apertural face and a small inframarginal sulcus.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6602	0·38	0·31
CPC 6603	0·38	0·33


1
2
3
4
5
6
7
8
9
10
11
12
13

Occurrence: Figured specimens (CPC 6602 and 6603) from Kisila Village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other locality: 7a.

Some records of *Gyroidina soldanii* d'Orbigny from Papua refer to specimens here identified as *G. acuta.*

GYROIDINA BROECKHIANA (Karrer, 1878)

(Pl. 29, figs 1–7; Text-fig. 21: 10–11)

1878 *Rotalia broeckhiana* Karrer, p. 98, pl. 5, fig. 26.
1884 *Rotalia broeckhiana* Karrer; Brady, p. 705, pl. 107, figs 4a–c.
1915 *Rotalia broeckhiana* Karrer; Cushman, p. 68, text-figs 61a–c; pl. 27, figs 4a–c (not pl. 70, figs 2a–c).
1951*b* *Gyroidina Broeckhiana* (Karrer); Hofker, p. 403, figs 281, 282a–b.
1960 *Gyroidina broeckhiana* (Karrer); Barker, p. 220, pl. 107, figs 4a–c.

Material examined: 43 specimens.

G. broeckhiana is a distinctive species characterized by the strongly biconvex test. Hofker (1951*b*) stated that the umbilical area is filled, but the present specimens, though they lack the pseudoumbilicus of other species of *Gyroidina* in Papua-New Guinea, have an 'umbilical depression' as defined by Reiss (1960). The aperture is interiomarginal, umbilical-extraumbilical, extending for two-thirds the length of the apertural face. The umbilical aperture is open only on the last chamber, and has a distinct narrow lip. The aperture is not as restricted as figured by Hofker (1951*b*); no double apertures or secondary apertures have been observed. The test is finely and densely perforate, the pore diameter being about 1 micron. The wall is granular in texture and the septal walls are double. Each chamber has a small marginal prolongation and an infundibulum is developed.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6608	0·51	0·36
CPC 6609	0·50	0·37

TEXT-FIGURE 21

1–2 CPC 6598 *Gyroidina orbicularis* **d'Orbigny, 'Atlantis' station 2993. 1, aperture and umbilicus; 2, infundibulum.**

3–5 *Gyroidina orbicularis* **d'Orbigny, locality 39. 3, CPC 6599, showing continuous aperture; 4, CPC 6500, showing divided aperture; 5, CPC 6601, infundibulum.**

6–7 *Gyroidina acuta* **Boomgaart, locality 39. 6, CPC 6606, aperture and umbilicus; 7, CPC 6607, infundibulum.**

8–9 *Gyroidina torulus*, **sp.nov., locality 27. 8, CPC 6619, aperture and umbilicus; 9, CPC 6620, infundibulum.**

10–11 *Gyroidina broeckhiana* **(Karrer), locality 21. 10, CPC 6612, aperture and umbilicus; 11, infundibulum.**

12–13 *Gyroidina cushmani* **Boomgaart, locality 13a. 12, CPC 6626, aperture and umbilicus; 13, CPC 6627, infundibulum.**

The scale represents 0·25 mm.

Occurrence: Figured specimens (CPC 6608 and 6609) from east of Amaimon, between the Gogol River and Amaimon, New Guinea (upper Miocene); other localities: 7a, 7b, 21.

G. broeckhiana has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

GYROIDINA TORULUS sp.nov.

(Pl. 28, figs 10–20; Text-fig. 21: 8–9)

Material examined: 81 specimens.

Diagnosis: A trochoid species, dorsal surface concave with raised central area, ventral surface convex; chambers in $1\frac{1}{2}$ to 2 whorls, 7 to 9 visible from ventral side; sutures narrow, distinct, straight, radial, usually smooth; infundibulum strongly developed; aperture interiomarginal, umbilical-extraumbilical.

Description: Test trochoid, dorsal surface usually concave with raised rounded central area above proloculus, rarely flat; ventral surface strongly convex. Circular in outline, periphery slightly lobate in top view, broadly rounded in edge view. Proloculus large, globular, usually followed by 11 to 14 chambers arranged in $1\frac{1}{2}$ to 2 whorls, rare specimens with up to 18 chambers, increasing slowly in size as added and overlapping on to dorsal side to form concave dorsal surface; 7 to 9 chambers visible from ventral side. Sutures narrow, distinct, on dorsal side straight and radial, at first smooth, later depressed; on ventral side straight, radial, smooth. Surface of test smooth. Test wall finely and densely perforate, pore diameter about 1 micron, granular in texture; septal walls double. Small marginal prolongation sometimes formed, usually absent; infundibulum strongly developed, associated with small depression in apertural face. Umbilicus wide, umbilical walls bent sharply towards axis of coiling to form narrow deep pseudoumbilicus. Aperture interiomarginal, umbilical-extraumbilical, with narrow lip along apertural face and triangular umbilical lips visible on as many as last three chambers; septal foramen sometimes divided into two parts by small fragile flap of shell material near umbilicus, attached to previous whorl.

Dimensions:

	Maximum Diameter	Height	Maximum Diameter of proloculus
Holotype	0·47	0·42	0·13
Paratype A	0·49	0·39	0·12
Paratype B	1·14	0·83	0·28

Occurrence: Holotype (CPC 6614) and paratype A (CPC 6615) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); paratype B (CPC 6616) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); found only in those two samples.

G. torulus is not known to have been recorded previously from Papua-New Guinea.

Remarks: Only megalospheric specimens of *G. torulus* have been found. They are similar to *G. girardana* (Reuss), but have a more rounded periphery in edge view and fewer chambers in the last whorl—7 to 9 as against 10 given for *G. girardana*—and the sutures on the ventral side are not curved as in the holotype of *girardana*.

Paratype B is a very large specimen of a type found at only one locality, in association with specimens identical with the holotype and paratype A. These large specimens vary in the convexity of the dorsal surface, and some, such as paratype B, are almost flat dorsally; they also have more chambers in the last whorl than do the holotype and paratype A. Most of the larger specimens have radial dorsal sutures; paratype B differs in having slightly curved dorsal sutures and has been selected to illustrate the extreme variation of specimens considered to be referable to *Gyroidina torulus* sp.nov.

The specimen figured by LeRoy (1953) as Gyroidina *girardana* closely resembles the larger specimens of *G. torulus*, but differs from the holotype, paratype A, and most other specimens. Cushman & Todd (1945) also figured a similar specimen as *Gyroidina girardana*, but it has more elongate and narrower dorsal chambers than does *G. torulus.*

The horizontal section figured (Pl. 28, fig. 19) is that of a large specimen similar to paratype B. The bilamellid septa are clearly shown and there also appears to be a radiate wall texture, caused by the perforation of the test. Petrological examination shows that many grains are radially arranged, but that smaller interspersed grains have other orientations and that the total arrangement of grains is random. Fragments of the wall do not give an extinction cross, and the wall is regarded as granular in texture. The wall texture of these specimens of *G. torulus* is similar to that observed in *Cibicides refulgens* Montfort.

The specific name is the Latin *torulus*, diminutive of *torus*, protuberance, bulge, referring to the raised central area of the dorsal surface.

GYROIDINA CUSHMANI Boomgaart, 1949
(Pl. 29, figs 8–16; Text-fig. 21: 12–13

1949 *Gyroidina cushmani* Boomgaart, p. 124, pl. 9, figs 9a–c.

Material examined: 52 specimens.

Specimens occurring commonly at several localities agree in all respects with the description given by Boomgaart (1949) for *G. cushmani* and are referred to that species. Two specimens of *G. cushmani* occur in a slide labelled 'Hilly country E. of Semarang, Java, upper course of Ngembrak River, between Larip and Karangasem, lower Miocene'. The larger specimen has a greater thickening of imperforate shell material around the umbilical margin than does any specimen from Papua-New Guinea, but the smaller specimen is identical in all respects. An amended description of the species is given here to include details of the apertural characteristics and the internal structure:

Test trochoid, plano-convex, dorsal surface flat or raised in central area, ventral surface strongly convex; periphery narrowly rounded. Proloculus globular, following chambers arranged in 2 to $2\frac{1}{2}$ whorls, increasing slowly in size as added, 7 to 9 chambers visible from ventral side. Umbilicus large, umbilical chamber walls bent sharply towards axis of coiling to form deep pseudombilicus. Sutures on dorsal side narrow, distinct, straight or only very slightly curved, oblique, at first smooth, later slightly depressed; on ventral side narrow, distinct, radial, slightly depressed except around umbilical margin, where they are deeply depressed, causing stellate appearance accentuated in some specimens by small knobs of clear shell material on umbilical chamber margins. Test very finely and densely perforate, pore diameter about 1 micron. Wall granular in texture, septal walls double. Surface of test smooth. Each chamber with small marginal prolongation and inframarginal sulcus, associated with well developed infundibulum. Aperture interiomarginal, umbilical-extraumbilical, with distinct umbilical lips visible on last 2 or 3 chambers.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6621	0·41	0·28
CPC 6622	0·48	0·34
CPC 6623	0·33	0·23

Occurrence: Figured specimens (CPC 6621 and 6623) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); figured specimen (CPC 6622) from the north-west flank of the Wira Anticline, Puri-Purari River area, Papua (upper Miocene locality 13a); other localities: 1d, 13b, 21, 30, 41.

G. cushmani has not been recorded previously from Papua-New Guinea.

Remarks: Boomgaart (1949) referred to the chambers on the ventral side as having 'knob-like thickenings around the open umbilicus'. This is a secondary effect not shown by all the present specimens. The stellate appearance of the umbilicus is caused primarily by the deeply depressed sutures and the sharp angle in the chamber wall at the umbilical margin. *Gyroidina basicrassata*, described by Bermudez (1949), has thickened umbilical margins as in *G. cushmani* Boomgaart, and may be a synonym of *cushmani.*

Genus ORIDORSALIS Andersen, 1961*

The apertural characteristics of the three species here referred to *Oridorsalis* differ from those given in the original generic diagnosis (Andersen, 1961). The primary interiomarginal ventral aperture is present, and the supplementary dorsal apertures; in addition, a supplementary umbilical aperture is developed to different degrees, and small openings occur on the ventral side along the suture between the penultimate and last chambers. Ventral sutural openings were recorded by Loeblich & Tappan (1964a) in the type species, *O. westi* Andersen. No reference was made

* The generic name *Oridorsalis* must be regarded as masculine in gender, although Andersen (1961) stated that it is neuter. Article 11f of the International Code of Zoological Nomenclature (1961) states that a genus-group name 'must be a noun in the nominative singular or be treated as such'. *Oridorsalis* may therefore be either masculine or feminine, but under the provisions of article 30 (a) (i) (2) must in this case be regarded as masculine.

in the original generic definition to internal structure, but both an infundibulum and a murus reflectus occur in the three species examined from Papua-New Guinea. The type species must be re-examined for these features; meanwhile, the morphological characteristics in common indicate that the present species are to be referred to the genus *Oridorsalis.*

Oridorsalis variapertura sp.nov.

(Pl. 29, figs 17–23; Text-fig. 22: 1–2)

Material examined: 66 specimens.

Diagnosis: A trochoid planoconvex species with broadly rounded periphery; proloculus large; sutures on dorsal side narrow, straight or slightly curved, reflexed, on ventral side narrow, sinuous; apertures multiple, primary aperture ventral interiomarginal, with supplementary umbilical aperture and openings along suture between last two chambers and on dorsal side along spiral suture; small marginal prolongation, depression at each apertural margin, murus reflectus distinct, infundibulum small.

Description: Test trochoid, plano-convex, circular in outline, periphery slightly lobate in top view, broadly rounded in edge view. Peripheral part of dorsal surface flat, central area raised; ventral surface strongly convex, with small umbilical hollow. Early chambers on dorsal side obscured by thickened shell material, proloculus as seen in thin section large. Later chambers visible for only 1 or $1\frac{1}{2}$ whorls, narrow and elongate; on ventral side triangular in shape, usually six chambers visible, increasing only slowly in size as added. Surface of last whorl on dorsal side narrow, smooth or slightly depressed, reflexed, straight or slightly curved; on ventral side narrow, slightly depressed, sinuous, with distinct bend near umbilicus. Test wall very finely perforate on both dorsal and ventral sides, pore index about 0·6 microns, granular in texture; septal walls double. Apertures multiple, primary aperture ventral interiomarginal, with narrow distinct lip; narrow supplementary umbilical aperture opening into umbilical hollow, several small circular openings along suture between penultimate and last chamber. On dorsal side small openings along spiral suture of last chamber clearly shown at inner proximal margin. Each chamber with small marginal prolongation, shallow depression in apertural face at both peripheral and umbilical margins of primary aperture, more distinct at umbilical margin. Murus reflectus well developed, distinct, infundibulum small.

Dimensions:

	Maximum Diameter	Height
Holotype	0·89	0·59
Paratype	0·77	0·54

Occurrence: Holotype (CPC 6628) and paratype (CPC 6629) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 18, 21.

O. variapertura sp.nov. has not been recorded previously from Papua-New Guinea.

Remarks: The coarsely granular test of *O. variapertura* makes the preparation of satisfactory thin sections difficult, and obscures details of the wall, particularly in transmitted light. Double septal walls have been observed only by the examination of thin sections under reflected light, which clearly shows the partings between the laminae.

No described forms similar to *O. variapertura* are known from the literature. The specimen figured by Cushman (1931, Pl. 8, figs 4a-c) as *Gyroidina soldanii* appears to be congeneric and possibly even conspecific with *variapertura*. A constriction is shown in the aperture of this specimen, but it is not clear if separate apertures are developed.

The specific name is from the Latin *varius*, different and *apertura*, an opening, referring to the multiple apertures.

ORIDORSALIS UMBONATUS (Reuss, 1851)

(Pl. 30, figs 1–6; Text-fig. 22: 4–5)

1851 *Rotalina umbonata* Reuss, p. 75, pl. 5, figs 35a–c.
1884 *Pulvinulina umbonata* Reuss; Brady, p. 695, pl. 105, figs 2a–c.
1921 *Pulvinulina umbonata* (Reuss); Cushman, p. 339, pl. 71, figs 1a–c.
1929*a* *Eponides umbonata* (Reuss); Cushman, p. 98, pl. 14, figs 8a–c.
1932 *Pulvinulina umbonata* (Reuss); Heron-Allen & Earland, p. 430, pl. 15, figs 16–18.
1940 *Eponides umbonata* (Reuss); Coryell & Rivero, p. 336, pl. 43, figs 21a–c.
1941*a* *Eponides umbonata* (Reuss); LeRoy, p. 39, pl. 2, figs 102–104.
1941*b* *Eponides umbonata* (Reuss); LeRoy, p. 84, pl. 3, figs 19–21.
1945 *Eponides umbonata* (Reuss); Cushman & Stainforth, p. 62, pl. 11, figs 4a–b.
1951 *Eponides umbonata* (Reuss); Phleger & Parker, p. 22, pl. 11, figs 10a–b, 13a–b, 14a–b.
1951 *Eponides umbonatus* (Reuss); Asano, pt 14, p. 12, figs 91–92.
1954 *Pseudoeponides umbonatus* (Reuss); Parker, p. 530, pl. 9, figs 20–21.
1957 *Eponides umbonatus* (Reuss); Todd, p. 268 (tab.), p. 274 (tab.), p. 275, p. 276, pl. 68, figs 9a–b.
1957 *Eponides umbonatus* (Reuss); Agip Mineraria, pl. 40, fig. 10.
1957 *Eponides umbonatus* (Reuss); Samaniego & Gonzales, p. 203, pl. 23, figs 8a–b.
1958 *Eponides umbonatus* (Reuss); Batjes, p. 146, pl. 7, figs 10a–c.
1960 *Eponides umbonatus* (Reuss); Barker, p. 216, pl. 105, figs 2a–c.
1964 *Eponides umbonatus* (Reuss); Ishiwada, pl. 6, figs 89a–b.
1964 *Pseudoeponides umbonatus* (Reuss); LeRoy, p. 39, pl. 7, figs 33–38.
1964 *Oridorsalis umbonatus* (Reuss); Parker, p. 626, pl. 99, figs 4–6.

Material examined: 46 specimens.

O. umbonatus occurs frequently in several samples. The apertural characteristics shown by Papua-New Guinea specimens have not been recorded in available literature. On the ventral side there are two apertures, one interiomarginal, with a distinct narrow lip, and a second umbilical, opening into a small umbilical hollow. Dorsally, small openings may occur along the spiral suture at the inner proximal margin of the chambers, but these have not been observed on all specimens. None of the present specimens have openings along the suture between the last two chambers, but I have seen specimens in other collections which show this feature. Parker (1964) recorded small openings in the sutures of *O. umbonatus*, close to the umbilicus.

LeRoy (1941*b*, Pl. 3, fig. 20) illustrated a continuous umbilical-extraumbilical aperture. Phleger & Parker (1951, Pl. 11, figs 10b, 13b) showed two independent apertures. Specimens of *O. umbonatus* figured by Samaniego & Gonzales (1947) have a distinct umbilical aperture, and other published figures also show this aperture.

The dorsal view given by Samaniego & Gonzales shows an opening on the spiral suture at the proximal margin of the last chamber. LeRoy (1964) also figured an umbilical aperture, and the dorsal sutural apertures.

The test is very finely perforate on both the dorsal and ventral sides, the pore diameter ranging from 0·6 to 1 micron, and the wall is granular in texture. The nature of the septal walls is difficult to observe, but examination of thin sections in reflected light indicates that they are bilamellid; Reiss (1960) stated that *umbonatus* has single septa. Internally there is a small distinct murus reflectus, but no definite depression appears in the apertural face. The infundibulum is very slightly if at all developed; no distinct inframarginal sulcus is shown by any specimen observed. However, Hofker (1956*a*, p. 950) recorded an indentation near the margin, said to falsely suggest an analogy with *Alabamina*.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6634	0·53	0·31
CPC 6635	0·44	0·29

Occurrence: Figured specimens (CPC 6634 and 6635) from a sample west of Yangoru, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localites: 7a, 16d, 16g, 18, 21.

O. umbonatus has been recorded as *Eponides umbonatus*, ranging from the lower Miocene (Burdigalian) to the Pliocene; it also occurs in Recent deposits.

Remarks: Parker (1954) referred *umbonatus* to the genus *Pseudoeponides* Uchio; supplementary apertures were obscured on the dorsal side, but the ventral apertures were said to be 'obscure'. However, the supplementary apertures of *Pseudoeponides japonicus* Uchio, the type species, are wholly different in their nature and position from those of *Oridorsalis umbonatus*. Hofker (1958) has shown that *Pseudoeponides japonicus* has rotaliid structure and is related to *Streblus* (=*Ammonia*); Reiss (1960, p. 4) agreed with this. Andersen (1961), discussing Parker's specimens, referred to the possibility of *umbonatus* being referred to the genus *Oridorsalis*.

ORIDORSALIS PAUCIAPERTURA sp.nov.
(Pl. 30, figs 7–13; Text-fig. 22: 3)

Material examined: 39 specimens.

Diagnosis. A trochoid biconvex species with broadly rounded periphery; proloculus large; sutures narrow, dorsally slightly curved and reflexed, ventrally almost radial; primary aperture interiomarginal, one or two rounded openings ventrally at umbilicus, occurring also along suture between last two chambers and dorsally on spiral suture at inner proximal chamber margin; small marginal prolongation, distinct infundibulum, very small murus reflectus.

Description: Test trochoid, almost equally biconvex, umbilicus closed; circular in outline, periphery slightly lobate in top view, broadly rounded in edge view. Early chambers on dorsal side indistinct, proloculus large in thin section, later chambers longer than wide; 5 to 6 chambers visible from ventral side, triangular in shape, increasing only slowly in size as added. Surface of test smooth. Sutures in last whorl on dorsal side narrow, smooth, slightly curved and reflexed; on ventral side narrow, smooth, slightly curved, almost radial, meeting in centre of test. Test wall very finely perforate on both dorsal and ventral sides, pore diameter 0·6 to 1 micron, granular in texture; septal walls double. Primary aperture ventral interiomarginal, a short wide slit midway between periphery and umbilicus; one or two rounded openings at umbilicus, also occurring along suture between penultimate and last chamber; on dorsal side small opening in some specimens on spiral suture, at inner proximal margin of last chamber. Each chamber with small marginal prolongation, associated with shallow inframarginal sulcus and distinct infundibulum; murus reflectus very small, not observed in all specimens.

Dimensions:

	Maximum Diameter	Height
Holotype	0·61	0·34
Paratype	0·55	0·33

Occurrence: Holotype (CPC 6639) and paratype (CPC 6640) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 23, 38.

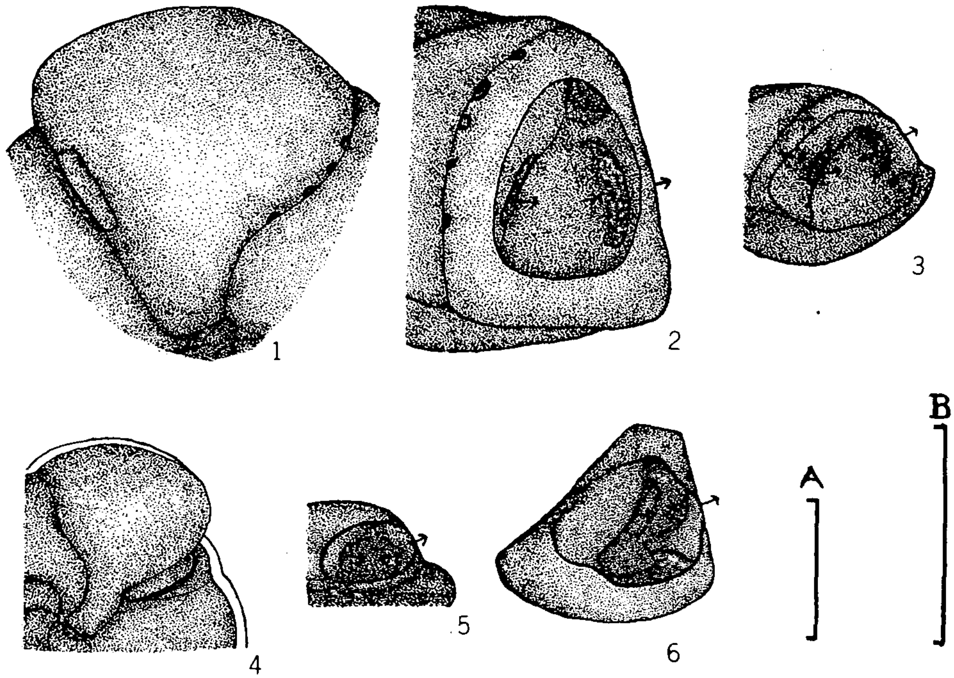
Previous references to *O. pauciapertura* sp. nov. from Papua-New Guinea are not known. A species recorded as *Eponides* sp. 4 is referable to the genus *Oridorsalis*; the few specimens examined are poorly preserved, but they lack the marginal prolongation and inframarginal sulcus of *pauciapertura* and do not seem to be referable to that species.

Remarks: The bilamellid septa of *O. pauciapertura* cannot be detected in transmitted light, and as with other granular species were observed by examination of thin sections under reflected light. The proloculus of *pauciapertura* is very large and globular, in thin sections prepared having a maximum internal diameter of 0·10 mm.

In *O. pauciapertura* the distinct umbilical aperture of *O. variapertura* and *O. umbonata* is replaced by small rounded openings, and the numerous small openings along the spiral suture in *variapertura* reduced to one opening at the proximal margin of the last chamber. *O. pauciapertura* also has a more distinct marginal prolongation of the chamber and a more strongly developed infundibulum, while the murus reflectus, if present, is very small. These differences are given specific significance only, and *pauciapertura* sp.nov. is considered to be congeneric with *Oridorsalis variapertura* and *O. umbonata*.

The specimen figured by Cushman (1934, Pl. 17, figs 1a-c) as *Eponides* species (?) has the general features of *Oridorsalis pauciapertura*, but the supplementary apertures were not recorded and it is not definitely referable to that species.

The specific name is from the Latin *paucus*, few, little, and *apertura*, an opening, referring to the few supplementary apertures.



TEXT-FIGURE 22

1–2		*Oridorsalis variapertura*, **sp.nov., locality 39. 1, CPC 6632, showing primary, umbilical and sutural apertures; 2, infundibulum and murus reflectus.**
3	CPC 6642	*Oridorsalis pauciapertura*, **sp.nov., locality 21. Infundibulum.**
4–5		*Oridorsalis umbonatus* **(Reuss). 4, CPC 6637, locality 31, showing primary and umbilical aperture; 5, CPC 6638, locality 163, showing small murus reflectus.**
6	CPC 6587	*Alabamina tubulifera* **(Heron-Allen & Earland), locality 21, showing infundibulum.**

Each scale represents 0·25 mm.

Figures 1–5 to scale A.

Figure 6 to scale 3.

Family OSANGULARIIDAE Loeblich & Tappan, 1964

Genus OSANGULARIA Brotzen, 1940

OSANGULARIA CULTER (Parker & Jones, 1865)
(Pl. 35, figs 1–5)

1865 *Planorbulina farcata* (Fichtel and Moll) var. *ungeriana* (d'Orbigny) subvar. *culter* Parker & Jones, p. 382, p. 421, pl. 19, figs 1a–b.
1929*a* *Pulvinulinella culter* (Parker & Jones); Cushman, p. 100, pl. 14, figs 13a–c.
1954 *Osangularia cultur* (Parker & Jones) [sic]; Parker, p. 530, pl. 9, figs 29–30.

Material examined: 31 specimens.

O. culter has been found in several samples. The test is granular in texture and finely perforate, but the pore diameter has not been determined. No indication of double septal walls has been observed in *O. culter*, but the bilamellid structure recorded by Reiss (1960) is confirmed on specimens of *O. bengalensis* (Schwager). Two apertures are developed in each chamber of *O. culter*, one areal and elongate, extending obliquely into the apertural face near the periphery, the other a rounded to oval opening near the umbilicus, often with a distinct neck and usually areal, but on some specimens reaching to the base of the apertural face. Both apertures remain open on earlier chambers. The murus reflectus is as described by Reiss (1960) and is drawn very strongly inward, attached not only to the previous coil at the proximal chamber margin but also to the proximal chamber wall (the previous apertural face) on the umbilical side of the small areal aperture.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6643	0·51	0·19
CPC 6644	0·47	0·17

Occurrence: Figured specimens (CPC 6643 and 6644) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other localities: 21, 30, 31, 38, 40.

O. culter has been recorded as both *Parrella culter* and *Osangularia culter*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

OSANGULARIA BENGALENSIS (Schwager, 1866)

(Pl. 35, figs 6–9)

1866 *Anomalina bengalensis* Schwager, p. 259, pl. 7, fig. 111.
1948*c* *Parrella bengalensis* (Schwager); Cushman, p. 13, pl. 2, figs 17a–c.

Material examined: 11 specimens.

Specimens of *O. bengalensis* have been found only rarely. It is a more heavily built species than *O. culter*, and biconvex, with more chambers per whorl and more reflexed sutures. Two apertures are developed in *bengalensis*, one an oblique areal aperture near the periphery and the second a smaller aperture near the umbilicus. This second aperture is low and interiomarginal, not areal as in *culter*, and is in the same position as shown by Reiss (1960) for specimens identified as *O.* cf. *bengalensis.* All specimens of *bengalensis* available are infilled and the murus reflectus has not been observed. The wall is granular in texture, but no pores have been observed; the septal walls are double.

Dimensions of figured specimen:	Maximum Diameter	Height
CPC 6645	0·79	0·41

Occurrence: Figured specimen (CPC 6645) from east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene, locality 7a); other localities: 7b, 11.

O. bengalensis has been recorded as both *Parrella bengalensis* and *Osangularis bengalensis*, ranging from lower Miocene (Burdigalian) to upper Miocene.

Family ANOMALINIDAE Cushman, 1927

Subfamily ANOMALININAE Cushman, 1927

Genus ANOMALINA d'Orbigny, 1826

ANOMALINA GLABRATA Cushman, 1924

(Pl. 32, figs 1–7)

1924 *Anomalina glabrata* Cushman, p. 39, pl. 12, figs 5–7.
1941*a* *Anomalina glabrata* Cushman; LeRoy, p. 45, pl. 1, figs 90–92.
1941*b* *Anomalina glabrata* Cushman; LeRoy, p. 88, pl. 3, figs 16–18.
1941*c* *Anomalina glabrata* Cushman; LeRoy, p. 119, pl. 2, figs 19–21.
1944*b* *Anomalina glabrata* Cushman; LeRoy, p. 92, pl. 6, figs 16–18.
1959 *Anomalina glabrata* Cushman; Graham & Militante, p. 115, pl. 19, figs 8a–c.
1960 *Anomalina glabrata* Cushman; Chang, p. 73, pl. 15, figs 4a–c, 5a–c, 6a–c.
1964 *Anomalina glabrata* Cushman; LeRoy, p. 43, pl. 6, figs 8–10.

Material examined: 27 specimens.

This small, widespread, and easily recognizable Indo-Pacific species occurs commonly at several localities. The test is densely perforate on both the dorsal and ventral sides, the pore diameter being 2 to 4 microns, and the wall is granular in texture. The nature of the septal walls is difficult to observe. The inner ends of the septa in horizontal section are thickened, and at this point there are indications of bilamellid structure; the septa are considered to be double. No internal structure is present. The aperture is in most cases wholly ventral, opening into the ventral umbilicus, but in rare specimens extends over to the dorsal side, remaining open on the last chamber only.

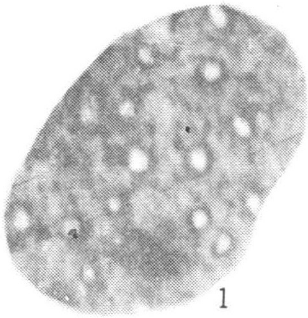
Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6647	0·40	0·17
CPC 6648	0·32	0·14

Occurrence: Figured specimens (CPC 6647 and 6648) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); other localities: 14a, 27.

A. glabrata has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Genus ANOMALINOIDES Brotzen, 1942

The wall texture of the type species of the genus *Anomalinoides*, *A. pinguis* (Jennings), is granular and the septal walls are double. The illustrations of the septal wall given by Belford (1960, p. 102) reproduced unsatisfactorily, and a section of another specimen is figured here (Text-fig. 23). The aperture of *A. pinguis* was stated to be on the ventral side, but is now regarded as dorsal. The same conclusion also applies to the new species of *Anomalinoides* described from the upper Cretaceous of Western Australia. The test of *A. pinguis* is wholly involute and is perforate on both the dorsal and ventral sides, the pore diameter being 6 to 8 microns. The synonymy of *A. pinguis* and *A. plummerae* Brotzen, apparently doubted by Reiss (1963*b*, p. 72) was discussed and confirmed by Brotzen (1948) with reference to notes by Plummer.



1

2

TEXT-FIGURE 23

1–2, ***Anomalinoides pinguis*** **(Jennings) Upper Cretaceous, Pecan Gap, Texas, U.S.A. 1, CPC 6651, pores, X500; 2, CPC 6652, part of horizontal section, showing bilamellid septa, X117.**

The record of radiate walls in species of *Anomalinoides* from the Upper Cretaceous of Western Australia (Belford, 1960) requires checking. This observation was based on thin sections, and although some indication of radiate texture can be seen, the total distribution of grains is probably random; if this is so the wall should be considered as granular in texture. Infilling of the chambers causes some difficulty in examination of fragments of the wall of these specimens.

Brotzen (1942, p. 23) distinguished between *Anomalina* and *Anomalinoides* on the apertural characteristics, that of *Anomalina* being peripheral and that of *Anomalinoides* peripheral and umbilical. Hofker (1956*a*, p. 943) noted that *Anomalina* never has umbilical apertures. However, Reiss (1958) doubted the existence of a genus *Anomalinoides*, as all specimens of *Anomalina* examined by him were found to have the apertural characteristics of *Amomalinoides.* The differences between *Anomalina* and *Anomalinoides* seem to be small, but the genus *Anomalinoides* is retained in this paper, as its synonymy with *Anomalina* has not yet been definitely demonstrated. Loeblich & Tappan (1964*a*) tentatively recognized both genera, *Anomalina* as based on the original figure and description.

ANOMALINOIDES COLLIGERUS (Chapman & Parr, 1937)

(Pl. 32, figs 8–15)

1884 *Anomalina ammonoides* Brady, p. 672, pl. 94, figs 2a–c, 3a–c (not *Rosalina ammonoides* Reuss).
1937*b* *Anomalina colligera* Chapman & Parr, p. 117, pl. 9, fig. 26.
1941*a* *Anomalina ammonoides* LeRoy, p. 45, pl. 2, figs 40–42 (not *Rosalina ammonoides* Reuss).
1944*b* *Anomalina ammonoides* LeRoy, p. 92, pl. 6, figs 19–24 (not *Rosalina ammonoides* Reuss).
1949 *Anomalina bradyi* Said, p. 41.
1950 *Anomalina colligera* Chapman & Parr; Parr, p. 362, pl. 15, figs 3a–c.
1960 *Anomalina colligera* Chapman & Parr; Barker, p. 194, pl. 94, figs 2a–c, 3a–c.
1964 *Anomalina bradyi* Said; LeRoy, p. 43, pl. 6, figs 12–14.

Material examined: 48 specimens.

A. colligerus occurs commonly in several samples. The Papua-New Guinea specimens are identical with specimens from 'Challenger' station 174d, 178° 10′ E., 19° 10′ S., off Kandavu, Fiji Islands at 210 fathoms, except that adult forms do not have a raised boss on the ventral side; this feature occurs only on some rare young specimens. Brady (1884) indicated that the 'Challenger' specimens varied in this feature, some being depressed at both umbilici, others being umbonate at one or both sides. Parr (1950) stated that Tasmanian specimens lack the umbilical boss shown by some tropical specimens. The lack of a raised umbonal plug is therefore not a valid basis for separation of the Papua-New Guinea specimens as a distinct species.

The test is coarsely perforate on the dorsal side, the pore diameter being 6 to 8 microns; very few specimens show pores on the ventral side, and then only rare, fine scattered pores on the last two or three chambers. The wall is granular in texture and the septal walls are double; the outer wall is clear and transparent and the inner lining dark and opaque, appearing in the figured horizontal section (Pl. 18, fig. 13) as a distinct dark line. No internal structure is developed. The aperture is interio-marginal, periphero-dorsal, open along the spiral suture for about one-half of the last whorl, with small distinct lips over the dorsal umbilicus.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6653	0·82	0·25
CPC 6654	0·78	0·23

Occurrence: Figured specimens (CPC 6653 and 6654) from west of Yangoru, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other localities: 1d, 27.

Anomalinoides colligerus has been recorded as *Anomalina* sp. 2, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Remarks: Anomalina flintii Cushman is similar to *Anomalinoides colligerus*, but is described and figured as coarsely perforate on both sides of the test and with a raised spiral suture on the dorsal side. *Anomalina inversa* Boomgaart is also similar, but has a subacute periphery and is coarsely perforate on both sides.

ANOMALINOIDES EVOLUTUS sp.nov.

(Pl. 34, figs 1–6)

Material examined: 18 specimens.

Diagnosis: A concavo-convex species, oval in outline, periphery narrowly rounded; chambers arranged in 1½ to 2 whorls, 11 to 13 in test; evolute to involute on dorsal side, evolute on ventral side; sutures curved, smooth or slightly depressed; aperture interiomarginal, with narrow lip.

Description: Test concavo-convex, dorsal surface concave, ventral surface convex, central part of ventral surface depressed; oval in outline, periphery lobate in side view, narrowly rounded in edge view. Proloculus large, globular, chambers arranged in 1½ to 2 whorls, with 11 to 13 chambers in test. Chambers on dorsal surface ranging from evolute to strongly and at times wholly involute, degree of involution increasing with greater concavity of dorsal surface; on ventral surface overlapping previous whorls to some extent, but never completely involute. All chambers visible from ventral side, number visible on dorsal side depending on degree of involution of test, 7 to 8 chambers in last whorl. Early chambers of last whorl often with coarse raised reticulate ornament around margin of pores, particularly on dorsal side, surface otherwise smooth. Sutures on both dorsal and ventral sides slightly curved, at first smooth, later narrow, distinct, depressed; spiral suture on ventral side depressed. Test wall perforate, on the dorsal surface pores oval in outline, pore diameter 8 microns, on ventral surface pores fewer, circular, on early chambers first developed in central part of test, later extending over entire chamber surface, diameter about 4 microns; granular in texture. Septal walls double, no internal structure developed. Aperture interiomarginal, with narrow lip, a low slit along peripheral and dorsal chamber margins.

Dimensions:

	Maximum Diameter	Height
Holotype	0·42	0·17
Paratype	0·45	0·19

Occurrence: Holotype (CPC 6658) and paratype (CPC 6659) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

A. evolutus sp.nov. has been recorded as *Anomalina* sp. 5, ranging from lower Miocene (Burdigalian) to middle Miocene.

Remarks: The coiling, apertural characteristics, granular wall texture and double septal walls of this species indicate that it is to be referred to the genus *Anomalinoides*. Both the holotype and the paratype are only slightly concave on the dorsal side and are clearly evolute.

The specific name refers to the coiling of the test.

ANOMALINOIDES CAVUS sp.nov.

(Pl. 33, figs 1–8)

Material examined: 25 specimens.

Diagnosis: A trochoid somewhat compressed species with broadly rounded periphery; umbilicus narrow, deep; chambers arranged in 1½ to 2 whorls, 8 to 11 visible from ventral side; sutures narrow, slightly curved, usually smooth; aperture interiomarginal, with umbilical lips.

Description: Test trochoid, somewhat compressed, oval in outline, with broadly rounded periphery. Chambers evolute but slightly overlapping dorsal side, early chambers on ventral side involute, later chambers becoming evolute, with narrow deep umbilicus, often exposing earlier chambers. Chambers arranged in 1½ to 2 whorls, increasing only slowly in size as added, 8 to 11 visible from ventral side. Sutures on both dorsal and ventral sides narrow, slightly curved, usually smooth, sometimes slightly depressed between younger chambers. Surface of test smooth. Test wall finely perforate, pore diameter on both sides ranging from 2 to 3 microns; granular in texture; septal walls double. No internal structure present. Aperture a narrow interiomarginal slit with small lips over umbilicus visible on several chambers, extending over to dorsal side, open on last one or two chambers only.

Dimensions:

	Maximum Diameter	Height
Holotype	0·59	0·22
Paratype	0·45	0·16

Occurrence: Holotype (CPC 6661) and paratype (CPC 6662) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); found only in this sample.

Anomalinoides cavus sp.nov. has not previously been recorded from Papua-New Guinea.

Remarks: *A. cavus* differs from *A. pinguis*, the type species, by having the aperture more strongly developed on the ventral side. The ventral umbilicus of *A. cavus* is similar to that of species of *Gavelinella*, but the aperture of this genus does not extend to the dorsal side. It is considered that the new species *cavus* is more correctly referred to the genus *Anomalinoides*.

The specific name is from the Latin *cavus*, hole, hollow, referring to the deep umbilicus.

Genus HETEROLEPA Franzenau, 1884

HETEROLEPA MEDIOCRIS (Finlay 1940)

(Pl. 23, figs 10–14; Text-fig. 15: 14)

1884 *Truncatulina ungeriana* Brady, p. 664, pl. 94, figs 9a–c (not of d'Orbigny).
1940 *Cibicides mediocris* Finlay, p. 464, pl. 67, figs 198–199.
1957 *Cibicides pseudoungerianus* Todd, p. 269 (tab.), p. 274 (tab.), p. 275, p. 276, p. 279 (tab.), p. 292 (tab.), pl. 71, figs 14a–c; pl. 80, figs 9a–b, 10a–c (not of Cushman).
1960 *Cibicides pseudoungerianus* Barker, p. 194, pl. 94, figs 9a–c (not of Cushman).
1964 *Cibicides pseudoungerianus* Ishiwada, pl. 8, figs 115a–b (not of Cushman).
1964 *Cibicides pseudoungerianus* LeRoy, p. 45, pl. 8, figs 13–15 (not of Cushman).

Material examined: 61 specimens.

Dr D. G. Jenkins of the New Zealand Geological Survey forwarded topotype specimens of *Cibicides mediocris* Finlay and the specimen figured by Brady (1884) is obviously conspecific with them. I have also seen specimens from the Bryam Marl which agree with the description of *C. pseudoungerianus* Cushman, and are here identified as this species; Brady's specimen has no resemblance to them and in my opinion should not be placed in the synonymy of *pseudoungerianus*. Finlay's species *mediocris* is here referred to the granular, bilamellid genus *Heterolepa*, as reinstated and defined by Loeblich & Tappan (1962*c*).

H. mediocris occurs commonly in a number of samples; the specimens are not as strongly convex on the dorsal side as those figured by Todd (1957). On the ventral side the number of chambers visible ranges from 10 to 13, the later chambers on some specimens becoming slightly evolute, with their inner margins depressed. The test is coarsely perforate on the dorsal side, the pore diameter usually being 6 to 10 microns, with some rare larger pores having a diameter of 14 microns. Rare specimens have pores on the ventral side, and on the later chambers only. Fragments of the wall show a typical granular appearance, but in thin section there are indications of a radiate arrangement of some grains, this orientation in some specimens being strongly developed. However, the overall distribution of the grains is obviously random and the wall is here regarded as granular in texture. The septal walls are double and no internal structure is present.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6666	0·83	0·30
CPC 6667	0·80	0·28

Occurrence: Figured specimens (CPC 6666 and 6667) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 7a, 13a, 21, 27, 31.

H. mediocris has been recorded as *Cibicides pseudoungerianus*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

HETEROLEPA CAVATA sp.nov.

(Pl. 34, figs 7–13)

Material examined: 17 specimens.

Diagnosis: A large trochoid plano-convex species with margin of clear shell material; chambers in 2 to $2\frac{1}{2}$ whorls, 9 to 11 visible from ventral side; dorsal sutures broad, smooth, or slightly depressed, ventral sutures narrow, at first smooth, later depressed; aperture interiomarginal, extending along spiral suture.

Description: Test large, trochoid, compressed, plano-convex, dorsal surface flat, ventral surface convex, periphery with margin of clear shell material, in side view lobate on later chambers, narrowly rounded in edge view. Chambers arranged in 2 to $2\frac{1}{2}$ whorls, increasing slowly in size as added, early chambers on dorsal side often obscured by shell material; 9 to 11 chambers visible from ventral side, with last 3 to 4 chambers becoming slightly evolute, forming small umbilical hollow, spiral groove formed along umbilical margin of evolute chambers. Sutures on dorsal side broad, curved, reflexed, slightly depressed on last one or two chambers, otherwise smooth; on ventral side narrow, distinct, at first smooth, later slightly depressed and on last one or two chambers strongly depressed, sometimes reflexed near periphery. Test wall perforate, pore diameter on dorsal side usually 5 to 6 microns, with some specimens having larger pores, diameter 10 to 12 microns, among smaller series; pores not developed on early chambers of last whorl on ventral side, appearing on later chambers, more sparsely developed than on dorsal side, diameter 3 to 6 microns, rare pores having a diameter of 10 microns, granular in texture. Septal walls double, no internal structure present. Aperture interiomarginal, periphero-dorsal, a thin slit with narrow lip, extending along spiral suture on dorsal side.

Dimensions:

	Maximum Diameter	Height
Holotype	0·93	0·32
Paratype	0·86	0·32

Occurrence: Holotype (CPC 6670) and paratype (CPC 6671) from a sample east of Karova Creek, Kerema-Karova Creek area, Papua (middle Miocene); other locality: 21.

Heterolepa cavata sp.nov. has been recorded as *Cibicides* sp. 4, ranging from the lower Miocene (Burdigalian) to the upper Miocene.

Remarks: The compressed test, granular wall texture and bilamellid septal walls indicate that this species may be referred to the genus *Heterolepa* as reinstated and defined by Loeblich & Tappan (1962*c*). Examination of the wall texture in thin section indicates that some larger grains have a radiate orientation, but the total grain distribution is random and the wall is therefore regarded as granular in texture.

H. cavata sp.nov. is distinct from other described species which have been referred to the genera *Planulina*, *Cibicides*, and *Eponides*, particularly in the evolute nature of the later chambers, the umbilical hollow, and the spiral groove on the ventral side. The specific name is from the Latin *cavatus*, hollowed out, referring to the ventral umbilical hollow.

Genus MELONIS de Montfort, 1808

MELONIS POMPILIOIDES (Fichtel & Moll, 1798)

(Pl. 30, figs 17–20)

1798 *Nautilus pompilioides* Fichtel & Moll, p. 31, pl. 2, figs
1884 *Nonionina pompilioides* Fichtel & Moll, sp.; Brady, p. 727, pl. 109, figs 10a–b, 11.
1929*a* *Nonion pompilioides* (Fichtel & Moll); Cushman, p. 89, pl. 13, figs 25a–b.
1939 *Nonion pompilioides* (Fichtel & Moll); Phleger, p. 1403, pl. 3, figs 3–4.
1939 *Nonion pompilioides* (Fichtel & Moll); Cushman, p. 19, pl. 5, figs 9a–b, 10, 11a–b, 12a–b. (Synonymy).
1941*b* *Nonion pompilioides* (Fichtel & Moll); LeRoy, p. 78, pl. 6, figs 28–29.
1948 *Nonion pompilioides* (Fichtel & Moll); Renz, p. 149, pl. 5, figs 31a–b, 32.
1950 *Nonion pompilioides* (Fichtel & Moll); Asano, pt 1, p. 4, figs 15–16.
1953 *Nonion pompilioides* (Fichtel & Moll); Bandy, p. 177, pl. 21, figs 12a–b.
1956 *Nonion pompilioides* (Fichtel & Moll); White, p. 247, pl. 27, figs 9a–b.
1958 *Nonion pompilioides* (Fichtel & Moll); Batjes, p. 141, pl. 6, figs 14a–b.
1958 *Nonion pompilioides* (Fichtel & Moll); Todd, p. 190, pl. 1, figs 11a–b.
1958 *Melonis pompilioides* (Fichtel & Moll); Voloshinova, p. 149, pl. 3, figs 1a–b.
1958 *Melonis sphaeroides* Voloshinova, p. 153, pl. 3, figs 8a–b, 9.
1959 *Nonion pompilioides* (Fichtel & Moll); Dieci, p. 55, pl. 4, figs 27a–b.
1960 *Nonion*(?) *pompilioides* (Fichtel & Moll); Barker, p. 224, pl. 109, figs 10a–b, 11.
1961 *Nonion pompilioides* (Fichtel & Moll); Bandy, p. 21, pl. 5, figs 12a–b.
1964 *Nonion pompilioides* (Fichtel & Moll); LeRoy, p. 27, pl. 10, figs 10–11.
1964 *Melonis pompilioides* (Fichtel & Moll); Parker, p. 626, pl. 100, figs 15–16.

Material examined: 15 specimens.

M. pompilioides occurs rarely in several samples. Boltovskoy (1958) noted that the main differences between *M. pompilioides* and *M. affinis* (Reuss) are the increase in width over the last 3 to 5 chambers, and the somewhat coarser perforation of *M. pompilioides*. However, the Papua-New Guinea specimens here referred to *M. pompilioides* have finer pores than *M. affinis*, the pore diameter being 3 to 4 microns. On some specimens the perforations in the early chambers of the outer whorl are surrounded by a raised ornament, giving an impression of coarse perforation. The wall is granular in texture and the septal walls are double. The two specimens figured show the observed extremes of the ratio between maximum diameter and thickness.

Voloshinova (1958) proposed the new name *Melonis sphaeroides* for the specimens figured by Brady as *Nonionina pompilioides*. In my opinion, Brady's specimens may be considered to fall within the range of variation of *pompilioides*, and a new name is not necessary for them.

Dimensions of figured specimens:

	Maximum Diameter	Thickness
CPC 6673	0·55	0·39
CPC 6674	0·51	0·49

Occurrence: Figured specimens (CPC 6673 and 6674) from the Masaweng River, north of Finschhafen, New Guinea (upper Miocene, locality 16f); other localities: 6, 12a, 16d, 161, 24.

M. pompilioides has been recorded as *Nonion pompilioides*, ranging from middle Miocene to Pliocene; it also occurs in Recent deposits.

Remarks: Nørvang (1959) discussed several species referred to *Nonion*, including *N. pompilioides*, *N. affine* (Reuss), and *N. barleeanum* (Williamson) and concluded that the only differences between them are the compression of the test and the size. These features were regarded as too variable to be valid criteria for specific differentiation, and Nørvang preferred to place all the species examined in the synonymy of *N. pompilioides*. Todd (1958) included *barleeanum* with *pompilioides* in population counts, stating that there may be two species, but that the differences are a matter of degree. Boltovskoy (1958) considered *barleeanum* to be close to *affine*, but was not able to examine either original material or topotypes. Both *pompilioides* and *affine* are recognized here, as all specimens of *pompilioides* observed are relatively broader, and the pore diameter is also different.

MELONIS AFFINIS (Reuss, 1851)
(Pl. 31, figs 1–4)

1851 *Nonionina affine* Reuss, p. 72, pl. 5, figs 32a–b.
1929*a* *Nonion affinis* (Reuss); Cushman, p. 89, pl. 13, figs 24a–b.
1939 *Nonion affine* (Reuss); Cushman, p. 9, pl. 2, figs 13a–b. (Synonymy).
1941*b* *Nonion affinis* (Reuss); LeRoy, p. 77, pl. 6, figs 26–27.
1948 *Nonion affine* (Reuss); Renz, p. 148, pl. 6, figs 3a–b.
1958 *Nonion affine* (Reuss); Batjes, p. 140, pl. 6, figs 12a–b.
1958 *Nonion affine* (Reuss); Boltovskoy, p. 195. (Synonymy).
1961 *Nonion affine* (Reuss); Kaasschieter, p. 203, pl. 11, figs 3a–b, 4a–b.
1964 *Melonis affinis* (Reuss); Parker, p. 626, pl. 100, figs 11–12.

Material examined: 30 specimens.

Abundant specimens of *M. affinis* occur in two samples. Boltovskoy (1958) placed many specific names in the synonymy of *affinis* after a study of specimens deposited in the collection of the United States National Museum and also the Cushman collection. The greatest difference shown by the present specimens is in the number of chambers in the outer whorl, ranging from 11 to 14, as against 10 to 11 reported by Boltovskoy for topotype specimens. From an examination of topotypes Boltovskoy reported that the aperture has 'an indistinct enlargement in the central part of the base of the apertural face'; this feature has not been observed in specimens from Papua-New Guinea. The ratio of maximum diameter to thickness of test for the present specimens ranges from 1·8 to 2·0, similar to the range of 2·0 to 2·3 recorded for topotype specimens. The observed differences between the Papua-New Guinea specimens and topotype material are small and a new specific name does not seem to be required.

The test is perforate, the pore diameter being 4 to 5 microns, and the wall is granular in texture; the septal walls are double.

Dimensions of figured specimens:

	Maximum Diameter	Thickness
CPC 6676	0·55	0·29
CPC 6677	0·39	0·20

Occurrence: Figured specimens (CPC 6676 and 6677) from east of Yekimbolje village, Maprik subdistrict, Sepik district, New Guinea (upper Miocene); other locality: 21.

Specimens here referred to *Melonis affinis* have been recorded as *Nonion nicobarense*, ranging from lower Miocene (Burdigalian) to Pliocene.

Subfamily ALMAENINAE Myatlyuk, 1959

Genus ANOMALINELLA Cushman, 1927

ANOMALINELLA ROSTRATA (Brady, 1881)

(Pl. 33, figs 9–13)

1881 *Truncatulina rostrata* Brady, p. 65.
1884 *Truncatulina rostrata* Brady; Brady, p. 668, pl. 94, figs 6a–c.
1914 *Truncatulina rostrata* Brady; Heron-Allen & Earland, p. 709, pl. 52, figs 33–36.
1954 *Anomalinella rostrata* (Brady); Cushman, Todd, & Post, p. 371, pl. 91, fig. 24.
1957 *Anomalinella rostrata* (Brady); Todd, p. 274 (tab.), 276, 279 (tab.), 282, 283, pl. 84, fig. 5.
1957 *Anomalinella rostrata* Brady; Daleon & Samaniego, p. 63, pl. 2, fig. 33.
1959 *Anomalinella rostrata* (Brady); Graham & Militante, p. 115, pl. 19, figs 9a–b. (Synonymy).
1959 *Anomalinella rostrata* (Brady); Bhatia & Mohan, pp. 658, text-fig. 6, figs 2a–b.
1960 *Anomalinella rostrata* (Brady); Barker, p. 194, pl. 94, figs 6a–c.
1964 *Anomalinella rostrata* (Brady); Le Roy, p. 44, pl. 6, figs 15–17.

Material examined: 31 specimens.

This distinctive species is widespread in the Indo-Pacific region; it occurs commonly in several of the present samples. The test is coarsely perforate, the pore diameter being 10 to 12 microns, and the wall is granular in texture. The septal walls are double; in thin section the outer wall is brown and opaque, the inner lining colourless and translucent. The supplementary peripheral aperture is open only on the last chamber; on earlier chambers it is closed by a porous plate which in time becomes fused with the chamber wall so that the outline of the aperture cannot be detected. No internal structure is present.

Dimensions of figured specimen:

	Maximum Diameter	Thickness
CPC 6679	0·77	0·42

Occurrence: Figured specimen (CPC 6679) from the sea-cliff, 250 yards north of the L.M.S. Mission, Delena, Papua (lower Miocene); other localities: 1d, 17.

A. rostrata has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Superfamily ROBERTINACEA Reuss, 1850

Family CERATOBULIMINIDAE Cushman, 1927

Subfamily CERATOBULIMININAE Cushman, 1927

Genus CERATOBULIMINA Toula, 1915

CERATOBULIMINA PACIFICA Cushman & Harris, 1927

(Pl. 36, figs 1–7; Text-fig. 24: 1–2)

1884 *Bulimina contraria* Brady, p. 409, pl. 54, figs 18a–b (not of Reuss).
1911 *Buliminella contraria* Cushman, p. 89, text-figs 143a–c (not of Reuss).
1927 *Ceratobulimina pacifica* Cushman & Harris, p. 176, pl. 29, figs 9a–c.
1941*a* *Ceratobulimina pacifica* Cushman & Harris; LeRoy, p. 42, pl. 1, figs 30–32.
1941*b* *Ceratobulimina pacifica* Cushman & Harris; LeRoy, p. 85, pl. 4, figs 34–35.
1944*b* *Ceratobulimina pacifica* Cushman & Harris; LeRoy, p. 89, pl. 17, figs 7–8.
1946 *Ceratobulimina pacifica* Cushman & Harris; Cushman, p. 113, pl. 18, figs 11a–c, 12–16. (Synonymy).
1951*b* *Ceratobulimina pacifica* Cushman et Harris; Hofker, p. 316, figs 214 (tab.), 215–217, 218a–d (given as fig. 219).
1960 *Ceratobulimina pacifica* Cushman & Harris; Barker, p. 112, pl. 54, figs 18a–b.
1964 *Ceratobulimina pacifica* Cushman & Harris; LeRoy, p. 40, pl. 9, figs 23–24.

Material examined: 76 specimens.

C. pacifica occurs commonly at several localities. The nature of the incomplete partition of each chamber of *Ceratobulimina* has been described by Troelsen (1954; 1955*b*) and Hofker (1951*b*; 1954). Troelsen stated that the septal foramen is secondary and lies on the peripheral side of the internal partition, while Hofker maintained that the areal part of each aperture remains as the septal foramen. My observations on *C. pacifica* support the conclusion of Troelsen. Cushman & Harris also considered that a small part of the aperture remained open in earlier chambers; as stated by Cushman & Harris, the plate closing the earlier apertures is a secondary structure. The lamination of the wall of a species of *Ceratobulimina* (s.l.) apparently was observed first by Cushman & Harris (1927) in *C. eximia* (Rzehak), which was referred by Troelsen (1954) to the subgenus *Ceratocancris* Finlay. In addition, specimens of *Ceratobulimina pacifica* from Papua-New Guinea have bilamellid septa, and the internal partition is also bilamellid. This feature was first observed on the walls of broken specimens, and later confirmed in thin sections. The internal partition is continuous with the wall of the corresponding chamber; its formation, as interpreted from thin sections, is shown in Text-figure 24, figure 2. Reiss (1958) placed *Ceratobulimina* in his superfamily Monolamellidea, but this should be confirmed by re-examination of *C. contraria*, the type species.

Chapman & Parr (1937*b*) first referred the specimen figured by Brady to *C. pacifica*; Cushman (1946) noted only that this specimen may belong to *C. pacifica.* There is no feature separating Brady's specimen from *C. pacifica*, and I follow the opinion of Chapman & Parr.

Dimensions of figured specimens:

	Maximum Diameter	Height
CPC 6682	0·69	0·43
CPC 6683	0·62	0·42

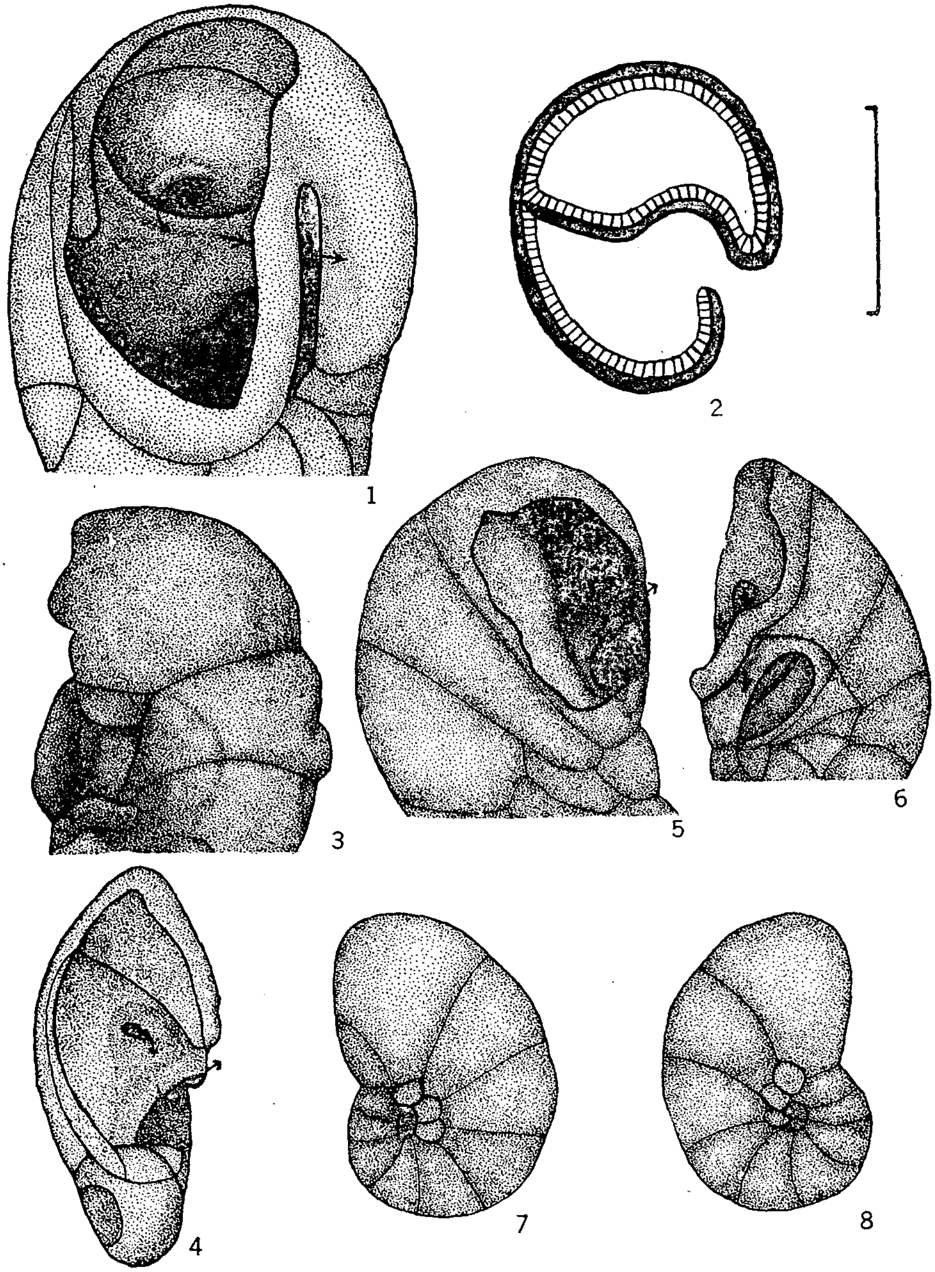
Occurrence: Figured specimens (CPC 6682 and 6683) from the Nuru Valley, New Guinea, between Diduella and Old Bauri, on hill with garden plot (upper Miocene); other localities: 38, 40.

C. pacifica has been recorded from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Genus LAMARCKINA Berthelin, 1881

The structure of the genus *Lamarckina* has been studied by Brotzen (1948) Hofker (1951*b*; 1956*b*) and Troelsen (1954). I have examined specimens of *L. scabra* (Brady), and agree with the observations of Troelsen, with some additional comments on the development of the test.

A large umbilical flap is developed on the last chamber of *L. scabra*, with an interiomarginal aperture along its inner edge. Hofker (1951*b*; 1956*b*, p. 108) considered this flap to be the toothplate of the next chamber, formed externally to the test, and stated that *Asterigerina* and *Lamarckina* are the only two genera known to have this feature. This view is not supported by my investigations, or by those of Troelsen (1954). The final chamber has an internal partition attached to the ventral wall, extending to the umbilical margin of the secondary septal foramen in the middle of the previous apertural face and running towards the periphero-dorsal angle of the final chamber, but not reaching it. The free edge has a small fold and is denticulate. It has not been possible, because of insufficient material, to determine the method of formation of the internal partition, but it is probably formed in the same way as that of *Ceratobulimina*, and other aragonitic genera, that is, by a fold of the chamber wall; a bilamellid structure has not been demonstrated. It can be shown that the internal partition forms the umbilical wall of all but the last chamber. The structure of the test indicates that when a new chamber is about to be added the entire ventral margin of the existing last chamber is resorbed, including the umbilical flap considered by Hofker to be the toothplate of the next chamber. The internal partition of the new chamber extends back to the distal margin of the internal partition of the previous chamber, which now forms the umbilical wall of that chamber. The line of junction between the old and new internal partitions is visible at this stage, but in earlier chambers is obscured. The new chamber again forms a large umbilical flap. Troelsen (1954, p. 451) stated 'when a new chamber is added, a thin plate . . . . closes the aperture and replaces part of the septum (the former apertural face) up to the base of the septal foramen'. This clearly describes the appearance of the test, and infers resorption of part of the chamber wall. The thin plate is the internal partition of the new chamber, closing the large opening left by the resorption of the ventral wall of the previous chamber, and leaving an areal secondary septal foramen at its peripheral edge. Troelsen also observed a thin plate sealing the 'vestibule under the short internal partition'; this again is the internal partition of the succeeding chamber. The partition of *L. scabra* is not attached to the spiral wall, as stated by Brotzen (1948, p. 122) for *Lamarckina*. Troelsen (1954) stated that *Lamarckina* has a rather small internal partition, and my observations indicate that it is not as strongly developed as that of *Ceratobulimina*.


1
2
3
5
6
4
7
8

LAMARCKINA SCABRA (Brady, 1884)

(Pl. 35, figs 15–17; Text-fig. 24: 3–4)

1884 *Pulvinulina oblonga* (Williamson) var. *scabra* Brady, p. 689, pl. 106, figs 8a–c.
1915 *Pulvinulina oblonga* (Williamson) var. *scabra* Brady; Cushman, p. 53, pl. 27, figs 5a–c.
1931 *Lamarckina scabra* (Brady); Cushman, p. 35, pl. 7, figs 6a–c. (Synonymy).
1951*b* *Lamarckina scabra* (Brady); Hofker, p. 313, figs 212a–b, 213.
1957 *Lamarckina scabra* (Brady); Agip Mineraria, pl. 39, fig. 2.
1960 *Lamarckina scabra* (Brady); Barker, p. 218, pl. 106, figs 8a–c.

Material examined: 9 specimens.

L. scabra is rare in the present material, and has been found in only two samples; all specimens are dextrally coiled. The umbilicus is wide and deep, with a sharp angle in the wall of the test at the umbilical margin; the umbilical wall is ornamented by small striae and pustules. The test is aragonitic in composition and radiate in texture, but the perforation of the test has not been observed. Details of the internal partition and chamber development of *L. scabra* have already been given.

Dimensions of figured specimen:

	Maximum Diameter	Height
CPC 6688	0·32	0·17

Occurrence: Figured specimen (CPC 6688) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other locality: 1d.

L. scabra has been recorded from the lower and upper Miocene; it also occurs in Recent deposits.

LAMARCKINA VENTRICOSA (Brady, 1884)

(Pl. 35, figs 10–14)

1884 *Discorbina ventricosa* Brady, p. 654, pl. 91, figs 7a–c.
1915 *Discorbis ventricosa* (Brady); Cushman, p. 22, text-figs 26a–c; pl. 13, figs 1a–c.
1931 *Lamarckina ventricosa* (Brady); Cushman, p. 34, pl. 7, figs 5a–c.
1950 *Lamarckina ventricosa* (Brady); Said, p. 8, pl. 1, fig. 21.
1960 *Lamarckina ventricosa* (Brady); Barker, p. 188, pl. 91, figs 7a–c.

Material examined: 6 specimens.

TEXT-FIGURE 24

1–2 *Ceratobulimina pacifica* **Cushman & Harris, locality 21. 1, CPC 6687, aperture and internal structure; 2, camera-lucida drawing of a section CPC 6685, across the final chamber, showing formation of the internal structure; outer lamina solid, inner lamina banded.**

3–4 CPC 6689 *Lamarckina scabra* **(Brady), locality 27. 3, umbilicus, flap of last chamber broken away, showing formation of the umbilical wall by the internal structure; 4, internal structure and septal foramen.**

5–8 *Geminospira bradyi* **Bermudez, locality 17. 5, CPC 6699, internal structure and septal foramen; 6, CPC 6700, showing main aperture opening into the corresponding secondary chamber; 7–8, CPC 6701, opposite sides of the same specimen, showing beginning of the secondary chambers.**

The scale represents 0·25 mm.

L. ventricosa occurs very rarely and has been found in only one sample; it is more rounded than *L. scabra*, with an inflated last chamber, and is more strongly pustulose on the dorsal side. The wall is aragonitic, and is radiate in texture; the pores have not been observed. Other morphological details are as given for *L. scabra*.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6690	0·39	0·25
CPC 6691	0·42	0·27

Occurrence: Figured specimens (CPC 6690 and 6691) from the 'Tubu Siltstone', Tubu area, Papua (upper Miocene, locality 1d); known only from this sample.

L. ventricosa is recorded from lower and upper Miocene; it also occurs in Recent deposits.

Subfamily EPISTOMININAE Wedekind, 1937

Genus HOEGLUNDINA Brotzen, 1948

HOEGLUNDINA ELEGANS (d'Orbigny, 1826)

(Pl. 36, figs 8–13)

1826 *Rotalia elegans* d'Orbigny, p. 276. (Figured Parker, Jones & Brady, 1871, pl. 12, fig. 142).
1884 *Pulvinulina elegans* d'Orbigny, sp.; Brady, p. 699, pl. 105, figs 3a–c, 4a–c, 5a–c, 6.
1915 *Pulvinulina elegans* (d'Orbigny); Cushman, p. 63, pl. 26, figs 3a–c. (Synonymy).
1927*e* *Epistomina elegans* (d'Orbigny); Cushman, p. 182, pl. 31, figs 1a–c, 2a–c, 3a–c, 4a–c, 5a–c; pl. 32, figs 1–3, 4a–b, 5a–b, 6a–b, 7–8. (Synonymy).
1931 *Epistomina elegans* (d'Orbigny); Cushman, p. 65, pl. 13, figs 6a–c. (Synonymy).
1941*a* *Epistomina elegans* (d'Orbigny); LeRoy, p. 40, pl. 1, figs 5–7.
1941*b* *Epistomina elegans* (d'Orbigny); LeRoy, p. 84, pl. 4, figs 13–15.
1944*a* *Epistomina elegans* (d'Orbigny); LeRoy, p. 35, pl. 3, figs 15–17.
1945 *Epistomina elegans* (d'Orbigny); Cushman & Todd, p. 59, pl. 9, figs 10a–c, 11a–b.
1948 *Höglundina elegans* (d'Orbigny); Brotzen, p. 92, pl. 17, figs 7–8.
1951*b* *Epistomina elegans* (d'Orbigny); Hofker, p. 375, figs 254–256, 257a–c.
1951 *Höglundina elegans* (d'Orbigny); Phleger & Parker, p. 22, pl. 12, figs 1a–b.
1951 *Epistomina elegans* (d'Orbigny); Asano, pt 14, p. 17, figs 130–131.
1952 *Höglundina elegans* (d'Orbigny); Bermudez, p. 57, pl. 8, figs 13a–c.
1953 *Höglundina elegans* (d'Orbigny); Bandy, p. 177, pl. 23, figs 9a–c.
1954 *Höglundina elegans* (d'Orbigny); Parker, p. 531, pl. 10, figs 4, 8.
1955 *Höglundina elegans* (d'Orbigny); Walton, p. 1009, pl. 103, figs 5, 14.
1956*b* *Höglundina elegans* (d'Orbigny); Hofker, p. 124, pl. 16, figs 9–14.
1957 *Epistomina elegans* (d'Orbigny); Agip Mineraria, pl. 41, fig. 10.
1957 *Epistomina elegans* (d'Orbigny); Samaniego & Gonzales, p. 204, pl. 23, figs 9a–c.
1958 *Epistomina elegans* (d'Orbigny); Batjes, p. 155, pl. 10, figs 2a–c.
1959 *Hoeglundina elegans* (d'Orbigny); d'Onofrio, p. 177, pl. 2, figs 10a–b.
1960 *Höglundina elegans* (d'Orbigny); Barker, p. 216, pl. 105, figs 3a–c, 4a–c, 5a–c, 6.
1961 *Epistomina elegans* (d'Orbigny); Hornibrook, p. 122, pl. 17, fig. 367.
1964 *Hoeglundina elegans* (d'Orbigny); LeRoy, p. 38, pl. 6, figs 27–28.

Material examined: 56 specimens.

H. elegans occurs abundantly in several samples. The test is aragonitic, and is radiate in texture, and the septa are bilamellid. The internal partition is as described by Brotzen (1948, p. 93) and thin sections indicate that it is formed by a fold of the chamber wall, as in *Ceratobulimina* and other aragonitic genera. The wall of the test is very finely perforate, with a pore diameter of about 0·4 microns.

Dimensions of figured specimens:	Maximum Diameter	Height
CPC 6692	0·73	0·38
CPC 6693	0·73	0·36

Occurrence: Figured specimen (CPC 6692) from Kisila village, east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); figured specimen (CPC 6693) from 2 miles east of Josefstaal, Lower Ramu-Atitau area, New Guinea (upper Miocene); other localities: 1d, 21, 22, 27, 40.

H. elegans has been recorded both as *Epistomina elegans* and *Hoeglundina elegans*, ranging from lower Miocene (Burdigalian) to Pliocene; it also occurs in Recent deposits.

Remarks: Hofker (1951*b*) described Pacific specimens in *H. elegans*, stating that the toothplates were of the same structure. The possibility that specimens from the two areas represented geographic subspecies was mentioned, as the test in Pacific specimens was stated to be less opaque than that of specimens from the West Indies. In the absence of comparative material the Papua-New Guinea specimens are here referred to *elegans*.

Family ROBERTINIDAE Reuss, 1850

Genus GEMINOSPIRA Makiyama & Nakagawa, 1941

Specimens which have often been recorded as the species described by Williamson (1858) as *Bulimina pupoides* d'Orbigny var. *convoluta* are here identified as *Geminospira bradyi*. A detailed description of this species is given below.

G. bradyi, which was figured by Brady (1884) from 'Challenger' Station 185 in Torres Strait as *Bulimina convoluta* Williamson, has been observed in slides from the following localities:

1. H.M.S. 'Penguin' Magnetic Shoal, off Port Walcott, N.W. Australia, 20° 32′ 35″ S., 117° 13′ 02″ E., at a depth of 8 fathoms.
2. Anchor mud, H.M.A.S. 'Moresby', 30 miles north-west of Bathurst Island at a depth of 65 fathoms.
3. Anchor mud, H.M.A.S. 'Moresby', north-west of Bathurst Island, no distance given, at a depth of 40 fathoms.
4. Kerimba Archipelago, Station 2a. (Given by Heron-Allen & Earland, 1914, as 'Maiyapa Bay. Bottom:—Sand, mud and coral. Depth 10 fathoms').

Specimens of *Geminospira* very similar to *G. bradyi* also occur in a slide labelled 'Pliocene, coralline crag, polyzoan sand 10 feet below polyzoan crag, Sutton, England (Prestwich)'.

The specific name *convoluta* (in Brady's sense) was retained by Makiyama & Nakagawa (1941) for specimens of this type, and they referred the species to their genus *Geminospira*. Cushman & Parker (1947, p. 77) considered that Brady's specimens were probably not specifically identical with Williamson's specimens and perhaps did not belong to *Pseudobulimina*. Bermudez (1952) then proposed the new name *bradyi* for *convoluta* Brady (not Williamson) and referred it to *Geminospira*,

The description of the genus *Alliatina* Troelsen (type species *Cushmanella excentrica* di Napoli Alliata) leaves little doubt that *Alliatina* is a synonym of *Geminospira*. No information is available on the internal structure of the type species of *Geminospira*, *G. simaensis* Makiyama & Nakagawa, but it is reasonable to assume that it has the same form as that of *G. bradyi*. Troelsen noted (1954, p. 465) 'It is possible that "*Bulimina*" *convoluta* Millett (non Williamson) and "*B.*" *nitida* Millett should be referred to *Alliatina*'. The only difference between the observations made by Troelsen and myself concerns the interiomarginal aperture. Troelsen stated that when a new chamber is added this aperture is closed; in *Geminospira bradyi* it is covered by the accessory chamber, but remains open, forming the means of communication between the main and accessory chambers. Troelsen's figures also show that the accessory chambers are not present on early parts of the test.

The specimens described by Cushman (1933*b*) as *Nonionella translucens* are considered to be specimens of *Geminospira* in which the secondary chambers have not developed. The aperture in particular suggests this, as it is figured as a narrow slit extending into the apertural face. Todd (1957; 1961) referred *translucens* to the genus *Alliatina*. Cushman, Todd, & Post (1954) and Graham & Militante (1959) retained it in *Nonionella*; the broken specimen figured by Graham & Militante has two small umbilical extensions and the septal foramen is above the base of the chamber. *Nonion glabrellum* Cushman also shows the features of *Geminospira*. LeRoy (1941*c*) figured a species of *Geminospira* as *Epistomina* aff. *convoluta* (Williamson). Huang (1963) described as *Paranonion oinomikadoi* specimens which in my opinion are young forms of *Geminospira*, with some showing the initial development of the secondary chambers.

The factors controlling the development of the secondary chambers are not known, but their formation does not appear to be related to the degree of maturity of the individual. Some specimens in the present material which have only the beginning of the secondary chamber series are larger than other specimens with a complete series. The type specimen of the variety described by Millett (1900) as *Bulimina convoluta* Williamson var. *nitida* is, from the magnifications given by Millett, as large as specimens with well-developed secondary chambers. These two forms may represent different generations. Specimens with secondary chambers seem to occur only rarely. Millett (1900) recorded 'typical' specimens abundantly at only one station and sparingly at a few others. Specimens described as the variety *nitida* were predominant at all except one station. Millett's variety *nitida* was referred doubtfully by Cushman & Parker (1947, p. 130) to *Cushmanella*. Heron-Allen & Earland (1914) recorded adult specimens as rare, with the variety *nitida* appearing to be confined to tropical waters. Hofker (1951*b*) found only two specimens, both with secondary chambers. For the present specimens the ratio between forms with well-developed secondary chambers and those without is about 1 to 3.

GEMINOSPIRA BRADYI Bermudez, 1952

(Pl. 37, figs 1–7; Text-fig. 24: 5–8)

1884 *Bulimina convoluta* Brady, p. 409, pl. 113, figs 6a–b (not *Bulimina pupoides* var. *convoluta* Williamson).
1900 *Bulimina convoluta* Millett, p. 279, pl. 2, figs 9a–c (not of Williamson).
1900 *Bulimina convoluta* var. *nitida* Millett, p. 280, pl. 2, figs 10a–c.
1942 *Pseudobulimina evoluta* Brotzen (sic), p. 36, fig. 16 (not *Bulimina pupoides* var. *convoluta* Williamson).
1949 *Pseudobulimina convoluta* Said, p. 26, pl. 4, fig. 4 (not of Williamson).
1951*b* *Pseudobulimina convoluta* Hofker, p. 386, figs 265, 266a–b, 267a–f (not of Williamson).
1952 *Geminospira bradyi* Bermudez, p. 80, pl. 13, figs 7a–b.
1959 *Geminospira bradyi* Bermudez; Graham & Militante, p. 90, pl. 13, figs 16a–b.
1960 *Pseudobulimina* sp.nov.(?) Barker, p. 232, pl. 113, figs 6a–b.

Material examined: 62 specimens.

Specimens referred to *G. bradyi* occur abundantly at one locality; they are undoubtedly conspecific with the specimens referred to *P. convoluta* by Hofker (1951*b*). My observations differ in some respects from those of Hofker, and in my opinion the internal partition is not as complicated as Hofker has indicated.

Hofker described the aperture as 'loop-shaped, ventrally situated, sutural'. I have observed two apertures, one an interiomarginal elongate slit and the other a small areal oval opening in the apertural face. The internal partition of the last chamber begins near the inner margin of the interiomarginal aperture, and is attached to the inner side of the apertural face, extending to the areal aperture. The base of the internal partition is attached to the apertural face of the previous chamber and extends to the peripheral margin of the septal foramen, whence it bends sharply back to reach the periphero-dorsal angle of the final chamber. A small free folded edge extends along the length of the upper border of the internal partition and encloses the areal aperture; this areal aperture, somewhat enlarged by resorption, forms the septal foramen. In earlier chambers the partition is reduced, first losing the free folded part and finally being reduced to a low ridge extending across the chamber. The partition neither forms part of the apertural face of the main chamber, nor the separating wall of the umbilical chamber part, as described by Hofker. The attachment of the partition to the inner side of the apertural face is visible externally as a thin line, but this cannot be taken to indicate that it forms part of the apertural face.

The accessory chambers are not visible on the earliest chambers. They first appear as small unconnected projections on both the dorsal and ventral sides, becoming larger in successive chambers until finally they meet and coalesce, forming one wall extending unbroken from the dorsal to the ventral side. The accessory chambers are subsequently formed, as stated by Hofker, and are 'held back' for one chamber, being formed simultaneously with the addition of a new chamber; the final chamber does not have an accessory chamber. Hofker stated that the attached part of the internal partition forms 'the sutures between the second chamber and that of the foregoing' and this is presumed to mean between the main and accessory chambers; I do not agree with this interpretation. The final chamber also has a small aperture on the dorsal side, which on earlier chambers is closed by a small plate; this plate is probably formed at the same time as are the accessory chambers.

95044—(8)

G. bradyi has an aragonitic radiate test and is very finely perforate, the pore diameter being about 0·4 to 0·6 microns. The septa are very thin and no indication of double septal walls has been observed. However, by analogy with other aragonitic genera examined it may reasonably be inferred that *G. bradyi* is in fact bilamellid.

Dimensions of figured specimens:	Length	Breadth	Height
CPC 6695	0·56	0·31	0·16
CPC 6696	0·30	0·19	0·11
CPC 6697	0·32	0·20	0·15

Occurrence: Figured specimens (CPC 6695 to 6697) from the road cutting at the new residence, north of the aerodrome, Madang, New Guinea (Pliocene); other locality: 27.

G. bradyi has not been recorded previously from Papua-New Guinea.

Remarks: It is not certain that *bradyi* is the correct specific name for the present specimens. As far as can be determined, the species *Bulimina convoluta* (Williamson) var. *dehiscens* Heron-Allen & Earland, 1924, and *Pulvinulina mayori* Cushman, 1924, are the earliest proposed names which may be prior synonyms of *bradyi.* The variety *dehiscens* Heron-Allen & Earland was referred by Cushman & Harris (1927) to *Ceratobulimina,* but has all the characteristics of *Geminospira* and was referred to this genus by Bermudez (1952). *Pulvinulina mayori* Cushman is also referable to *Geminospira* but Bermudez (1952) considered this species as probably synonymous with *Bulimina convoluta* Williamson.

Published synonymies indicate that *mayori* at least has priority over *bradyi* as the specific name for specimens of the present type. Cushman (1924) included *convoluta* of Millett (1900) in the synonymy of *mayori,* and also doubtfully the references of Egger (1893), Sidebottom (1918), and Heron-Allen & Earland (1914). Millett (1900) referred *Bulimina convoluta* of Brady (1884) and of Egger (1893) to synonymy. Graham & Militante (1959) included *convoluta* of Brady, Egger, Millett, and Heron-Allen & Earland in the synonymy of *bradyi.* If Cushman was correct in placing *convoluta* of Millett (1900) in the synonymy of *Pulvinulina mayori,* then *mayori* takes precedence over *bradyi* as a specific name. However, the variety *dehiscens* Heron-Allen & Earland was described before *mayori* Cushman, and must be the first to be considered. No specimens of *dehiscens* have been available for examination.

If neither of these names is found to be a prior synonym of *bradyi,* the species *Nonionella translucens* Cushman should be considered. Published figures of *translucens* are very similar to Papua-New Guinea specimens without secondary chambers.

A definite statement as to whether or not any of these species is a prior synonym of *bradyi* depends on a comparison of specimens. As no information is available and no decision can be made, the Papua-New Guinea specimens are for the present referred to as *Geminospira bradyi.*

Genus Robertinoides Höglund, 1947

The internal partition of *Robertinoides* was first described by Höglund (1947). The different structural elements of *R. oceanicus* (Cushman & Parker) occurring in Papua-New Guinea are as described by Höglund. However, I cannot observe any opening at the base of the 'arch', as figured by Höglund (Pl. 19, fig. 3). Only the distal apertural opening connects directly with the exterior of the test, and then only by way of the 'window' and 'lip tube'. The proximal apertural opening can be reached only by way of the 'window' and the canal between the lamellae forming the dividing partition of the chamber. The passage of protoplasm from the distal chamber part to the exterior of the test as shown by Troelsen (1954, p. 63, fig. 3) for *R. declivis* (Norman) suggests that this species has the same internal partition as does *R. oceanicus*. It should be noted that the protoplasm passes over and not under the arch. No internal opening of the canal between the two lamellae of the partition has been detected; Troelsen also could not observe this feature in *R. declivis*. The presence of such an opening in *R. normani* (Goes) was at least implied by Höglund (p. 225) in a discussion of routes to the exterior of the test. The small aperture at the rear of the test of *oceanicus* can be reached only by way of the 'window' and the narrow canal between the partition lamellae. *R. oceanicus* has a low opening at the base of the partition connecting the proximal and distal chamber parts; there is no indication of the plate recorded by Troelsen (1954) in *R. declivis*. Sections of Recent specimens show that the test is bilamellid and that the internal partition is formed by a fold in the wall of the test. Höglund (1947, p. 221) discussing *Robertina arctica* d'Orbigny, stated 'The complicated internal construction consists only of folds in the chamber . . . .'. Troelsen (1954, p. 262) discussing *Robertinoides declivis* expressed the view that the apertures and the internal partition 'are parts of one single fold of the outer test wall'. The walls of the partition between the two chamber parts are very thin, and I have not been able to observe the inner lining on this part of the test; the inner lining can be seen only to bend inwards at the margins of the partition.

Hofker (1951*b*) observed a small slit at the base of the toothplate near the distal aperture, but I cannot detect this feature on specimens from Papua-New Guinea, or on Recent specimens from New Zealand. Hofker also observed a small tube formed at one border of the internal partition, connecting the small opening at the rear of the test and proximal aperture. This feature has not been observed on any available specimens. The canal between the proximal aperture and small accessory aperture is interpreted here as being the space between the lamellae forming the dividing partition of each chamber. For most of its length this space is narrow, but the lamellae become widely separated towards the apertures where the 'lip tube' and 'window' are formed.

On the basis of the tube formed at one border of the toothplate Hofker compared the structure of *Robertinoides* with that of the more highly organized Bulimininae, and homologized the proximal aperture of *Robertinoides* with that of *Buliminella*. I do not accept these relationships, which do not take into account other important morphological features.

ROBERTINOIDES OCEANICUS (Cushman & Parker, 1947)

(Pl. 37, figs 8–10; Text-fig. 25: 1–2)

1947 *Robertina oceanica* Cushman & Parker, p. 75, pl. 18, fig. 18. (Synonymy).
1951*b* *Robertinoides oceanica* (Cushman & Parker); Hofker, p. 380, figs 258–261, 262a–b, 263a–c, 264a–c.
1960 *Robertina oceanica* Cushman & Parker; Barker, p. 104, pl. 50, figs 19a–b.

Material examined: 12 specimens.

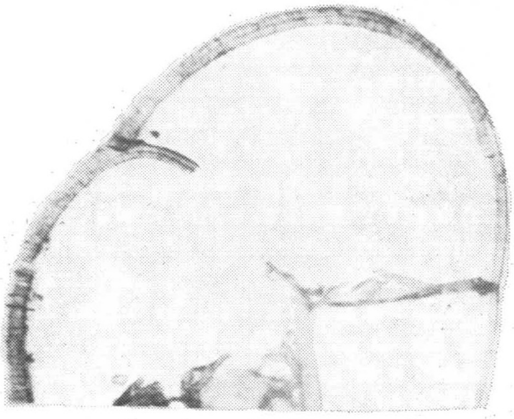
Rare specimens occurring in two samples from New Guinea are identical with specimens from a sample taken by the New Zealand Government Trawling Expedition, 1907, at Dredge Station C, 60 miles east of Lyttleton, New Zealand, at 100 fathoms. These specimens agree with the description of *R. oceanicus*, but the species is more variable than is indicated by Cushman & Parker. The length of the test of the Recent specimens ranges from 0·40 mm to 0·88 mm and the outline from sharply pointed and rapidly broadening to irregularly oval, as is the holotype of *oceanicus* and the figured New Guinea specimens. Cushman & Parker did not mention the small triangular aperture at the opposite side of the test from the two main apertures, but it is well-developed on both Recent and fossil specimens. The wall of the test is aragonitic and radiate in texture, and is very finely perforate, but the pore diameter has not been determined. Other morphological details have already been given.

Dimensions of figured specimens:

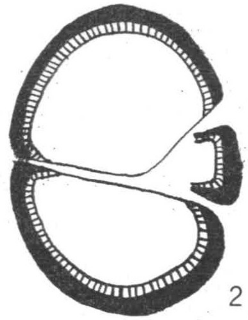
	Length	Maximum Width
CPC 6702	0·41	0·31
CPC 6703	0·36	0·23

Occurrence: Figured specimens (CPC 6703 and CPC 6702) from the Nagam River, west of Periama village, Wewak subdistrict, Sepik district, New Guinea (uppermost Miocene or Pliocene); other locality: 30.

Specimens identified as *Robertina* cf. *austriaca* Reuss have been recorded from the Miocene; these are probably the same as specimens here referred to *Robertinoides oceanicus.*



1



2

TEXT-FIGURE 25

1–2 *Robertinoides oceanicus* **(Cushman & Parker), from a sample taken by the New Zealand Government Trawling Expedition, 1907, at Dredge Station C, 60 miles east of Lyttleton, New Zealand, at 100 fathoms. 1, CPC 6704, photograph showing bilamellid structure in the last two chambers, and the partition of the last chamber, X158; 2, camera lucida drawing of a section, CPC 6705, across the final chamber, showing the outer and inner layers, the proximal and distal apertures, and the canal between the layers of the partition leading to the supplementary aperture at the rear of the test, X94.**

BIBLIOGRAPHY

The references indicated by * have not been seen; for the original reference to many species reliance has been placed on the Catalogue of Foraminifera.

AGIP MINERARIA MILAN, 1957—Foraminiferi Padani (Terziario e Quaternario). *Agip Mineraria.*

ALLAN, R. S., 1956—Report of the Standing Committee on datumplanes in the geological history of the Pacific Region. *Proc. 8th Pacif. Sci. Cong.*, 2 (1953), 325–423.

AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE, 1961—Code of Stratigraphic Nomenclature. *Bull. Amer. Assoc. Petrol. Geol.*, 45 (5), 645–665.

ANDERSEN, H. V., 1961—Genesis and paleontology of the Mississippi River mudlumps, part II, Foraminifera of the mudlumps, Lower Mississippi River delta. *Geol. Bull. N. Orleans*, 35, 1–208.

ANGLO-PERSIAN OIL COMPANY, 1930—The oil exploration work in Papua and New Guinea, 1920–1929, Vols. 1–4. *London, Harrison and Sons, Ltd.*

*ASANO, K., 1938—On the Japanese species of *Bolivina* and its allied genera. *J. geol. Soc. Japan*, 45 (538).

ASANO, K., 1950—Illustrated catalogue of Japanese Tertiary smaller Foraminifera: part 1, Nonionidae; part 2, Buliminidae. Compiled and edited by L. W. Stach. *Tokyo, Hosokawa Printing Co.*

ASANO, K., 1951—Illustrated catalogue of Japanese Tertiary smaller Foraminifera; part 13, Anomalinidae; part 14, Rotaliidae. Compiled and edited by L. W. Stach. *Tokyo, Hosokawa Printing Co.*

ASANO, K., 1952—Illustrated catalogue of Japanese Tertiary smaller Foraminifera: supplement No. 1. Compiled and edited by L. W. Stach. *Tokyo, Hosokawa Printing Co.*

ASANO, K., 1958—The Foraminifera from the adjacent seas of Japan, collected by the S.S. Soyomaru, 1922–1930. Part 4, Buliminidae. *Sci. Reps. Tohoku Univ.*, 2nd ser. (Geol.), 29, 1–41.

AUSTRALASIAN PETROLEUM COMPANY, 1961—Geological results of petroleum exploration in Western Papua, 1937–1961. *J. geol. Soc. Aust.*, 8 (1), 1–133.

BANDY, O. L., 1952—The genotype of *Siphogerina*. *Contr. Cushman Fdn*, 3 (1) 17–18.

BANDY, O. L., 1953—Ecology and paleoecology of some California Foraminifera. Part 1: The frequency distribution of Recent Foraminifera off California. *J. Paleont.*, 27 (2), 161–182.

BANDY, O. L., 1954—Aragonite tests among the Foraminifera. *J. sediment. Petrol.*, 24 (1), 60–61·

BANDY, O. L., 1961—Distribution of Foraminifera, Radiolaria and Diatoms in sediments of the Gulf of California. *Micropaleontology*, 7 (1), 1–26.

BANDY, O. L., 1963—Larger living foraminifera of the continental borderland of Southern California. *Contr. Cushman Fdn*, 14 (4) 121–126.

BANDY, O. L., and BURNSIDE, R. J., 1951—The genus *Siphogenerina* Schlumberger. *Contr. Cushman Fdn*, 2 (1), 13–15.

BARKER, R. W., 1960—Taxonomic notes on the species figured by H. B. Brady in his Report on the Foraminifera dredged by H.M.S. 'Challenger' during the years 1873–1876. *Spec. Publ. Soc. econ. Paleont. Mineral.*, 9, i–xxiv, 1–238.

BATJES, D. A. J., 1958—Foraminifera of the Oligocene of Belgium. *Mem. Inst. Roy. Sci. nat. Belg.*, 143, 1–188.

BELFORD, D. J., 1958—The genera *Nuttallides* Finlay, 1939, and *Nuttallina*, n. gen. *Contr. Cushman Fdn*, 9 (4), 93–98.

BELFORD, D. J., 1960—Upper Cretaceous Foraminifera from the Toolonga Calcilutite and Gingin Chalk, Western Australia. *Bull. Bur. Min. Resour. Aust.*, 57, 1–198.

BELFORD, D. J., 1962—Miocene and Pliocene planktonic Foraminifera, Papua-New Guinea. *Bull. Bur. Min. Resour. Aust.*, 62 (1), 1–50.

BEMMELEN, R. W. van, 1949—THE GEOLOGY OF INDONESIA. *The Hague, Govt. Printing Office.*

BERMUDEZ, P. J., 1949—Tertiary smaller Foraminifera of the Dominican Republic. *Spec. Publ. Cushman Lab.*, 25, i–iv, 1–322.

BERMUDEZ, P. J., 1952—Estudio sistematico de los Foraminiferos rotaliformes. *Bol. geol. Caracas*, 2 (4), 1–152.

*BERTHELIN, G., 1881—Coup d'oeil sur la faune rhizopodique du calcaire grossier inferieur de la Marne. *C.R. Assoc. franc. Avanc. Sci. 9e Sess. Reims* (1880).

BHATIA, S. B., 1956—Recent Foraminifera from shore sands of Western India. *Contr. Cushman Fdn*, 7 (1), 15–24.

BHATIA, S. B., & MOHAN, K., 1959—Miocene (Burdigalian) Foraminifera from Kathiawar, Western India. *J. Paleont.*, 33 (4), 641–661.

BLACKMON, P., & TODD, Ruth, 1959—Mineralogy of some Foraminifera as related to their classification and ecology. *J. Paleont.*, 33 (1), 1–15.

B.M.R., 1960—Summary of oil search activities in Australia and New Guinea to the end of June, 1959. *Bur. Min. Resour. Aust. Rep.*, 41A, 1–68, App. 1–5.

BOLLI, H. M., LOEBLICH, A. R., Jr, and TAPPAN, HELEN, 1957—Planktonic foraminiferal familes Hantkeninidae, Orbulinidae, Globorotaliidae and Globotruncanidae. *Bull. U.S. nat. Mus.*, 215, 3–50.

BOLTOVSKOY, E., 1958—Problems in taxonomy and nomenclature exemplified by *Nonion affine* (Reuss). *Micropaleontology*, 4 (2), 193–200.

BOLTOVSKOY, E., 1963—News report, Argentina. *Micropaleontology*, 9 (1), 111–112.

BOOMGAART, L., 1949—Smaller Foraminifera from Bodjonegoro (Java). *Min. Geol. Inst. Rijks Univ., Utrecht*, 1–175.

BOOMGAART, L., & VROMAN, J., 1936—Smaller Foraminifera from the Marl Zone between Sonde and Modjokerto (Java). *Proc. Acad. Sci. Amst.*, 39 (3), 419–425.

*BRADY, H. B., 1877—Supplementary note on the Foraminifera of the Chalk (?) of the New Britain Group. *Geol. Mag.*, n.s., dec. 2, 4 (12), 534–536.

*BRADY, H. B., 1881—Notes on some of the reticularian Rhizopoda of the 'Challenger' Expedition: part III. *Quart. J. microsc. Soc. London*, n.s., 21.

BRADY, H. B., 1884—Report on the Foraminifera dredged by H.M.S. 'Challenger' during the years 1873–1876. *Challenger Reports*, Zool., 9, I–XXI, 1–814.

BRADY, H. B., 1888—Note on the so-called 'Soapstone' of Fiji. *Quart. J. geol. Soc. London*, 44, 1–10.

BROTZEN, F., 1936—Foraminiferen aus dem Schwedischen untersten Senon von Eriksdal in Schonen. *Arsberätt. sverig. geol. Unders.*, 30 (3), (ser. C, no. 396), 1–206.

BROTZEN, F., 1940—Flintrannans och Trindelrannans (Oresund). *Ibid.*, 34 (5), (ser. C, no. 435), 21–33. (Swedish with German summary).

BROTZEN, F., 1942—Die Foraminiferengattung *Gavelinella* nov. gen. und die Systematik der Rotaliiformes. *Ibid.*, 36 (8), (ser. C, no. 451), 1–60.

BROTZEN, F., 1948—The Swedish Paleocene and its foraminiferal fauna. *Ibid.*, 42 (2), (ser. C, no. 493), 1–140.

BROWN, N. K., Jr, & BRONNIMANN, P., 1957—Some Upper Cretaceous rotaliids from the Caribbean Region. *Micropaleontology*, 3 (1), 29–38.

*BRUNNICH, M. T., 1772—Zoologiae Fundamenta. Copenhagen (the author).

BYKOVA, N. K., in RAUZER-CHERNOUSOVA, D. M., and FURSENKO, A. V., 1959—Osnovy Paleontologii. Obshchaya chast prosteyshie. *Akad. Nauk* SSSR, 1–368.

CHANG, L. S., 1960—A biostratigraphic study of the Miocene in Western Taiwan based on smaller Foraminifera (part II: Benthonics). *Bull. geol. Surv. Taiwan*, 12, 67–91.

CHAPMAN, F., 1914—Description of a limestone of Lower Miocene age from Bootless Inlet, Papua. *Proc. Roy. Soc. N.S.W.*, 48, 281–301.

CHAPMAN, F., 1915—Report on the Foraminifera and Ostracoda obtained by the F.I.S. 'Endeavour' from the east coast of Tasmania, and off Cape Wiles, South Australia. *Aust. Dept. Trade Fisher. Zool. (Biol.) Results*, 3 (1), 3–51.

CHAPMAN, F., 1941—Report on foraminiferal soundings and dredgings of the F.I.S. 'Endeavour' along the continental shelf of the south-east coast of Australia. *Trans. Roy. Soc. S. Aust.*, 65 (2), 145–211.

CHAPMAN, F., & PARR, W. J., 1937*a*—Foraminifera and Ostracoda from soundings made by the trawler 'Bonthorpe' in the Great Australian Bight. *J. Roy. Soc. W. Aust.*, 21 (1934–35), 1–6.

CHAPMAN, F., & PARR, W. J., 1937*b*—Foraminifera. *Australian Antarctic Exped.*, 1911–1914, Sci. Reps., ser. C, 1 (2), 1–190.

CHIJI, M., 1959—Some species of *Uvigerina* and their stratigraphic occurrences in the Nadaura district of the Toyoma Tertiary Basin, Japan. *Bull. Osaka Mus. nat. Hist.*, 11, 15–32.

CIFELLI, R., 1962—The morphology and structure of *Ammonia beccarii* (Linné). *Contr. Cushman Fdn*, 13 (4), 119–126.

CLOUD, P. E., 1956—Provisional correlation of selected Cenozoic sequences in the Western and Central Pacific. *Proc. 8th Pacif. Sci. Cong.* (1953), 2, 555–573.

COLE, W. S., 1954—Larger Foraminifera and smaller diagnostic Foraminifera from Bikini drill holes. *Prof. Pap. U.S. geol. Surv.*, 260–0, 569–608.

COLE, W. S., 1957—Geology of Saipan, Mariana Islands: larger Foraminifera. *Ibid.*, 280–1, 321–360.

CONDON, M. A., FISHER, N. H., & TERPSTRA, G. R. J., 1958—Summary of oil search activities in Australia and New Guinea to the end of 1957. *Bur. Min. Resour. Aust. Rep.*, 41, 1–101, App. 1–5.

CORYELL, H. N., & RIVERO, F. C., 1940—A Miocene microfauna of Haiti. *J. Paleont.*, 14 (4), 324–344.

CRESPIN, IRENE, 1938*a*—The occurrence of *Lacazina* and *Biplanispira* in the Mandated Territory of New Guinea. *Palaeont. Bull. Canberra*, 3, 1–8.

CRESPIN, IRENE, 1938*b*—A lower Miocene limestone from the Ok Ti River, Papua. *Ibid.*, 3, 9–12.

CRESPIN, IRENE, 1950—Australian Tertiary microfaunas and their relationships to assemblages elsewhere in the Pacific Region. *J. Paleont.*, 24 (4), 421–429.

CRESPIN, IRENE, 1956—Micropalaeontological investigations in the Bureau of Mineral Resources, Geology and Geophysics, 1927–1952. *Bur. Min. Resour. Aust. Rep.*, 20, 1–77.

CRESPIN, IRENE, 1962—*Lacazinella*, a new genus of trematophore Foraminifera. *Micropaleontology*, 8 (3), 337–340.

CUSHMAN, J. A., 1911—A monograph of the Foraminifera of the North Pacific Ocean. Part II. Textulariidae. *Bull. U.S. nat. Mus.*, 71, 1–108.

CUSHMAN, J. A., 1913—A monograph of the Foraminifera of the North Pacific Ocean. Part III. Lagenidae. *Ibid.*, 71, 1–118.

CUSHMAN, J. A., 1915—A monograph of the Foraminifera of the North Pacific Ocean. Part V. Rotaliidae. *Ibid.*, 71, 1–87.

CUSHMAN, J. A., 1921—Foraminifera of the Philippine and adjacent seas. *Ibid.*, 100 (4), 1–488.

CUSHMAN, J. A., 1922*a*—The Foraminifera of the Atlantic Ocean. Part 3. Textulariidae. *Ibid.*, 104, 1–149.

CUSHMAN, J. A., 1922*b*—Shallow-water Foraminifera of the Tortugas Region. *Publ. Carneg. Instn*, 311 (*Dep. Marine Biol. Pap.*, 17), 1–85.

CUSHMAN, J. A., 1923—The Foraminifera of the Atlantic Ocean. Part 4. Lagenidae. *Bull. U.S. nat. Mus.*, 104, 1–228.

CUSHMAN, J. A., 1924—Samoan Foraminifera. *Publ. Carneg. Instn*, 342 (*Dep. Marine Biol. Pap.*, 21), 1–75.

CUSHMAN, J. A., 1925—Notes on the genus *Cassidulina*. *Contr. Cushman Lab.*, 1 (3), 51–60.

CUSHMAN, J. A., 1926*a*—Some Pliocene *Bolivinas* from California. *Ibid.*, 2 (2), 29–51.

CUSHMAN, J. A., 1926*b*—Foraminifera of the typical Monterey of California. *Ibid.*, 2 (3), 53–69.

CUSHMAN, J. A., 1926*c*—The generic position of '*Pulvinulina favus* H. B. Brady'. *Ibid.*, 2 (3), 70–71.

CUSHMAN, J. A., 1926*d*—Recent Foraminifera from Porto Rico. *Publ. Carneg. Instn*, 344, 73–84.

CUSHMAN, J. A., 1926*e*—Foraminifera of the genera *Siphogenerina* and *Pavonina*. *Proc. U.S. nat. Mus.*, 67, no. 2597, art. 25 (1925), 1–24.

CUSHMAN, J. A., 1927*a*—American Upper Cretaceous species of *Bolivina* and related genera. *Contr. Cushman Lab.*, 2 (4), 85–91.

CUSHMAN, J. A., 1927*b*—An outline of a reclassification of the Foraminifera. *Ibid.*, 3 (1), 1–105.

CUSHMAN, J. A., 1927*c*—The designation of some genotypes in the Foraminifera. *Ibid.*, 3 (4), 188–190.

CUSHMAN, J. A., 1927*d*—Recent Foraminifera from off the west coast of America. *Bull. Scripps Instn, tech. Ser.*, 1 (10), 119–188.

CUSHMAN, J. A., 1927*e*—*Epistomina elegans* (d'Orbigny) and *E. partschiana* (d'Orbigny). *Contr. Cushman Lab.*, 3 (4), 180–187.

CUSHMAN, J. A., 1928—On *Rotalia beccarii* (Linné). *Ibid.*, 4 (4), 103–107.

CUSHMAN, J. A., 1929*a*—A late Tertiary fauna of Venezuela and other related regions. *Ibid.*, 5 (4), 77–101.

CUSHMAN, J. A., 1929*b*—*Planulina ariminensis* d'Orbigny and *P. wuellerstorfi* (Schwager). *Ibid.*, 5 (4), 102–105.

CUSHMAN, J. A., 1930—The Foraminifera of the Choctawhatchee Formation of Florida. *Bull. Florida geol. Surv.*, 4, 1–89.

CUSHMAN, J. A., 1931—The Foraminifera of the Atlantic Ocean. Part 8. Rotaliidae, Amphisteginidae, Calcarinidae, Cymbaloporettidae, Globorotaliidae, Anomalinidae, Planorbulinidae, Rupertiidae and Homotremidae. *Bull. U.S. nat. Mus.*, 104, I–IX, 1–179.

CUSHMAN, J. A., 1932—Notes on the genus *Virgulina*. *Contr. Cushman Lab.*, 8 (1), 7–23.

CUSHMAN, J. A., 1933*a*—Some new Recent Foraminifera from the tropical Pacific. *Ibid.*, 9 (4), 77–95.

CUSHMAN, J. A., 1933*b*—The Foraminifera of the tropical Pacific collections of the 'Albatross', 1899–1900; part II—Lagenidae to Alveolinellidae. *Bull. U.S. nat. Mus.*, 161, I–VI, 1–79.

CUSHMAN, J. A., 1934—Smaller Foraminifera from Vitilevu, Fiji *in* LADD, H. S., Geology of Vitilevu, Fiji. *Bull. Bernice P. Bishop Mus.*, 119, 102–140.

CUSHMAN, J. A., 1937—A monograph of the foraminiferal Subfamily Virgulininae. *Spec. Publ. Cushman Lab.*, 9, I–XV, 1–228.

CUSHMAN, J. A., 1939—A monograph of the foraminiferal Family Nonionidae. *Prof. Pap. U.S. geol. Surv.*, 191, 1–100.

CUSHMAN, J. A., 1942*a*—The Foraminifera of the tropical Pacific collections of the 'Albatross', 1899–1900; part 3—Heterohelicidae and Buliminidae. *Bull. U.S. nat. Mus.*, 161, I–V, 1–67.

CUSHMAN, J. A., 1942*b*—A report on samples obtained by the boring at Heron Island, Great Barrier Reef, Australia. App. 1 in *Rep. Gt Barrier Reef Comm.*, 5, 112–119.

CUSHMAN, J. A., 1945—The species of the Subfamily Reussellinae of the foraminiferal Family Buliminidae. *Contr. Cushman Lab.*, 21 (2), 23–54.

CUSHMAN, J. A., 1946—The genus *Ceratobulimina* and its species. *Ibid.*, 22 (4), 107–117.

CUSHMAN, J. A., 1948*a*—Arctic Foraminifera. *Spec. Publ. Cushman Lab.*, 23, 1–79.

CUSHMAN, J. A., 1948*b*—FORAMINIFERA, THEIR CLASSIFICATION AND ECONOMIC USE. 4th Edn. *Harvard, Univ. Press.*

CUSHMAN, J. A., 1949—Recent Belgian Foraminifera. *Mem. Inst. Roy. Sci. nat. Belg.*, 111, 1–59.

CUSHMAN, J. A., & CAHILL, E. D., 1933—Miocene Foraminifera of the coastal plain of the Eastern United States. *Prof. Pap. U.S. geol. Surv.*, 175–A, 1–35.

CUSHMAN, J. A., & EDWARDS, P. G., 1937—Notes on the early described Eocene species of *Uvigerina* and some new species. *Contr. Cushman Lab.*, 13 (2), 54–61.

CUSHMAN, J. A., & Harris, R. W., 1927—Some notes on the genus *Ceratobulimina. Contr. Cushman Lab.*, 3 (4), 171–179.

CUSHMAN, J. A., & JARVIS, P. W., 1929—New Foraminifera from Trinidad. *Contr. Cushman Lab.*, 5 (1), 6–17.

CUSHMAN, J. A., & MARTIN, L. T., 1935—A new genus of Foraminifera, *Discorbinella*, from Monterey Bay, California. *Contr. Cushman Lab.*, 11 (4), 89–90.

CUSHMAN, J. A., & MOYER, DOROTHY A., 1930—Some Recent Foraminifera from off San Pedro, California. *Contr. Cushman Lab.*, 6 (3), 49–62.

CUSHMAN, J. A., & PARKER, FRANCES L., 1940—The species of the genus *Bulimina* having Recent types. *Contr. Cushman Lab.*, 16 (1), 7–23.

CUSHMAN, J. A., & PARKER, FRANCES L., 1947—*Bulimina* and related foraminiferal genera. *Prof. Pap. U.S. geol. Surv.*, 210–D, 55–176.

CUSHMAN, J. A., & SIEGFUS, S. S., 1935—New species of Foraminifera from the Kreyenhagen Shale of Fresno County, California. *Contr. Cushman Lab.*, 11 (4), 90–95.

CUSHMAN, J. A., & STAINFORTH, R. M., 1945—The Foraminifera of the Cipero Marl Formation of Trinidad, British West Indies. *Spec. Publ. Cushman Lab.*, 14, 1–75.

CUSHMAN, J. A., & STEVENSON, F. V., 1948—A Miocene foraminiferal fauna from Ecuador. *Contr. Cushman Lab.*, 24 (3), 50–68.

*CUSHMAN, J. A., & STEWART, R. E., 1930—Tertiary Foraminifera from Humboldt County, California. *Trans. San Diego Soc. nat. Hist.*, 6 (2), 41–94.

CUSHMAN, J. A., & TODD, RUTH, 1941—The structure and development of *Laticarinina pauperata* (Parker and Jones). *Contr. Cushman Lab.*, 17 (4), 103–105.

CUSHMAN, J. A., & TODD, RUTH, 1942*a*—The Recent and fossil species of *Laticarinina. Ibid.*, 18 (1), 14–20.

CUSHMAN, J. A., & TODD, RUTH, 1942*b*—The genus *Cancris* and its species. *Ibid.*, 18 (4), 72–94.

CUSHMAN, J. A., & TODD, RUTH, 1945—Miocene Foraminifera from Buff Bay, Jamaica. *Spec. Publ. Cushman Lab.*, 15, 1–73.

CUSHMAN, J. A., & TODD, RUTH, 1949—Species of the genera *Allomorphina* and *Quadrimorphina. Contr. Cushman Lab.*, 25 (3), 59–72.

CUSHMAN, J. A., TODD, RUTH, & POST, RITA, J., 1954—Recent Foraminifera of the Marshall Islands. *Prof. Pap. U.S. geol. Surv.*, 260–H, 319–384.

*CZJZEK, J., 1848—Beitrag zur Kenntnis der fossilien Foraminiferen des Wiener Beckens. *Naturw. Abh.*, 2 (1).

DALEON, B. A., & SAMANIEGO, R., 1957—Small foraminiferal hypotypes from the Neogene of Panay Island. *Philipp. Geol.*, 11 (2), 26–68.

DAM, A. TEN, 1947—Structure of *Asterigerina* and a new species. *J. Paleont.*, 21 (6) 584–586.

DAVID, T. W. E., ed BROWNE, W. R., 1950—THE GEOLOGY OF THE COMMONWEALTH OF AUSTRALIA. Vol. 1 *London, Arnold.*

DECIMA, A., 1963—Il Pleistocene in Facies Levantina di Montallegro (Sicilia Sud-Occidentale). *Estr. geol. romana*, 2, 59–118. (Univ. Catania, publ. 49).

DELAGE, Y., & HEROUARD, E., 1896—TRAITE DE ZOOLOGIE CONCRETE. TOME 1. LA CELLULE ET LES PROTOZOAIRES. *Paris.*

DIECI, G., 1959—I Foraminiferi Tortoniani di Montegibbio e Castelvetro. *Palaeont. ital.*, 54 (n.s. 24), 1-113.

DROOGER, C. W., 1953—Miocene and Pleistocene Foraminifera from Oranjestad, Aruba (Netherlands Antilles). *Contr. Cushman Fdn*, 4 (4), 116-147.

DROOGER, C. W., 1954—Remarks on the species concept in paleontology. *Micropalaeontologist*, 8 (4), 23-26.

DROOGER, C. W., 1960—Some early rotaliid Foraminifera, parts I-III. *Proc. Acad. Sci. Amst.*, ser. B (3), 287-334.

*EGGER, J. G., 1893—Foraminiferen Meeresgrundproben, gelothet von 1874 bis 1876 von S. M. Sch. Gazelle. *Abh. bayer. Akad. Wiss., Math-Phys. Kl.*, 18 (2), 193-458.

*EHRENBERG, C. G., 1838—Uber dem blossen Auge unsichtbar Kalkthierchen und Kieselthierchen als Hauptbestandtheile der Kreidegebirge. *Ber. preuss. Akad. Wiss. Jahrg.*, 3, 192-200.

*EHRENBERG, C. G., 1839—Uber die Bildung der Kreidefelsen und des Kreidemergels durch unsicht bare Organismen. *Abh. preuss. Akad. Wiss.*, (1938), 59-147.

*EICHWALD, E. VON, 1830—ZOOLOGIA SPECIALIS, Vol. 2.

*EIMER, G. H. T., & FICKERT, C., 1899—Die Artbildung und Verwandtschaft bei den Foraminiferen, Entwurf einer naturlichen Eintheilung derselben. *Z. Wiss. Zool.*, 65 (4), 527-636.

ELLIS, B. F., & MESSINA, ANGELINA R., 1940 *et seq.*—Catalogue of Foraminifera. *Spec. Publ. Amer. Mus. nat. Hist.*

*FICHTEL, L. VON, & MOLL, J. P. C. VON, 1798 (1803 reprint)—Testacea microscopica aliaque minuta ex generibus *Argonauta* et *Nautilus* ad naturum delineata et descripta. *Vienna*, 1-124.

FINLAY, H. J., 1939*a*—New Zealand Foraminifera; key species in stratigraphy—No. 2. *Trans. Roy Soc. N.Z.*, 69 (1), 89-128.

FINLAY, H. J., 1939*b*—New Zealand Foraminifera: key species in stratigraphy—No. 3. *Ibid.*, 69 (3), 309-329.

FINLAY, H. J., 1940—New Zealand Foraminifera: key species in stratigraphy—No. 4. *Ibid.*, 69 (4), 448-472.

*FORNASINI, C., 1900—Intorno ad alcuni esemplari di Foraminiferi Adriatici. *R. Accad. Sci. Inst. Bologna, Mem. Sci. nat.*, 5 (8), 357-402.

*FORNASINI, C., 1904—Illustrazione di specie orbignyane di Foraminiferi instituite nel 1826. *Ibid.*, 6 (1), 3-17.

*FORNASINI, C., 1906—Illustrazione di specie orbignyane di 'Rotalidi' instituite nel 1826. *R. Accad. Sci. Ist. Bologna, Mem. Sci. Nat.*, 6 (3), 61-70.

*FRANZENAU, A., 1884—*Heterolepa*, egy uj genus a foraminiferak rendjeben. (*Heterolepa*, eine neue Gattung aus der Ordnung Foraminiferen). *Mag. nemz. Muz., Termeszerr. Fuzetek*, 8, 181-184.

GALLOWAY, J. J., 1933—A MANUAL OF FORAMINIFERA. *Bloomington Principia Press.*

*GALLOWAY, J. J., & HEMINWAY, CAROLINE E., 1941—The Tertiary Foraminifera of Porto Rico. *N.Y. Acad. Sci., Sci. Surv. Porto Rico and Virgin Islands*, 3 (4), 275-491.

GALLOWAY, J. J., & WISSLER, S. G., 1927*a*—Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California. *J. Paleont.*, 1 (1), 35—87.

GALLOWAY, J. J., & WISSLER, S. G., 1927*b*—Correction of names of Foraminifera. *J Paleont.*, 1 (3), 193.

GERMERAAD, J. H., 1946—Geology of Central Seran, *in* RUTTEN, L., HOTZ, W., Geological, petrological and palaeontological results of explorations carried out from September 1917 till June 1919 in the Island of Ceram, ser. 3 (Geol.), no. 2, 7-135. *Amsterdam, Bussy.*

GLAESSNER, M. F., 1943—Problems of stratigraphic correlation in the Indo-Pacific Region. *Proc. Roy. Soc. Vic.*, 55, n.s., (1), 41-80.

GLAESSNER, M. F., 1945—PRINCIPLES OF MICROPALAEONTOLOGY. *Melbourne, Univ. Press.*

GLAESSNER, M. F., 1950—Geotectonic position of New Guinea. *Bull. Amer. Ass. Petrol. Geol.*, 34, 856-881.

GLAESSNER, M. F., 1952—Geology of Port Moresby, Papua. *Sir Douglas Mawson Anniv. Vol., Univ. of Adellaide*, 63-86.

GLAESSNER, M. F., 1954*a*—New aspects of foraminiferal morphology and taxonomy. *Contr. Cushman Fdn*, 5 (1), 21-25.

GLAESSNER, M. F., 1954*b*—Some problems of Tertiary geology in southern Australia. *J. Roy. Soc. N.S.W.*, 87, 31-45.

GLAESSNER, M. F., 1959*a*—Die Indo-pazifische Region *in* LOTZE, F., HANDBUCH DER STRATIGRAPHISCHEN GEOLOGIE, 3 (1), 288-310. *Stuttgart, Enke.*

GLAESSNER, M. F., 1959*b*—Tertiary stratigraphic correlation in the Indo-Pacific Region and Australia. *J. geol. Soc. India*, 1, 53-67.

GLAESSNER, M. F., 1963—Major trends in the evolution of the Foraminifera *in* KOENINGSWALD, G. H. R., EMEIS, J. D., BUNING, W. L., & WAGNER, C. W. (Editors), EVOLUTIONARY TRENDS IN FORAMINIFERA, 9–24 *Amsterdam, Elsevier.*

*GMELIN, J. F., 1791—*in* LINNAEUS, C., SYSTEMA NATURAE, 13th Ed. *Leipzig, Beer.*

GOODWIN, J. C., & THOMSON, J. N., 1954—Purisima Pliocene Foraminifera of the Halfmoon Bay area, San Mateo County, California. *Contr. Cushman Fdn*, 5 (4), 170–178.

GRAHAM, J. J., & MILITANTE, PRISCILLA, J., 1959—Recent Foraminifera from the Puerto Galera area, Northern Mindoro, Philippines. *Stanford Univ. Publ. geol. Sci.*, 7 (2), 1–170.

*HAECKEL, E., 1894—SYSTEMATISCHE PHYLOGENIE. Entwurf eines naturlichen Systems der Organismen auf Grund ihrer Stammesgeschiehte. Theil 7, Systematische Phylogenie der Protisten und flanzer. 1–XU, 1–400, *Berlin, Reimer.*

HAGN, H., 1953—Palaontologische Untersuchungen am Bohrgut der Bohrungen Ortenburg CF 1001, 1002 und 1003 in Niederbayern. *Z. dtsch. geol. Ges.*, 105 (3), 324–359.

HARMAN, R. A., 1964—Distribution of Foraminifera in the Santa Barbara Basin, California. *Micropaleontology*, 10 (1), 81–96.

HAYNES, J., 1954—Taxonomic position of some British Paleocene Buliminidae. *Contr. Cushman Fdn*, 5 (4), 185–191.

HERON-ALLEN, E., & EARLAND, A., 1914—The foraminifera of the Kerimba Archipelago (Portuguese East Africa)—Part 1. *Trans. zool. Soc. London*, 20 (12), 363–794.

HERON-ALLEN, E., & EARLAND, A., 1922—Protozoa; part II—Foraminifera. Brit. Antarctic ('Terra Nova') Exped. 1910. *Nat. Hist. Rep. Brit. Mus. (nat. Hist.), Zool.*, 6 (2) 25–268.

HERON-ALLEN, E., & EARLAND, A., 1924—The Miocene Foraminifera of the 'Filter Quarry', Moorabool River, Victoria, Australia. *J. Roy. microsc. Soc. London*, 121–186.

HERON-ALLEN, E., & EARLAND, A., 1932—Foraminifera. Part 1. The ice-free area of the Falkland Islands and adjacent seas. *'Discovery' Reps., Cambridge*, 4. 291–460.

HILTERMANN, H., & KOCH, W., 1950—Taxonomie und Vertikalverbreitung von *Bolivinoides*—Arten im Senon Nordwestdeutschlands. *Geol. Jb.*, 64, 595–632.

HOFKER, J., 1927—The Foraminifera of the 'Siboga' Expedition, part 1. *Monogr.*, 4, 1–78. *Leiden, Brill.*

HOFKER, J., 1948—On *Asterigerina gurichi* (Franke) and remarks on polymorphism and the stratigraphic use of Foraminifera. *J. Paleont.*, 22 (4), 509–517.

HOFKER, J., 1950—What is the genus *Eponides* ? *Micropaleontologist*, 4 (1), 15–16.

HOFKER, J., 1951*a*—The toothplate Foraminifera. *Ext. Arch. Nederland, Zool.*, 8 (4), 353–373.

HOFKER, J., 1951*b*—The Foraminifera of the 'Siboga' Expedition, part 3. *Monogr.* 4*a*, I–XII, 1–513. *Leiden, Brill.*

HOFKER, J., 1951*c*—On Foraminifera from the Dutch Cretaceous. *Publ. natuurhist. Genoot. Limburg*, 4, 1–40.

HOFKER, J., 1952*a*—Zur Fassung der Foraminiferengattung *Bolivinoides* Cushman, 1927. *Geol. Jb.*, 66, 377–382.

HOFKER, J., 1954—The toothplate of *Ceratobulimina. Contr. Cushman Fdn*, 5 (4), 147–148.

HOFKER, J., 1955—*Discopulvinulina cushmani* Hofker, a new name for *Hanzawaia concentrica* (Cushman). *Ibid.*, 6 (4), 128–130.

HOFKER, J., 1956*a*—Tertiary Foraminifera of Coastal Ecuador: pt. II. Additional notes on the Eocene species. *J. Paleont.*, 30 (4), 891–958.

HOFKER, J., 1956*b*—Foraminifera Dentata: Foraminifera of the Santa Cruz and Thatch-Island Virginia-Archipelago, West-Indies. *Skri. Univ. zool. Mus. Kbn*, 15, 1–237.

HOFKER, J., 1957—Foraminiferen der Oberkreide von Nordwestdeutschland und Holland. *Beih. Geol. Jb.*, 27, 1–464.

HOFKER, J., 1958—The taxonomic position of the genus *Pseudoeponides* Uchio, 1950. *Contr. Cushman Fdn*, 9 (2), 46–48.

HOFKER, J., 1959*a*—The genera *Eponides, Lacosteina, Nuttallides, Planorbulina* and *Halkyardia. Ibid.*, 10 (4), 111–118.

HOFKER, J., 1959*b*—Die asterigeriniden Foraminiferen. *Paläont. Z.*, 33 (4), 247–265.

HOFKER, J., 1960—Foraminiferen aus dem Golf von Neapel. *Ibid.*, 34 (3), 233–262.

HOFKER, J., 1962—Studien an planktonischen Foraminiferen. *Neues Jb. Geol. Paläont.*, 114 (1), 81–134.

HOFKER, J., 1963*a*—*Stainforthia* Hofker or *Chiloguembelina* Loeblich and Tappan. *Contr. Cushman Fdn*, 14 (4), 150–152.

HOFKER, J., 1963*b*—*Cassigerinella* Pokorny, 1955, and *Islandiella* Nørvang, 1958, *Micropaleontology*, 9 (3), 321–324.

HÖGLUND, H., 1947—Foraminifera in the Gullmar Fjord and the Skagerak. *Zool. Bid. Fran. Uppsala*, 26, 1-328.

HORNIBROOK, N. DE B., 1961—Tertiary Foraminifera from Oamaru District (N.Z.). Part 1—Systematics and Distribution. *Paleont. Bull. N.Z. geol. Surv.*, 34 (1), 1-192.

HORNIBROOK, N. DE B., 1963—News Report, New Zealand. *Micropaleontology*, 9 (4), 484-486.

HUANG, T., 1963—A new species of *Paranonion* from Southern Taiwan. *Proc. geol. Soc. China*, 6, 88-90.

HUANG, T., 1964—Smaller Foraminifera from the Sanhsienchi, Taitung, Eastern Taiwan. *Proc. geol. Soc. China*, 7, 63-72.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1961—International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology. *International Trust for Zoological Nomenclature, London.*

ISHIWADA, Y., 1964—Benthonic Foraminifera off the Pacific coast of Japan referred to biostratigraphy of the Kazusa Group. *Rep. geol. Surv. Japan*, 205, 1-45.

JENKINS, D. G., 1958—The true nature of *Bolivina hentyana* Chapman, 1916. *Micropaleontology*, 4 (3), 335-336.

JENNINGS, P. H., 1936—A microfauna from the Monmouth and basal Rancocas Groups of New Jersey. *Bull. Amer. Paleont.*, 23 (78), 159-234.

JONES, T. R., *in* GRIFFITH, J. W., & HENFREY, A., 1875—THE MICROGRAPHIC DICTIONARY: Ed. 3, Vol. 1. *London, Van Voorst.*

KAASSCHIETER, J. P. H., 1955—Smaller Foraminifera, *in* DROOGER, C. W., KAASSCHIETER, J. P. H. and KEY, A. J., 1955, The Microfauna of the Aquitanian-Burdigalian of Southwestern France. *Ver. Ned. Akad. Wetensch.*, 1st ser., 21 (2), 51-99.

KAASSCHIETER, J. P. H., 1961—Foraminifera of the Eocene of Belgium. *Mem. Inst. Roy. Sci. nat. Belg.*, 147, 1-271.

*KARRER, F., 1868—Die Miocene Foraminiferenfauna von Kostej im Banat. *S.B. Akad. Wiss. Wien, math.-naturw. Kl., Sit.*, 58 (1), 121-193.

*KARRER, F., 1878—Die Foraminiferen der Tertiaren Thone von Luzon, in DRASCHE, R. von, Fragmente zu einer Geologie der Insel Luzon (Philippinen), 75-99. *Vienna, K. Gerold's Sohn.*

KEYZER, F. G., 1953—Reconsideration of the so-called Oligocene fauna in the asphaltic deposits of Buton (Malay Archipelago). 2. Young Neogene Foraminifera and calcareous Algae. *Leid. geol. Meded.*, 17, 259-293.

KEYZER, F. G., 1955—*Lamarckinita*, new name, replacing *Ruttenella* Keyzer, 1953 (non *Ruttenella* van den Bold, 1946). *Contr. Cushman Fdn*, 6 (3), 119.

KLASZ, I. DE, & RERAT, D., 1962—Quelques nouveaux Foraminifères du Crétace et du Tertiare du Gabon (Afrique Equatoriale). *Rév. Micropaléont.*, 4 (4), 175-189.

KLEINPELL, R. M., 1938—Miocene stratigraphy of California. *Amer. Ass. Petrol. Geol.*, 1-450.

KLEINPELL, R. M., 1954—Neogene smaller Foraminifera from Lau, Fiji, *Bull. Bernice P. Bishop Mus.*, 211, 1-96.

KOCH, R., 1923—Die Jungtertiäre Foraminiferenfauna von Kabu (Res. Surabaja, Java). *Ecl. geol. helv.*, 18 (2), 342-361.

KOCH, R., 1925—Eine Jungtertiäre Foraminiferenfauna aus Ost-Seran. *Ibid.*, 19 (1), 207-213.

KOCH, R., 1926—Mitteltertiäre Foraminiferen aus Bulongan, Ost-Borneo. *Ibid.*, 19 (3), 722-751.

LANGE, W., 1962—Die Mikrofauna einiger Stormeer-Absatze (I. Interglazia) Schleswig-Holsteins. *N. Jb. Geol. Paläont., Abh.* 115 (2), 222-242.

LEROY, L. W., 1939—Some smaller Foraminifera, Ostracoda and Otoliths from the Neogene ('Miocene') of the Rokan-Tapanoeli area, Central Sumatra. *Natuur. k. Tijdschr. Nederl.-Indie*, 99 (6), 215-296.

LEROY, L. W., 1941*a*—Small Foraminifera from the Late Tertiary of the Sangkoelirang Bay area, East Borneo, Nederlands East Indies. *Quart. Colo. Sch. Mines*, 36 (1), pt 1, 1-62.

LEROY, L. W., 1941*b*—Small Foraminifera from the Late Tertiary of Siberoet Island, off the West Coast of Sumatra, Nederlands East Indies. *Ibid.*, 36 (1), pt 2, 63-108.

LEROY, L. W., 1941*c*—Some small Foraminifera from the type locality of the Bantamien Substage, Bodjong Beds, Bantam Residency, West Java, Nederlands East Indies. *Ibid.*, 36 (1), pt 3, 109-132.

LEROY, L. W., 1944*a*—Miocene Foraminifera of Central Sumatra, Netherlands East Indies. *Ibid.*, 39 (3), pt 1, 7-69.

LEROY, L. W., 1944*b*—Small Foraminifera from the Miocene of West Java, Netherlands East Indies. *Ibid.*, 39 (3), 71-113.

LEROY, L. W., 1948—The foraminifer *Orbulina universa* d'Orbigny, a suggested Middle Tertiary time indicator. *J. Paleont.*, 22 (4), 500-508.

LeRoy, L. W., 1953—Biostratigraphy of the Maqfi Section, Egypt. *Mem. geol. Soc. Amer.*, 54, 1–73.

LeRoy, L. W., 1964—Smaller Foraminifera from the Late Tertiary of Southern Okinawa. *Prof. Pap. U.S. geol. Surv.*, 454–F, 1–58.

*Linnaeus, C., 1758—Systema Naturae, 10th Edn, Vol. 1, 1–823. *Stockholm.*

Loeblich, A. R., Jr., & Tappan, Helen, 1957—Eleven new genera of Foraminifera. *Bull. U.S. nat. Mus.*, 215, 223-232.

Loeblich, A. R., Jr., & Tappan, Helen, 1961—Suprageneric classification of the Rhizopodea. *J. Paleont.*, 35 (2), 245–330.

Loeblich, A. R., Jr., & Tappan, Helen, 1962*a*—The status and type species of *Calcarina*, *Tinoporus* and *Eponides* (Foraminiferida). *Contr. Cushman Fdn*, 13 (2), 33–38.

Loeblich, A. R., Jr., & Tappan, Helen, 1962*b*—The foraminiferal genera *Cibicides*, *Heterolepa*, *Planulina* and *Holmanella*, new genus. *Ibid.*, 13 (3), 71–73.

Loeblich, A. R., Jr., & Tappan, Helen, 1964*a*—Protista 2: Sarcodina, chiefly 'Thecamoebians' and Foraminiferida. Treatise on Invertebrate Paleontology, part C (2 vols.), I–XXI, 1–900. *Geol. Soc. Amer. ad Univ. Kansos Press.*

Loeblich, A. R., Jr., & Tappan, Helen, 1964*b*—Stability of foraminiferal nomenclature. *Contr. Cushman Fdn*, 15 (1), 30–33.

*Makiyama, J., & Nakagawa, T., 1941—Pleistocene Foraminifera from Sima, Mie Prefecture. *J. geol. Soc. Japan*, 48 (572). (Japanese with English summary.)

Marie, P., 1941—Les Foraminifères de la Craie à *Belemnitella mucronata* du bassin de Paris. *Mem. Mus. nat. Hist. nat.* (n.s.) 12, 1–296.

Marks, P., Jr., 1951—A revision of the smaller Foraminifera from the Miocene of the Vienna Basin. *Contr. Cushman Fdn*, 2 (2), 33–73.

Martin, L., 1952—Some Pliocene Foraminifera from a portion of the Los Angeles Basin, California. *Contr. Cushman Fdn*, 3 (3–4), 107–141.

Mathews, R. D., 1945—*Rectuvigerina*, a new genus of Foraminifera from a restudy of *Siphogenerina*. *J. Paleont.*, 19 (6), 588–606.

McKnight, W. M., Jr., 1962—The distribution of Foraminifera off parts of the Antarctic coast. *Bull. Amer. Paleont.*, 44 (201), 65–158.

McLean, J. D., Jr., 1956—The Foraminifera of the Yorktown Formation in the York-James Peninsula of Virginia, with notes on the associated mollusks. *Bull. Amer. Paleont.*, 36 (160), 261–414.

McMillan, N. J., & Malone, E. J., 1960—The geology of the Eastern Highlands of New Guinea. *Bur. Min. Resour. Aust. Rep.*, 48, 1–57.

Millett, F. W., 1900—Report on the Recent Foraminifera of the Malay Archipelago, collected by Mr A. Durrand; part VIII. *J. Roy. microsc. Soc. London*, 273–182.

Montanaro Gallitelli, Eugenia, 1957—A revision of the foraminiferal family Heterohelicidae. *Bull. U.S. nat. Mus.*, 215, 133–154.

*Montfort, P. Denys de, 1808—Conchyliologie systematique et classification methodique des coquilles, Vol. 1 *Paris, Schoell.*

Myatlyuk, *in* Rauzer-Chernousova, D. M., & Fursenko, A. V., 1959—Osnovy Paleontologii. Obshchaya chast prosteyshie. *Akad. Nauk* SSSR, 1–368.

Nørvang, A., 1958—*Islandiella* n.g. and *Cassidulina* d'Orbigny. *Medd. Dansk naturh. Foren.*, 120, 25–41.

Nørvang, A., 1959—On *Nonion pompilioides* (Fichtel and Moll). *Medd. dansk. geol. Foren.*, 14 (2), 141–150.

Onofrio, Sara d', 1959—Foraminiferi di una carota sottomarina del Medio Adriatico. *G. Geol., Bologna*, ser. 2a, 27 (1956–1957), 147–190.

*Orbigny, A. d', 1826—Tableau methodique de la classe des Cephalopodes. *Ann. Sci. nat., Paris*, 1 (7), 96–314.

*Orbigny, A. d', 1839*a*—Foraminifères, *in* Sagra, R. de la, Histoire Physique, Politique et Naturelle de l'Ile de Cuba, 1–224. *Paris, Bertrand.*

*Orbigny, A. d', 1839*b*—Voyage dans l'Amerique Meridionale; Foraminifères. *Strasbourg, Bertrand*, 5 (5), 1–86.

*Orbigny, A. d', 1839*c*—Foraminifères des Iles Canaries, *in* Barker-Webb, P. & Berthelot, S. Histoire Naturelle des Iles Canaries. *Paris, Bethune*, 2 (2), Zool., 119–146.

Orbigny, A. d', 1846—Foraminifères fossiles du bassin tertiare de Vienne (Autriche). *Paris, Cide*, 1–303.

*Orbigny, A. d', 1852—Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnes. *Paris, Masson*, Vol. 3, 1–196.

PALMER, DOROTHY, K., 1934—Some large fossil Foraminifera from Cuba. *Mem. Soc. Cubana Hist. nat.*, 8, 235–264.

PARKER, FRANCES L., 1954—Distribution of the Foraminifera in the Northeastern Gulf of Mexico. *Bull. Mus. comp. Zool. Havard*, 111 (10), 453–588.

PARKER, FRANCES L., 1959—Eastern Mediterranean Foraminifera. Sediment cores from the Mediterranean Sea and the Red Sea, No. 4. *Reps. Swedish Deep-Sea Exped.*, 8, 219–283.

PARKER, FRANCES L., 1964—Foraminifera from the experimental Mohole drilling near Guadalupe Island, Mexico. *J. Paleont.*, 38 (4), 617–636.

*PARKER, W. K., and JONES, T. R., 1862, *in* CARPENTER, W. B.,—INTRODUCTION TO THE STUDY OF THE FORAMINIFERA. *London, Roy. Soc.*

*PARKER, W. K., and JONES, T. R., 1865—On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay. *Phil. Trans.*, 155, 325–441.

*PARKER, W. K., JONES, T. R., and BRADY, H. B., 1871—On the nomenclature of the Foraminifera. Part XIV—The species enumerated by d'Orbigny in the 'Annales des Sciences Naturelles', 1826, Vol. 7 (continued from *Ann. Mag. Nat. Hist.*, ser. 3, Vol. XVI, p. 41). *Ann. Mag. nat. Hist.*, ser. 4, 8, 145–179, 238–266.

PARR, W. J., 1932—Victorian shallow water Foraminifera. *Proc. Roy. Soc. Vic.*, 44 (1), 1–14.

PARR, W. J., 1950—Foraminifera. *B.A.N.Z. Antarctic Res. Exped.*, 1929–1931, ser. B, 5 (6), 233–392.

PATERSON, S. J., and KICINSKI, F. M., 1956—An account of the geology and petroleum prospects of the Cape Vogel Basin. *Bur. Min. Resour. Aust. Rep.*, 25, 47–70.

PEZZANI, F., 1963—Studio micropaleontologico di un campione della serie messininana di Tabiano Bagni (Parma). *Riv. ital. Palaeont.*, 69 (4), 559–664.

PHLEGER, F. B., 1939—Foraminifera of submarine cores from the continental slope. *Bull. geol. Soc. Amer.*, 50, 1395—1422.

PHLEGER, F. B., and PARKER, FRANCES L., 1951—Ecology of Foraminifera, North-West Gulf of Mexico. Pt. 2, Foraminifera distribution. *Mem. geol. Soc. Amer.*, 46, 1–64.

PHLEGER, F. B., PARKER, FRANCES L., and PEIRSON, Jean, 1953—North Atlantic Foraminifera. Sediment cores from the North Atlantic Ocean, No. 1. *Reps. Swedish Deep-Sea Exped.*, 7, 1–122.

PIERCE, R. L., 1956—Upper Miocene Foraminifera and fish from the Los Angeles area, California. *J. Paleont.*, 30 (6), 1288–1314.

RAU, W. W., 1964—Foraminifera from the Northern Olympic Peninsula, Washington. *Prof. Pap. U.S. geol. Surv.*, 374–G, 1–33.

REDMOND, C. D., 1949—What is the genus *Eponides*? *Micropaleontologist*, 3 (4), 19–21.

REDMOND, C. D., 1953—Miocene Foraminifera from the Tubara beds of Northern Colombia. *J. Paleont.*, 27 (5), 708–733.

REISS, Z., 1957—The Bilamellidea, nov. superfam., and remarks on Cretaceous Globorotaliids. *Contr. Cushman Fdn*, 8 (4), 127–145.

REISS, Z., 1958—Classification of lamellar Foraminifera. *Micropaleontology*, 4 (1), 51–70.

REISS, Z., 1959—The wall structure of *Cibicides, Planulina, Gyroidinoides* and *Globorotalites*. *Ibid.*, 5 (3), 355–358.

REISS, Z., 1960—Structure of so-called *Eponides*, and some other rotaliiform Foraminifera. *Bull. geol. Surv. Isreal, Paleont. Div.*, 29, 1–28.

REISS, Z., 1963*a*—Comments on wall structure of Foraminifera. *Micropaleontology*, 9 (1), 50–52.

REISS, Z., 1963*b*—Reclassification of perforate Foraminifera. *Bull. geol. Surv. Isreal*, 35, 1–111.

REISS, Z., and MERLING, P., 1958—Structure of some Rotalliidea. *Bull. geol. Surv. Israel, paleont. Div.*, 21, 1–19.

RENZ, H. H., 1948—Stratigraphy and fauna of the Agua Salada Group, State of Falcon, Venezuela. *Mem. geol Soc. Amer.*, 32, I–X, 1–219.

*REUSS, A. E., *in* CZJZEK, J., 1849—Uber zwei neue Arten von Foraminiferen aus dem Tegel von Baden und Mollersdorf. *Freunde Naturwiss. Wien, Ber. Mitteil.*, 5 (1848–1849).

*REUSS, A. E., 1850—Neue Foraminiferen aus den Schichton des Osterreichischen Tertiarbeckens. *Denkschr. Akad. Wiss. Wien, Math.-Naturw. Kl.*, 1, 365–390.

*REUSS, A. E., 1851—Ueber die fossilen Foraminiferen und Entomostraceen der Septarienthone der Umgegend von Berlin. *Z. dtsch. geol. Ges.*, 3, 49–91.

REYMENT, R. A., 1959—The foraminiferal genera *Afrobolivina* gen. nov., and *Bolivina* in the Upper Cretaceous and Lower Tertiary of West Africa. *Stockholm Contr. Geol.*, 3 (1), 1–57.

RICKWOOD, F. K., 1955—The geology of the Western Highlands, New Guinea. *J. geol. Soc. Aust.*, 2, 63–82.

SABOL, J. W., 1960—The microfauna of the Yorktown Formation from James River, Surry County, Virginia. *Bull. Amer. Paleont.*, 41 (191), 211–246.

SAEDELEER, H. DE, 1934—Beitrag zur Kenntnis der Rhizopoden, morphologische und systematische Untersuchungen und ein Klassifikationsversuch. *Mem. Mus. Roy. Hist. nat. Belg.*, 60.

SAID, R., 1949—Foraminifera of the Northern Red Sea. *Spec. Publ. Cushman Lab.*, 26, 1–44.

SAID, R., 1950—Additional Foraminifera from the Northern Red Sea. *Contr. Cushman Fdn*, 1 (1), 4–9.

SAMANIEGO, R. M., & GONZALES, B. A., 1957—Some smaller Foraminifera from the Pliocene of Panay Island, Philippines. *J. Paleont. Soc. India*, 2, 192–208.

*SCHLUMBERGER, C., 1882—Note sur quelques Foraminifères nouveaux ou peu connus du golfe de Gascogne; Campagne du Travailleur, 1880. *Feuille Jeunes Nat.*, Paris, 154, 117–120.

*SCHMARDA, L. K., 1871—ZOOLOGIE. *Vienna, Braumuller.*

*SCHROETER, J. S., 1782—Der Naturforscher, 17, 118–120.

*SCHROETER, J. S., 1783—Einleitung in die Conchylienkenntnis nach Linne. *Halle, Gabauer*, 1, 1–860.

*SCHUBERT, R. J., 1904—Die Ergebnisse der mikroskopischen Utersuchung der bei der ararischen Tiefbohrung zu Wels durchteuften Schichten. *Jb. geol. Reichsanst.*, 53 (1903), (3).

*SCHULTZE, M. S., 1854—Ueber den Organismus der Polythalamien (Foraminiferen), nebst Bemerkungen uber die Rhizopoden im Allgemeinen. *Wilhelm Englemann, Leipzig*, 1–68.

*SCHWAGER, C., 1866—Fossile Foraminiferen von Kar Nikobar. *Novara Exped.*, 1857–1859, *geol. Theil*, 2 (2), 187–268.

*SCHWAGER, C., 1876—Saggio di una classificazione dei Foraminiferi avuto riguardo alle loro famiglie naturalie. *Com. geol. Italia, Bull.*, 7, (11–12), 1, 475–485.

*SEGUENZA, G., 1862—Prime ricerche intorna ai rizopodi fossile delle argille Pleistoceniche dei dintorni di Catania. *Accad. Gioenia Sci. nat. Catania*, 2 (18), 84–126.

SIDEBOTTOM, H., 1918—Report on the Recent Foraminifera dredged off the east coast of Australia, H.M.S. 'Dart' station 19 (May 14, 1895), Lat. 29° 22′ S., Long. 153° 51′ E., 465 fathoms. Pteropod ooze. *J. Roy. microsc. Soc. London*, 121–152.

*SIEBOLD, C. T. E. VON, in SIEBOLD, C. T. E. VON, and STANNIUS, H. VON, 1845—LEURBUCH DER VERGLEICHENDE ANATOMIE: pt. 1, Wirbellose Thiere, No. 1, 1–679.

SLUIS, J. P. VAN DER, and VLETTER, D. R. DE, 1942—Youngtertiary smaller Foraminifera from the neighbourhood of Ngimbang, East Java. *Proc. Acad. Sci. Amst.*, 45 (10), 1010–1015.

SMITH, PATSY B., 1963—Quantitative and qualitative analysis of the Family Bolivinidae. *Prof. Pap. U.S. geol. Surv.*, 429-A, 1–39.

SMOUT, A. H., 1954—Lower Tertiary Foraminifera of the Qatar Peninsula. *Monogr. British Mus. nat. Hist.*, I-IX, 1–96.

SMOUT, A. H., 1955—Reclassification of the Rotaliidea (Foraminifera) and two new Cretaceous forms resembling *Elphidium*. *J. Wash. Acad. Sci.*, 45, (7) 201–210.

STACHE, G., 1865—Die Foraminiferen der tertiären Mergel des Whaingaroa-Hafens (Prov. Auckland). *Novara Exped.*, 1857–1859, *geol. Theil*, 1 (2), 159–304.

STANLEY, E. R., 1923—Report on the salient geological features and natural resources of the New Guinea Territory. *Rep. on Territory of New Guinea, Parl. Pap.*, 18, Appendix B, 1–99.

SUBBOTINA, N. N., PISCHVANOVA, L. S., and IVANOVA, L. V., 1960—Stratigraphy of the Oligocene and Miocene deposits of the Precarpathian region by means of Foraminifera. *Microfauna SSSR*, 11, 5–127. (in Russian).

THALMANN, H. E., 1932—Nomenclator (Um- and Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk uber die Foraminiferen der Challenger-Expedition, London, 1884, *Ecl. geol. helv.*, 25 (2), 293–312.

THALMANN, H. E., 1934—Mitteilungen über Foraminiferen, I. *Ecl. geol. helv.*, 27 (2), 428–440.

THALMANN, H. E., 1950—New names and homonyms in Foraminifera. *Contr. Cushman Fdn*, 1 (3–4), 41–45.

THALMANN, H. E., 1952—Bibliography and index to new genera, species and varieties of Foraminifera for the year 1951. *J. Paleont.*, 26 (6), 953–992.

TINOCO, I. DE M., 1958—Foraminiferos Quaternarios de Olinda, Estado de Pernambuco. *Monogr. Ser. graf. Inst. brasil. Geog. e Estat., Div. Geol. Mineral.*, 14, 1–61.

TODD, RUTH, 1953—Foraminifera from the Lower Tertiary of Amchitka Island, Aleutian Islands. *Contr. Cushman Fdn*, 4 (1), 1–7.

TODD, RUTH, 1957—Smaller Foraminifera, *in* Geology of Saipan, Mariana Islands, part 3. Paleontology. *Prof. Pap. U.S. geol. Surv.* 280–H, 265–320.

TODD, RUTH, 1958—Foraminifera from Western Mediterranean deep-sea cores. Sediment cores from the Mediterranean Sea and the Red Sea, No. 3. *Rep. Swedish Deep-Sea Exped.*, 8, 169–215.

TODD, RUTH, 1961—Foraminifera from the Onotoa Atoll, Gilbert Islands. *Prof. Pap. U.S. geol. Surv.* 354–H, 171–191.

TODD, RUTH, 1963—Nomenclature of Foraminifera. *Contr. Cushman Fdn*, 14 (3), 109–111.

TODD, RUTH, and BLACKMON, P., 1956—Calcite and aragonite in Foraminifera. *J. Paleont.*, 30 (1), 217–219.

TODD, RUTH, and BRONNIMANN, P., 1957—Recent Foraminifera and Thecamoebina from the Eastern Gulf of Paria. *Spec. Publ. Cushman Fdn*, 3, 1–43.

TODD, RUTH, and LOW, DORIS, 1961—Near-shore Foraminifera of Martha's Vineyard Island, Massachusetts. *Contr. Cushman Fdn*, 12 (1), 5–21.

TODD, RUTH, and POST, RITA, 1954—Smaller Foraminifera from Bikini drill holes. *Prof. Pap. U.S. geol. Surv.*, 260-N, 546–568.

TOULA, F., 1915—Über den marinen Tegel von Neudorf an der March (Deveny-Ujfalu) in Ungarn and seine Mikrofauna. *Jb. Geol. Reichsanst.*, 64 (1914), 4, 635–674.

TOULMIN, L. D., 1941—Eocene smaller Foraminifera from the Salt Mountain Limestone of Alabama. *J. Paleont.*, 15 (6), 567–611.

*TRAUTH, F., 1918—Das Eozänvorkommen bei Radstadt im Pongau und seine Beziehungen zu den gleichalterungen Ablagerungen bei Kirchberg am Wechsel and Wimpassing am Leithgebirge. *Denkschr. Akad. Wiss. Wien, Math.-Naturw. Kl.*, 95, 171–278.

TROELSEN, J. C., 1954—Studies on Ceratobuliminidae (Foraminifera). *Medd. dansk geol. Foren.*, 12, 448–472.

TROELSEN, J. C., 1955*a*—On the value of aragonite test in the classification of the Rotaliidea. *Contr. Cushman Fdn*, 6 (1), 50–51.

TROELSEN, J. C., 1955*b*—Notes on *Ceratobulimina* and *Allomorphina. Ibid.*, 6 (2), 80–81.

UCHIO, T., 1960—Ecology of living benthonic Foraminifera from the San Diego, California, area. *Spec. Publ. Cushman Fdn*, 5, –172.

VELLA, P., 1957—Studies in New Zealand Foraminifera. *Palaeont. Bull. N.Z. geol. Surv.*, 28, 1–64.

VLERK, I. M., VAN DER, 1955—Correlation of the Tertiary of the Far East and Europe. *Micropaleontology*, 1 (1), 72–75.

VOLOSHINOVA, N. A., 1958—New systematics of the Nonionidae. *Microfauna SSSR*, 9, 117–191.

VOLOSHINOVA, N. A., 1960—Uspekhi mikropaleontologii v dele izucheniya vnutrennego stroeniya foraminifer. *Trudy Permogo Seminara po Mikrofaune*, VNIGRI, 48–87.

WALTON, W. R., 1955—Ecology of living benthonic Foraminifera, Todos Santos Bay, Baja California. *J. Paleont.*, 29 (6), 952–1018.

WEDEKIND, P. R., 1937—EINFUHRUNG IN DIE GRUNDLAGEN DER HISTORISCHEN GEOLOGIE, BAND II. MIKROBIOSTRATIGRAPHIE DIE KORALLEN UND FORAMINIFERENZEIT. *Stuttgart, Enke*, 1–136.

WHITE, W. R., 1956—Pliocene and Miocene Foraminifera from the Capistrano Formation, Orange County, California. *J. Paleont.*, 30 (2), 237–260.

*WILLIAMSON, W. C., 1858—On the Recent Foraminifera of Great Britain. *Roy. Soc., London*, 1–107.

WOOD, A., 1949—The structure of the wall of the test in the Foraminifera; its value in classification. *Quart. J. geol. Soc. London*, 104, 229–255.

WOOD, A., 1963—Wall structure of Foraminifera in polarised light. *Micropaleontology*, 9 (4), 432.

WOOD, A., and HAYNES, J., 1957—Certain smaller British Paleocene Foraminifera. Part II—*Cibicides* and its allies. *Contr. Cushman Fdn*, 8 (2), 45–53.

WOOD, A., HAYNES, J., and ADAMS, T. D., 1963—The structure of *Ammonia beccarii* (Linné). *Contr. Cushman Fdn*, 14 (4), 156–157.

YABE, H., and ASANO, K., 1937—Contribution to the palaeontology of the Tertiary Formations of West Java. Part 1. Minute Foraminifera from the Neogene of West Java. *Sci. Rep. Tohoku Imp. Univ.*, 2nd ser. (Geol.), 19 (1), 87–126.

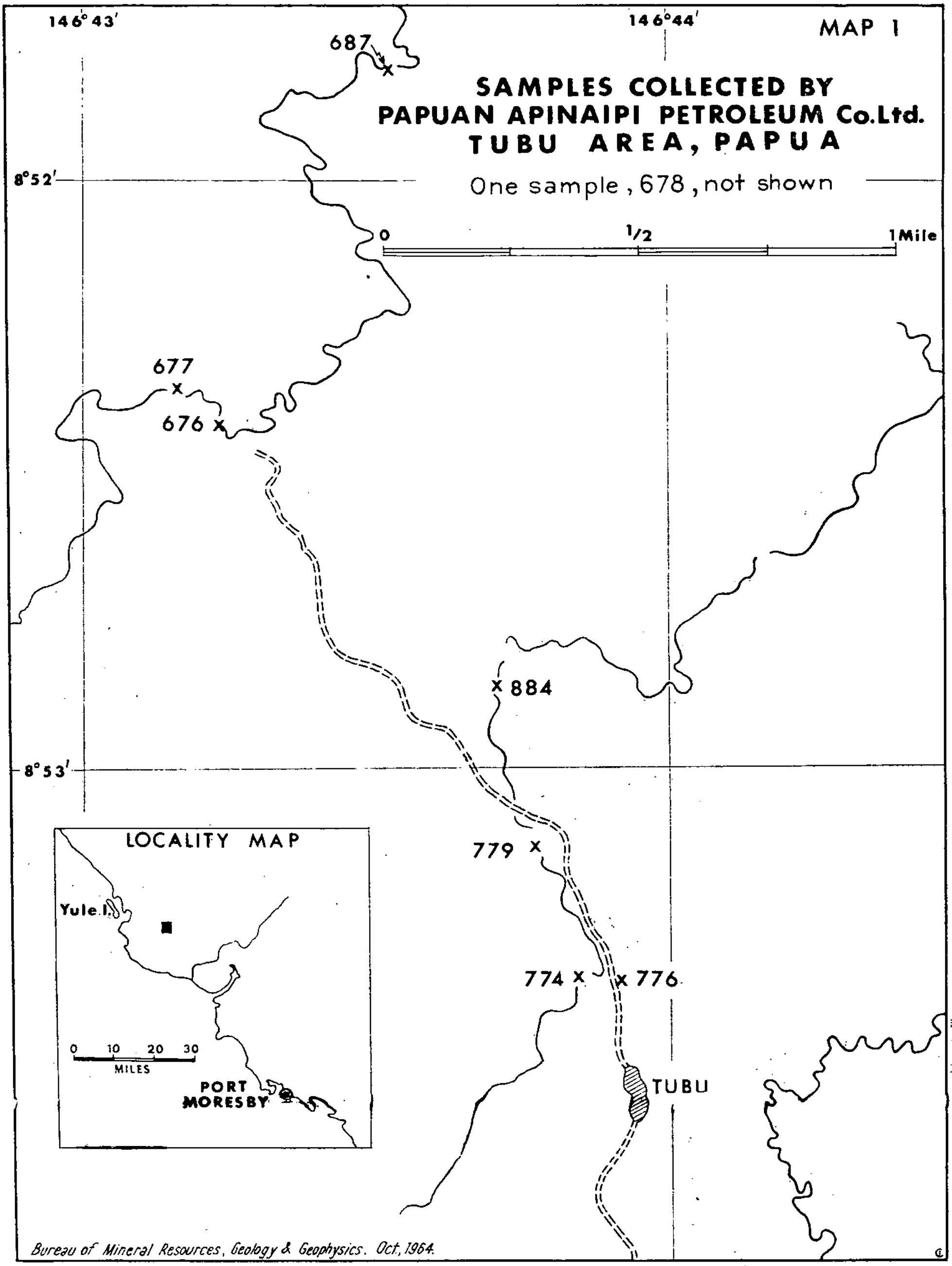
Appendix 1

SAMPLE LOCALITIES

PAPUA

1. *Tubu area* (Map 1). Samples forwarded by the Papuan Apinaipi Petroleum Company Ltd, from the 'Tubu Siltstone' (upper Miocene).

   1a, sample 676.
   1b, sample 677.
   1c, sample 678.
   1d, sample 687.
   1e, sample 774.
   1f, sample 776.
   1g, sample 779.
   1h, sample 884.


146°43'
146°44'
MAP 1
SAMPLES COLLECTED BY
PAPUAN APINAIPI PETROLEUM Co.Ltd.
TUBU AREA, PAPUA
One sample, 678, not shown
0
1/2
1 Mile
8°52'
8°53'
687
677
676
884
779
774
776
TUBU
LOCALITY MAP
Yule I.
0 10 20 30
MILES
PORT MORESBY
Bureau of Mineral Resources, Geology & Geophysics. Oct, 1964.

Yule Island and Delena-Pokama areas (Map 3). Samples forwarded by Mines Administration Pty Ltd.

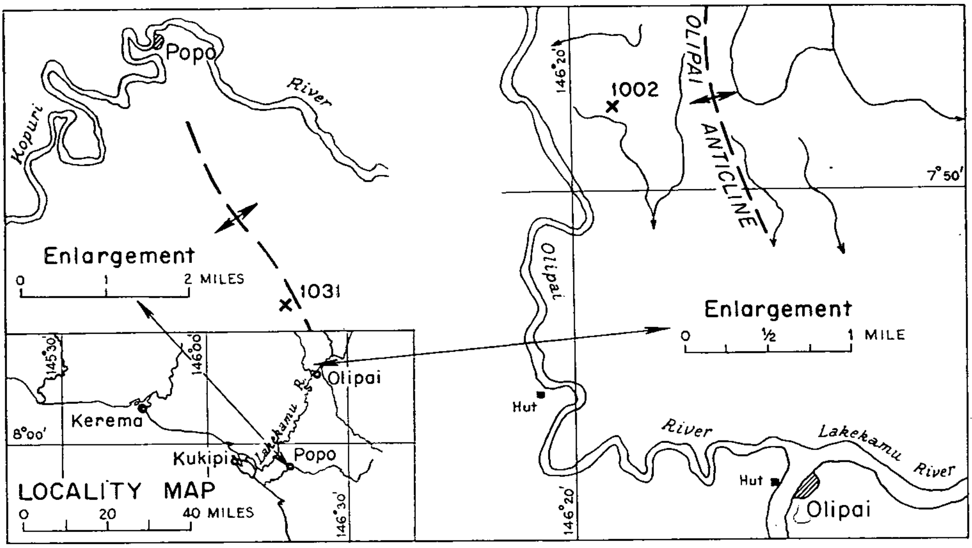
2. Sample 1830, sea-cliff below the L.M.S. Mission, Delena (lower Miocene, Burdigalian).
3. Sample 1836, sea-cliff 250 yards north of the L.M.S. Mission, Delena, (lower Miocene, Burdigalian).
4. Sample 1902, west of the wharf at the Roman Catholic Mission, Yule Island (lower Miocene, Burdigalian).

Lakekamu River and Popo areas (Map 2). Samples forwarded by Mines Administration Pty Ltd.

5. Sample 1002, 2½ miles north-north-west of the Olipai River-Lakekamu River junction (upper Miocene).
6. Sample 1031, near the culmination of the Popo Anticline, 3½ miles south-south-east of Popo village (upper Miocene).

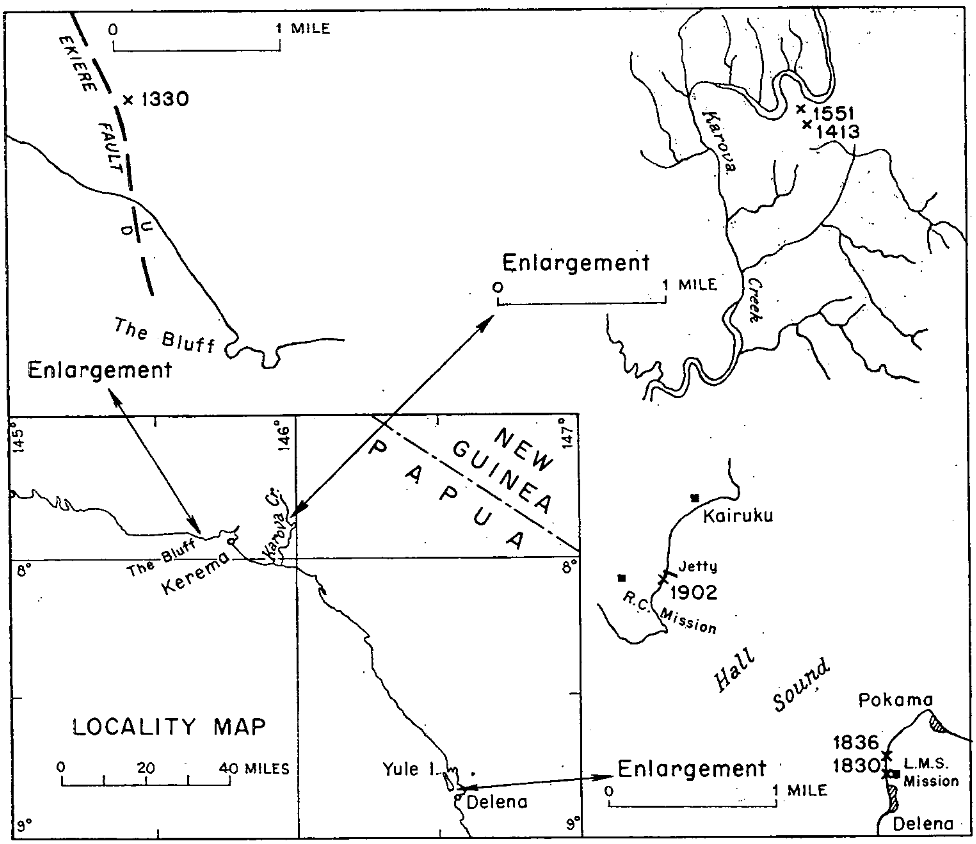
Kerema-Karova Creek area (Map 3). Samples forwarded by Mines Administration Pty Ltd.

7. Samples east of Karova Creek (middle Miocene.)
   7a, sample 1413.
   7b, sample 1551.
8. Sample 1330, Aipa Hills area, east of the Ekiere Fault (middle Miocene).



Bureau of Mineral Resources, Geology and Geophysics. October, 1964.

Map 2 Samples collected by Mines Administration Pty. Ltd.
Lakekamu River and Popo areas, Papua

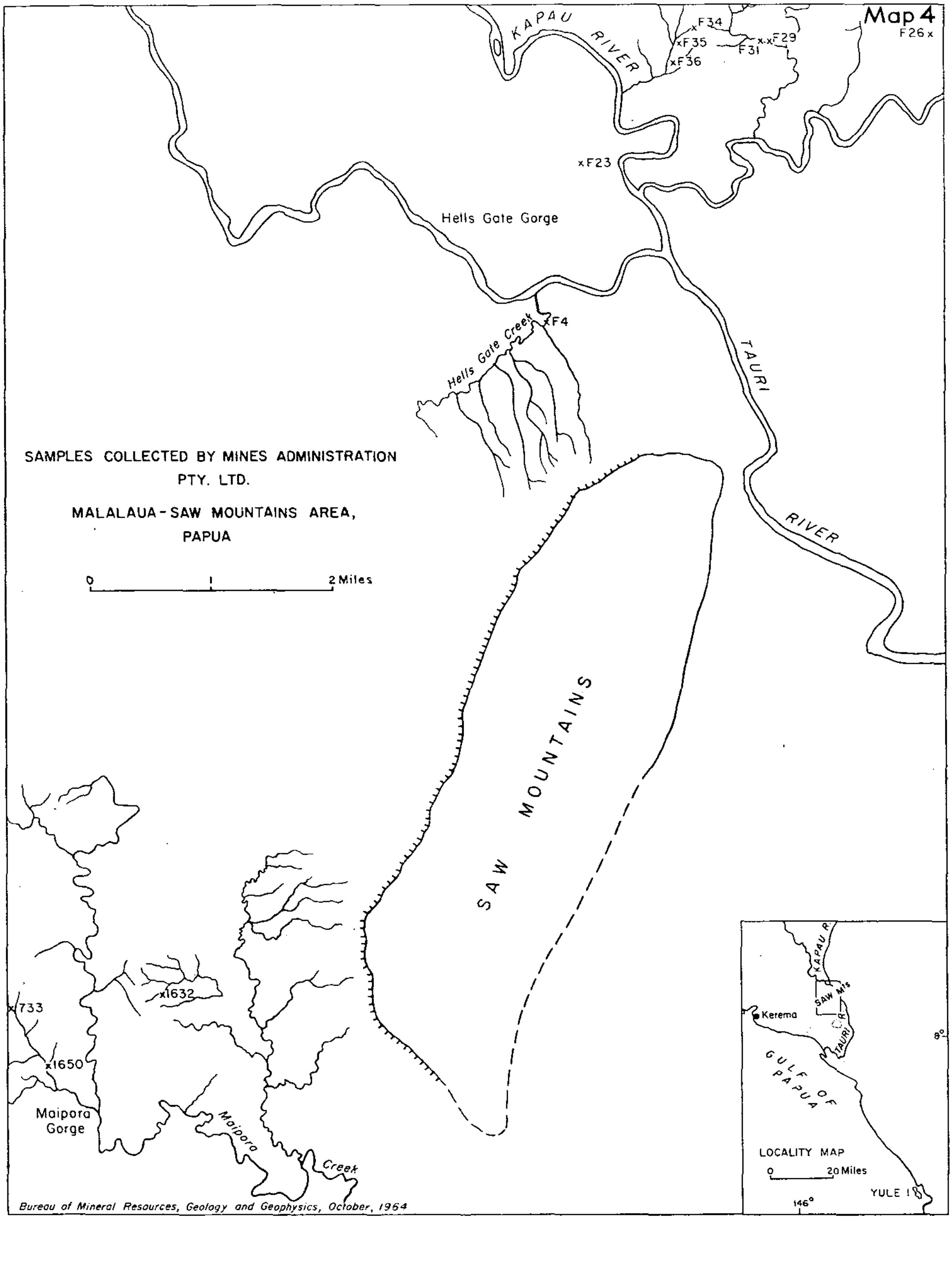


Bureau of Mineral Resources, Geology and Geophysics. October, 1964.

Map 3 Samples collected by Mines Administration Pty. Ltd.
Yule Island and Delena-Pokama areas, and Kerema-Karova
Creek areas, Papua

Malalaua-Saw Mountains area (Map 4). Samples forwarded by Mines Administration Pty Ltd.

9. Samples on upper Maipora Creek, west of the Saw Mountains (middle Miocene).
   - 9a, sample 733.
   - 9b, sample 1632.
   - 9c, sample 1650.
10. Sample F. 4, on Hell's Gate Creek, about ½ mile from the junction with the Tauri River (lower Miocene, Burdigalian).
11. Sample F.23, Poison Creek ½ mile west of the Kapau River (middle Miocene).
12. Samples from a section through the 'Murua Mudstone', Yamuiti Creek area (upper Miocene).
    - 12a, sample F.26.
    - 12b, sample F. 29.
    - 12c, sample F.31.
    - 12d, sample F.34.
    - 12e, sample F.35.
    - 12f. sample F.36.


Map 4
KAPAU RIVER
F34
F35
F36
F31
F29
F26
F23
Hells Gate Gorge
F4
Hells Gate Creek
TAURI RIVER
SAMPLES COLLECTED BY MINES ADMINISTRATION PTY. LTD.
MALALAUA - SAW MOUNTAINS AREA, PAPUA
0 1 2 Miles
SAW MOUNTAINS
733
1632
1650
Maipora Gorge
Maipora Creek
LOCALITY MAP
KAPAU R.
SAW Mts
Kerema
TAURI R.
GULF OF PAPUA
0 20 Miles
YULE I
146°
8°
Bureau of Mineral Resources, Geology and Geophysics, October, 1964

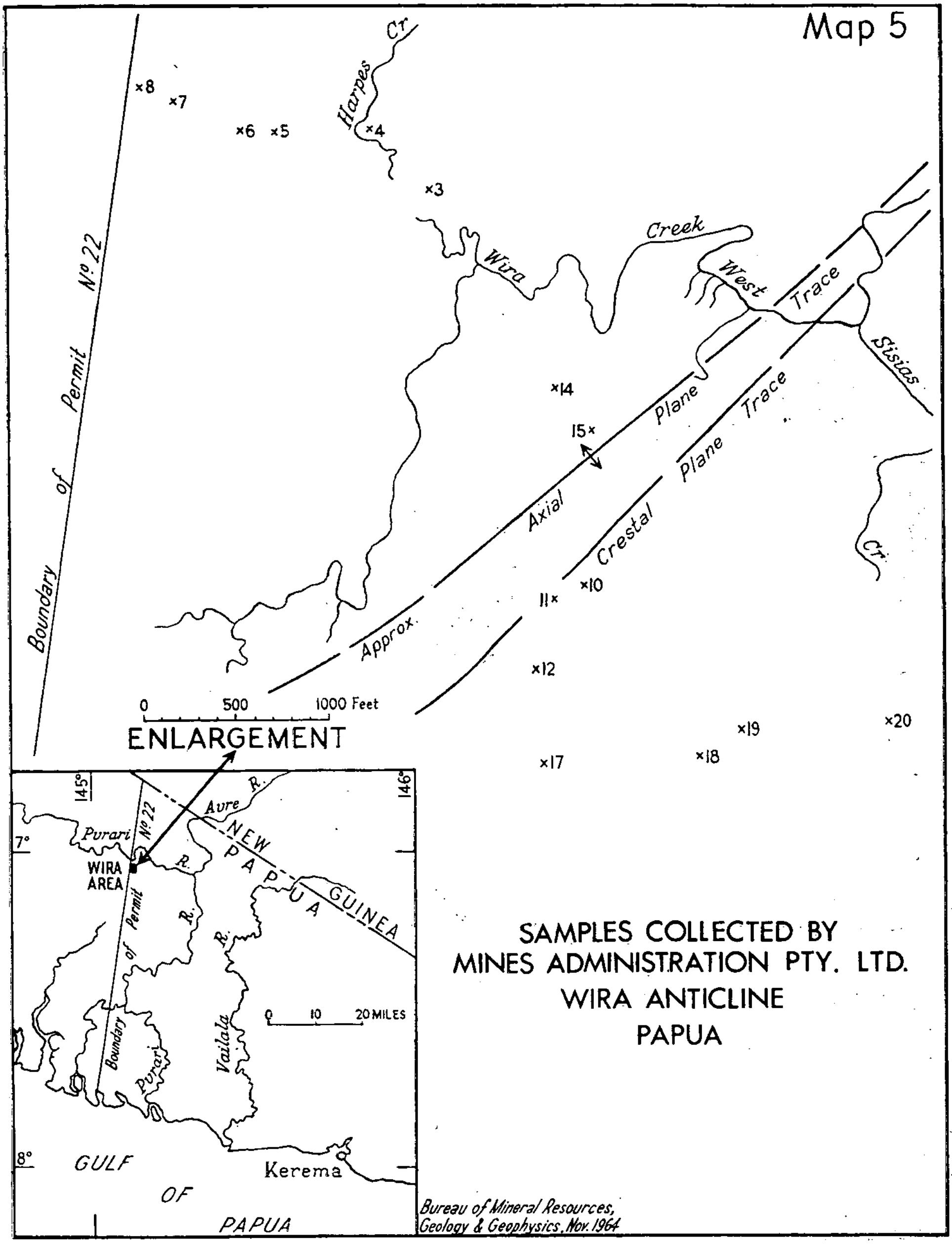
Wira Anticline, Puri-Purari River area (Map 5). Samples forwarded by Mines Administration Pty Ltd.

13. Samples from the north-west flank (upper Miocene).

    13h, sample 8.
    13g, sample 7.
    13f, sample 6.
    13e, sample 5.
    13d, sample 4. — 300 foot section.
    13c, sample 3.
    13b, sample 14, 15.
    13a, sample 10, 11, 12.

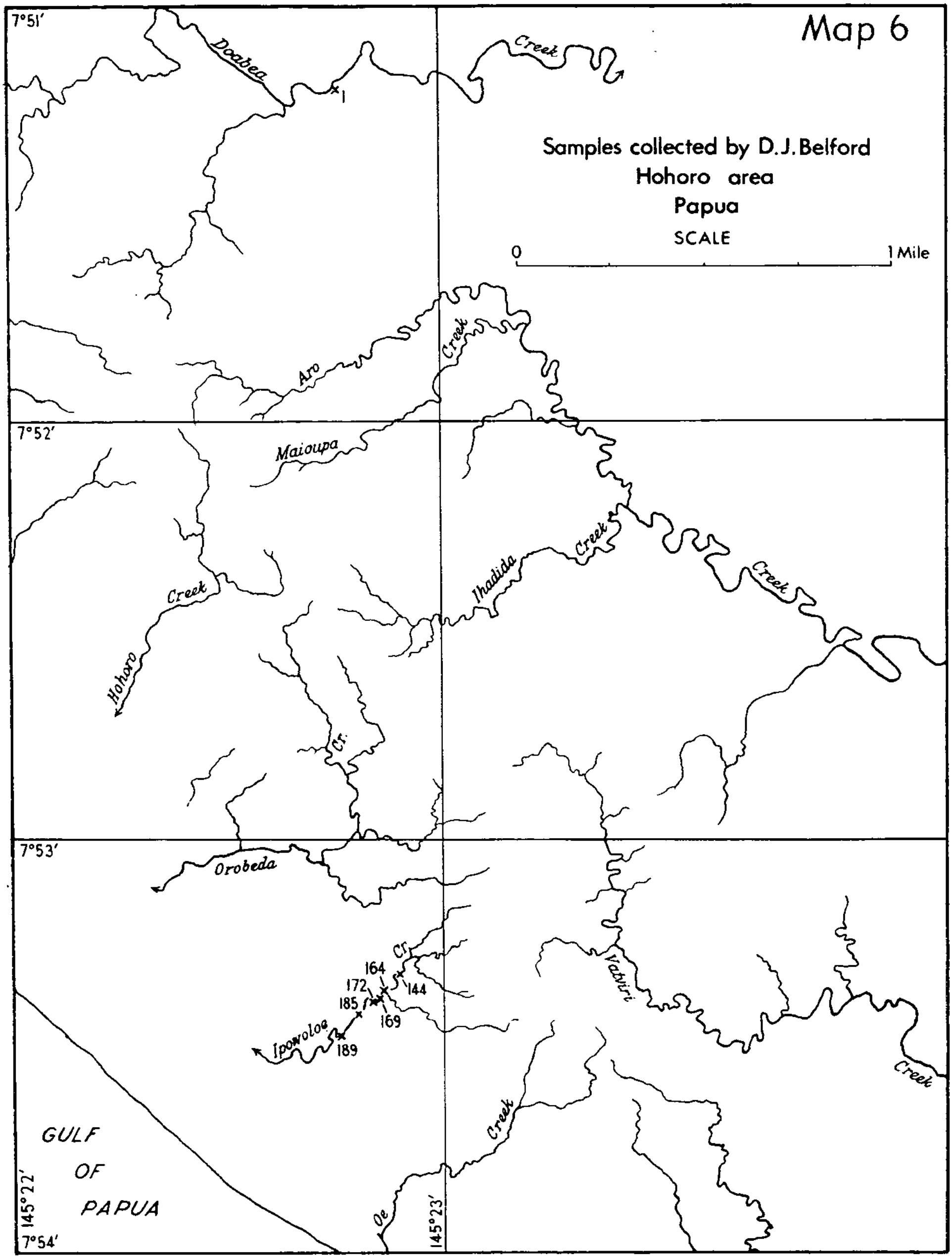
14. Samples from the south-east flank (upper Miocene).

    14d, sample 20.
    14c, sample 19. — 200 foot section.
    14b, sample 18.
    14a, sample 17.


Map 5
SAMPLES COLLECTED BY
MINES ADMINISTRATION PTY. LTD.
WIRA ANTICLINE
PAPUA
Boundary of Permit Nº 22
Harpes Cr.
Wira Creek
West Trace
Sisias Cr.
Approx. Axial Plane Trace
Crestal Plane Trace
×8 ×7 ×6 ×5 ×4 ×3 ×14 15× ×10 11× ×12 ×17 ×18 ×19 ×20
0 500 1000 Feet
ENLARGEMENT
145° 146° 7° 8°
Purari
Aure R.
NEW GUINEA
PAPUA
WIRA AREA
Vailala R.
0 10 20 MILES
GULF OF PAPUA
Kerema
Bureau of Mineral Resources, Geology & Geophysics, Nov. 1964

15. *Hohoro area* (Map 6). Samples collected by D. J. Belford (Pliocene).

15a, sample 1, 'Vaiviri Formation', Doabea Creek.
15b, sample 144, 'Doabea Formation', Ipowoloe Creek.
15c, sample 164, 'Vaiviri' Formation', Ipowoloe Creek.
15d, sample 169, 'Vaiviri Formation', Ipowoloe Creek.
15e, sample 172, 'Vaiviri Formation', Ipowoloe Creek.
15f, sample 185, 'Vaiviri' Formation', Ipowoloe Creek.
15g, sample 189, 'Vaiviri Formation', Ipowoloe Creek.

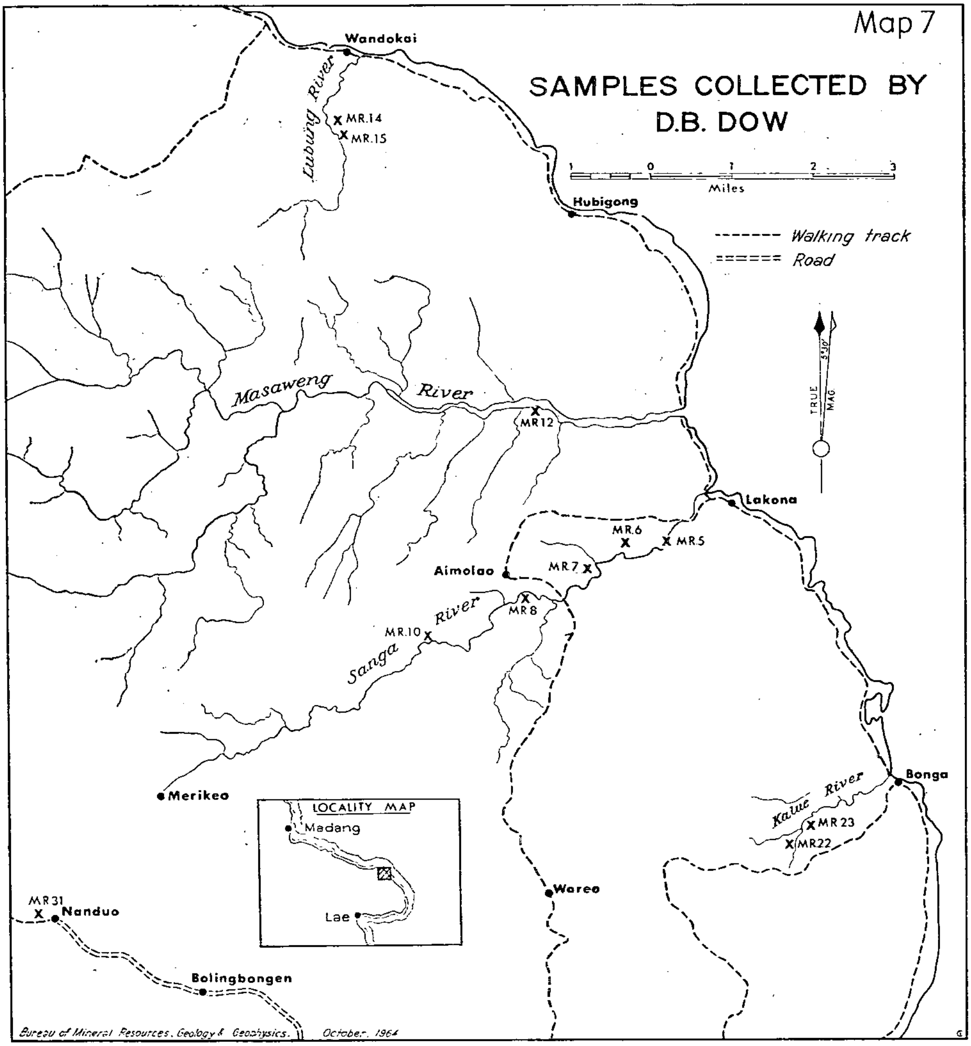

Map 6
Samples collected by D.J. Belford
Hohoro area
Papua
SCALE
0
1 Mile
7°51′
7°52′
7°53′
7°54′
145°22′
145°23′
Doabea
Creek
Aro
Creek
Maioupa
Ihadida
Creek
Creek
Creek
Hohoro
Cr.
Orobeda
Cr.
Ipowoloa
Vabiri
Creek
Creek
Oe
GULF
OF
PAPUA
1
164
172
185
144
169
189

NEW GUINEA

North of Finschhafen (Map 7). Samples collected by D. B. Dow, Bureau of Mineral Resources.

16. Samples from the Masaweng River area (upper Miocene).

    16a, sample MR.5.
    16b, sample MR.6.
    16c, sample MR.7.
    16d, sample MR.8.
    16e, sample MR.10.
    16f, sample MR.12.
    16g, sample MR.14.
    16h, sample MR.15.
    16i, sample MR.22.
    16j, sample MR.23.
    16k, sample MR.31.

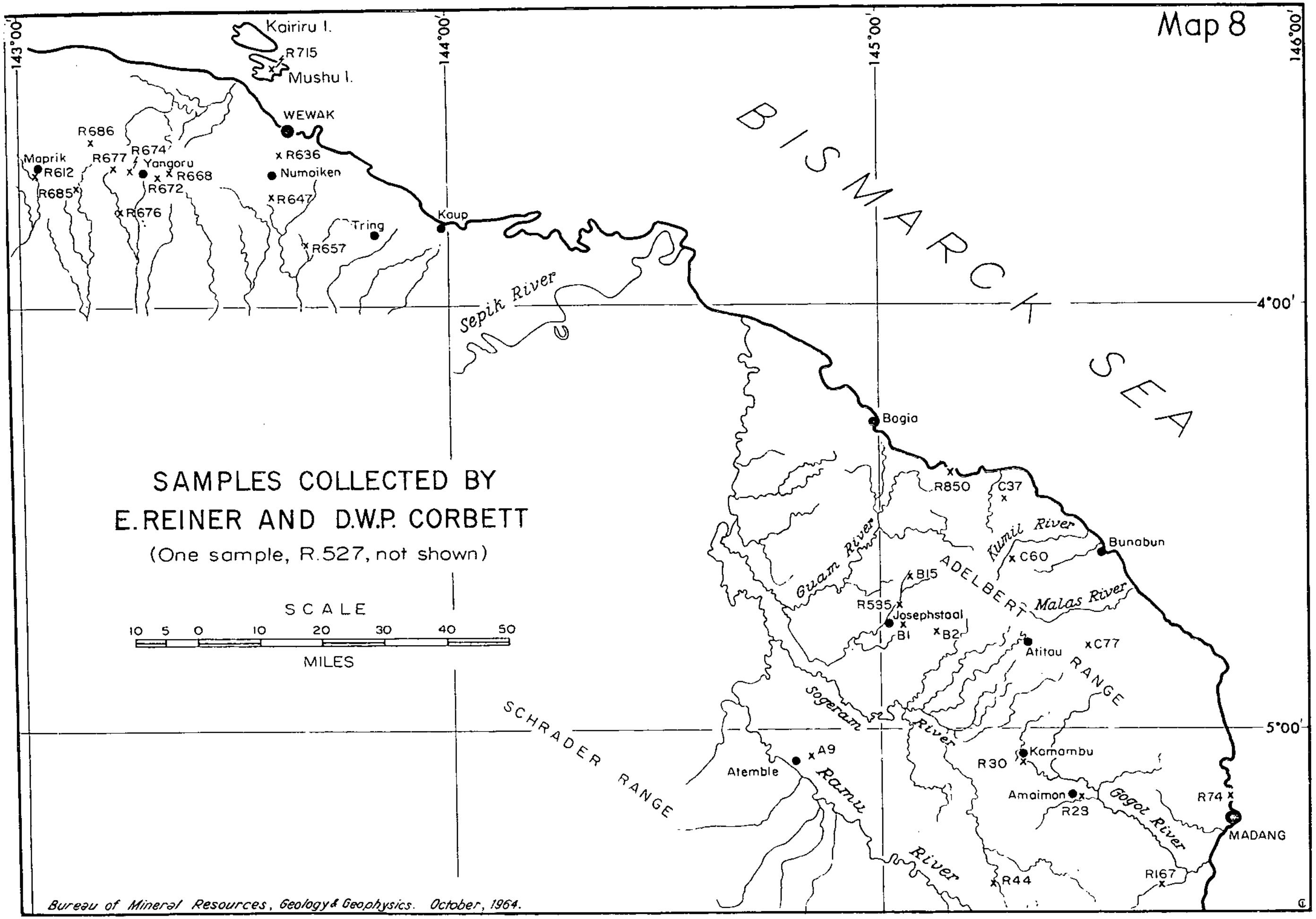

Map 7
SAMPLES COLLECTED BY D.B. DOW
Miles
Walking track
Road
TRUE
MAG
Wandokai
Lubung River
MR.14
MR.15
Hubigong
Masaweng River
MR12
Lakona
MR.6
MR5
MR.7
Aimolao
MR8
MR.10
Sanga River
Merikeo
LOCALITY MAP
Madang
Lae
Bonga
Kaiue River
MR 23
MR22
Wareo
MR31
Nanduo
Bolingbongen
Bureau of Mineral Resources, Geology & Geophysics.
October, 1964

Central and Western Highlands (Map 8). Samples collected by Dr E. Reiner, formerly of the Division of Land Research and Regional Survey, Commonwealth Scientific and Industrial Research Organisation.

17. Sample R. 7, in the road cutting at the new residence, north of the aerodrome, Madang (Pliocene).
18. Sample R.23, east of Amaimon, between the Gogol River and Amaimon (upper Miocene).
19. Sample R.30, from the top of the ridge south of Kamambu (Old Kamambu) (upper Miocene).
20. Sample R.44, in the river below Banap II (upper Miocene).
21. Sample R.167, Nuru Valley, between Diduella and Old Bauri, on hill with garden plot (upper Miocene).
22. Sample R.527, Kolialo Creek, west of Tintingenei, Josefstaal subdistrict, Bogia district (upper Miocene).
23. Sample R.535, east of Moie, Josefstaal subdistrict, Bogia district (upper Miocene).
24. Sample R.550, in the road cutting south of Moab, Bogia district, (upper Miocene).
25. Sample R.612, below the cliff at Maprik, Screw River, Sepik district (upper Miocene).
26. Sample R.636, Numoiken road, south of Wewak, Sepik district (upper Miocene).
27. Sample R.647, Nagam River, west of Periama village, Wewak subdistrict, Sepik district (uppermost Miocene or Pliocene).
28. Sample R.657, in the creek of Ibab village, Wewak subdistrict, Sepik district (Pliocene).
29. Sample R.668, in the valley west of Montsi village, Wewak subdistrict, Sepik district (upper Miocene).
30. Sample R.672, east of Yekimbolje village, Maprik subdistrict, Sepik district (upper Miocene).
31. Sample R.674, west of Yangoru, Maprik subdistrict, Sepik district (upper Miocene).
32. Sample R.676, in the creek near Wibiti I village, Maprik subdistrict, Sepik district (Pliocene).
33. Sample R.677, Tjidiletebe village, Maprik subdistrict, Sepik district (upper Miocene).
34. Sample R.685, in the creek west of Winge, Maprik subdistrict, Sepik district (upper Miocene).
35. Sample R.686, north road near Kabeubis village, Maprik subdistrict, Sepik district (upper Miocene).
36. Sample R.715, Forsayth Plantation, Mushu Island, Sepik district (Pliocene).

Samples collected by Dr D. W. P. Corbett, formerly of the Bureau of Mineral Resources.

37. Sample A.9, east of Atemble, Lower Ramu-Atitau area (Pliocene).
38. Sample B.1, 2 miles east of Josefstaal, Lower Ramu-Atitau area (upper Miocene).
39. Sample B.2, Kisila village, east of Josefstaal, Lower Ramu-Atitau area (upper Miocene).
40. Sample B.15, Pagansop village, north-north-east of Josefstaal, Lower Ramu-Atitau area (upper Miocene).
41. Sample C.37, on a tributary of Kaukomba Creek, Lower Ramu-Atitau area (upper Miocene).
42. Sample C.60, 1 mile south of the Kumil River, Lower Ramu-Atitau area (upper Miocene).
43. Sample C.77, Subesam village, Lower Ramu-Atitau area (upper Miocene).



Map 8
SAMPLES COLLECTED BY
E. REINER AND D.W.P. CORBETT
(One sample, R.527, not shown)
SCALE
10 5 0 10 20 30 40 50
MILES
143°00'
144°00'
145°00'
146°00'
4°00'
5°00'
BISMARCK SEA
Kairiru I.
R715
Mushu I.
WEWAK
R686
Maprik
R612
R685
R677
R674
Yangoru
R668
R672
R676
R636
Numoiken
R647
R657
Tring
Kaup
Sepik River
Bogia
R850
C37
Kumil River
Bunabun
C60
Guam River
B15
ADELBERT
Malas River
R535
Josephstaal
B1
B2
Atitau
C77
RANGE
Sogeram River
SCHRADER RANGE
A9
Atemble
Ramu River
Kamambu
R30
Amaimon
R23
Gogol River
R74
MADANG
R167
R44
Bureau of Mineral Resources, Geology & Geophysics. October, 1964.

PLATES

PLATE 1

Figures		Page
1–2	*Brizalina alata* (Seguenza)	24
	1, CPC 6164, side view, x 40.	
	2, CPC 6165, side view, x 40.	
3–4	*Brizalina capitata* (Cushman)	26
	3, CPC 6166, side view, x 80.	
	4, CPC 6167, side view, x 80.	
5–7	*Bolivina robusta* Brady	21
	5, CPC 6161, side view; 6, edge view, both x 41.	
	7, CPC 6162, side view, x 41.	
8–9	*Brizalina plicatella* (Cushman)	26
	8, CPC 6168, side view, x 80.	
	9, CPC 6169, side view, x 80.	
10–12	*Brizalina* sp. cf. *B. variabilis* (Williamson)	27
	10, CPC 6171, side view; 11, edge view, both x 145.	
	12, CPC 6172, side view, x 145.	
13–16	*Brizalina pseudobeyrichi* (Cushman)	28
	13, CPC 6173, side view; 14, edge view, both x 58.	
	15, CPC 6174, side view, x 62.	
	16, CPC 6175, side view, x 53.	
17–18	*Brizalina subreticulata* (Parr)	29
	17, CPC 6176, side view, x 110.	
	18, CPC 6177, side view, x 110.	
19–22	*Brizalina* sp. cf. *B. pygmaea* (Brady)	31
	19, CPC 6180, side view; 20, edge view, both x 144.	
	21, CPC 6181, side view, x 144.	
	22, CPC 6182, side view, x 144.	


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 2

Figures		Page
1–6	*Brizalina multilineata* sp.nov.	31
	1, CPC 6183, holotype, side view, x 65.	
	2, paratype A, CPC 6184, side view, x 65.	
	3, paratype B, CPC 6185, side view, x 65.	
	4–5, paratype C, CPC 6186. 4, side view; 5, edge view, both x 74.	
	6, paratype, CPC 6187, side view, x 68.	
7–10	*Brizalina macella*, sp.nov.	33
	7–8, holotype CPC 6188. 7, side view; 8, edge view. 7, x 50; 8, x 56.	
	9, paratype A, CPC 6189, side view, x 50.	
	10, paratype B, CPC 6190, side view, x 50.	
11–12	*Brizalina vescistriata*, sp.nov.	34
	11, holotype, CPC 6191, side view, x 67.	
	12, paratype, CPC 6192, side view, x 67.	
13–16	*Brizalina semilineata*, sp.nov.	35
	13–14, holotype, CPC 6193. 13, side view; 14, edge view, both x 60.	
	15, paratype A, CPC 6194, side view, x 60.	
	16, paratype B, CPC 6195, side view, x 60.	
17–19	*Brizalina patula*, sp.nov.	37
	17, holotype, CPC 6196, side view, x 75.	
	18, paratype A, CPC 6197, side view, x 75.	
	19, paratype B, CPC 6198, side view, x 75.	
20–22	*Brizalina hastula*, sp.nov.	38
	20–21, holotype, CPC 6199. 20, side view; 21, edge view, both x 74.	
	22, paratype, 6200, side view, x 74.	
23–25	*Brizalina karreriana* (Brady)	39
	23, CPC 6201, side view; 24, edge view, both x 52.	
	25, CPC 6202, side view, x 52.	

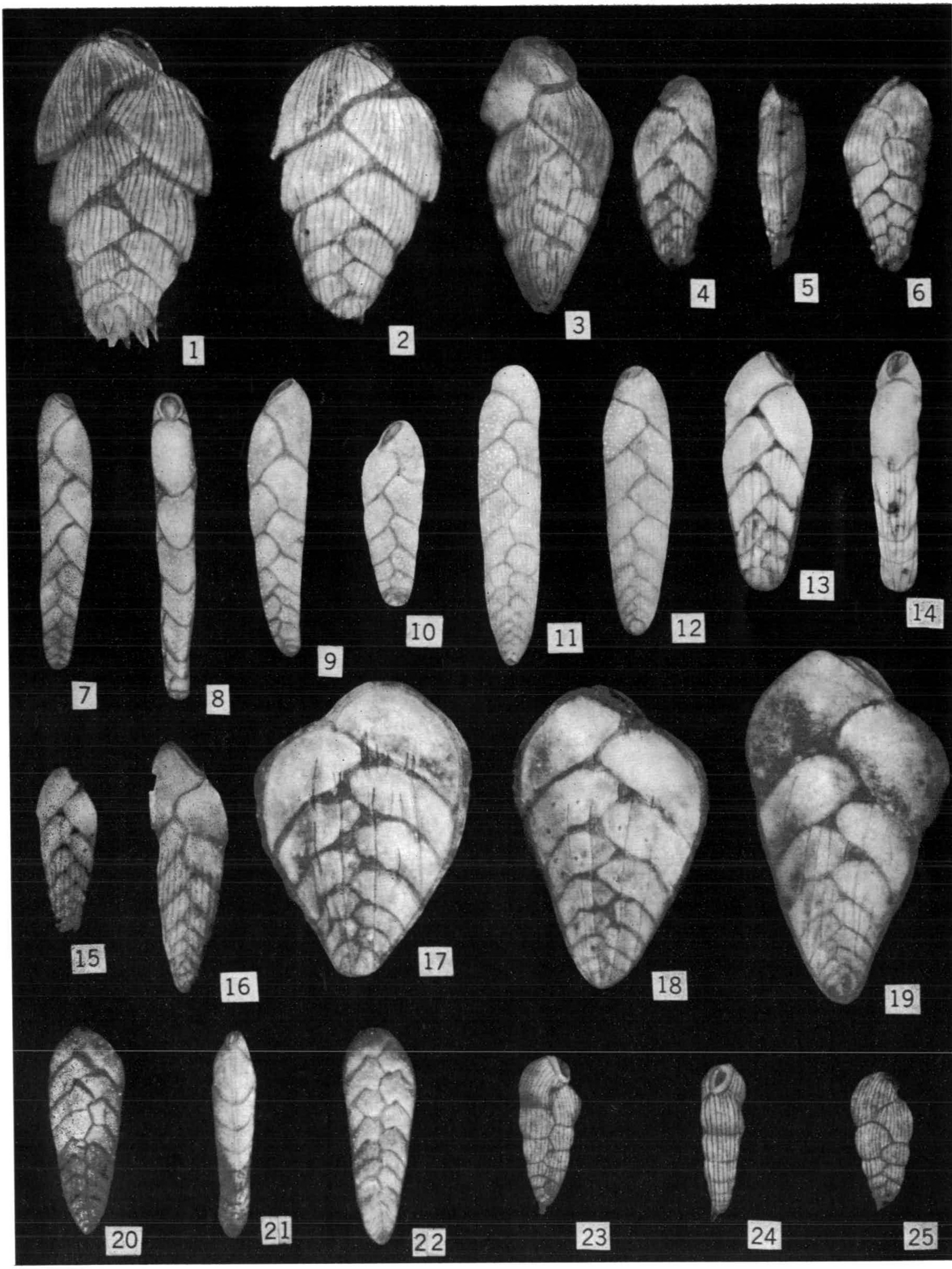

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

PLATE 3

Figures		Page
1–2	*Brizalina catenula*, sp.nov.	39
	1, holotype, CPC 6203, side view, x 127.	
	2, paratype, CPC 6204, side view, x 127.	
3–4	*Brizalina massula*, sp.nov.	40
	3, holotype, CPC 6205, side view, x 50.	
	4, paratype, CPC 6206, side view, x 50.	
5–7	*Brizalina tuberosa*, sp.nov.	41
	5–6, holotype, CPC 6207. 5, side view, x 128; 6, edge view, x 89.	
	7, paratype, CPC 6208, side view, x 128.	
8–11	*Bolivinita subangularis* (Brady)	19
	8, CPC 6159, side view; 9, top view; 10, edge view; all x 43.	
	11, CPC 6160, side view, x 48.	
12–13	*Brizalina semicarinata* sp.nov.	42
	12, holotype, CPC 6209, x 55.	
	13, paratype, CPC 6210, 55.	
14–16	*Laterostomella voluta*, sp.nov.	44
	14–15, holotype, CPC 6216, two side views, each x 150.	
	16, paratype, CPC 6217, x 150.	

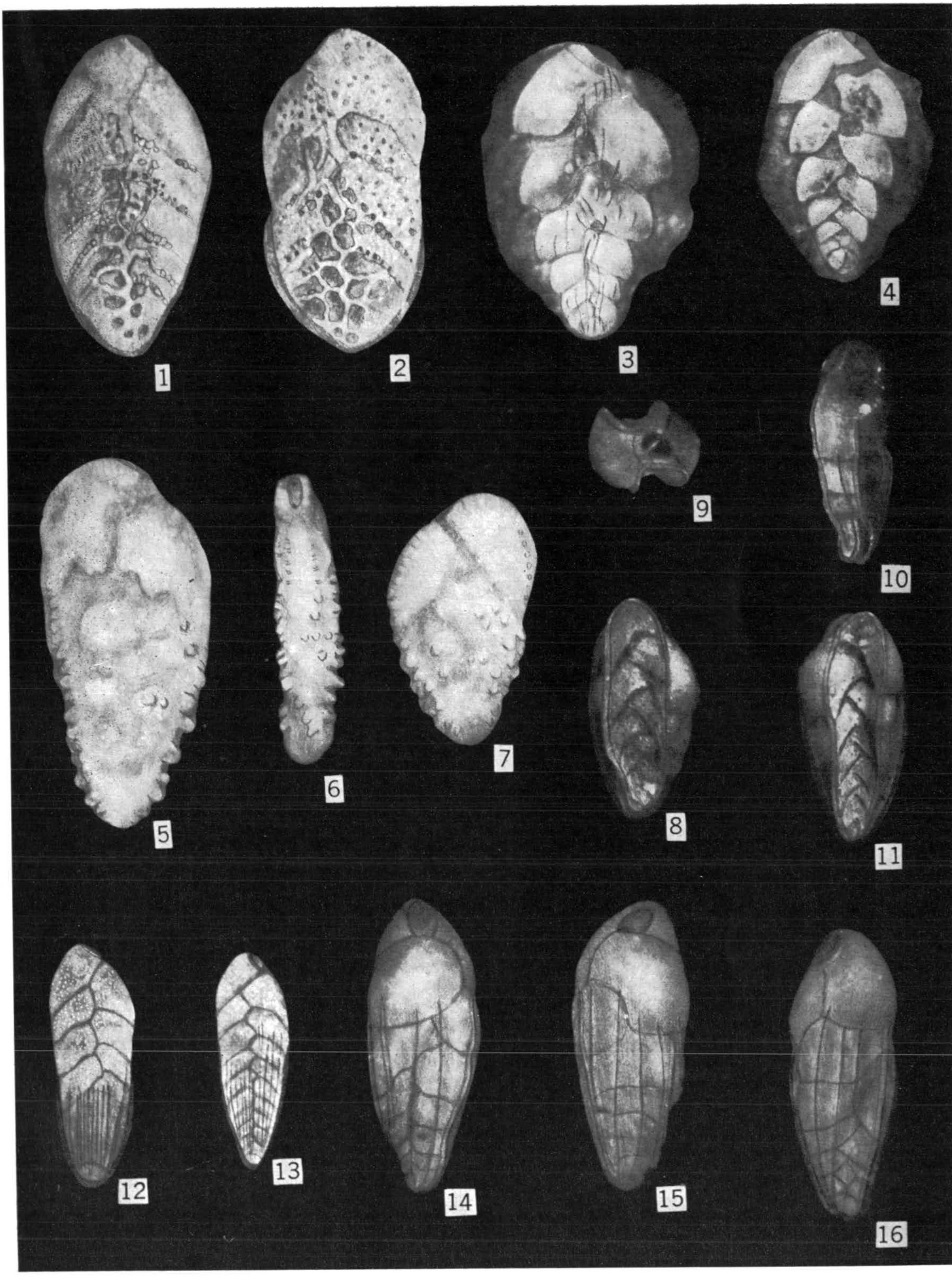

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

PLATE 4

Figures		Page
1–3	*Bolivinita compressa* Finlay	19
	1, CPC 6156, side view; 2, edge view, both x 55.	
	3, CPC 6157, side view, x 55.	
4–7	*Bolivinita quadrilatera* (Schwager)	18
	4, CPC 6153, side view; 5, edge view, both x 46.	
	6, CPC 6154, side view; 7, edge view, both x 46.	
8–9	*Brizalina* sp. *A*.	43
	8, CPC 6211, side view, x 55.	
	9, CPC 6212, side view, x 55.	
10–11	*Rectobolivina tenuicostata*	48
	10, holotype, CPC 6229, side view, x 61.	
	11, paratype, CPC 6230, side view, x 61.	
12–15	*Rectobolivina limbata* (Brady)	49
	12, CPC 6232, side view; 13, edge view, both x 54.	
	14, CPC 6233, side view, x 54.	
	15, CPC 6234, side view, smooth specimen, x 50.	
16–19	*Rectobolivina papula* sp.nov.	50
	16–17, holotype, CPC 6236. 16, side view; 17, edge view, both x 50.	
	18, paratype A, CPC 6237, side view, x 50.	
	19, paratype B, CPC 6238, side view, x 50.	
20–21	*Rectobolivina* sp. cf. *R. carinata* (Millett)	51
	20, CPC 6240, side view, x 76.	
	21, CPC 6241, side view, x 76.	
22–23	*Rectobolivina fasciata*, sp.nov.	52
	22, CPC 6243, holotype, side view, x 49.	
	23, CPC 6244, paratype, side view, x 49.	


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

PLATE 5

Figures		Page
1–3	*Bulimina aculeata* d'Orbigny	58
	1, CPC 6262, side view; 2, top view, both x 50.	
	3, CPC 6263, side view, 50.	
4–5	*Bulimina marginata* d'Orbigny	55
	4, CPC 6257, side view, x 98	
	5, CPC 6258, side view, x 98.	
6–8	*Bulimina striata* d'Orbigny	59
	6, CPC 6267, side view; 7, top view, both x 59.	
	8, CPC 6268, side view, x 59.	
9–11	*Bulimina alazanensis* Cushman	62
	9, CPC 6271, side view; 10, top view, both x 86.	
	11, CPC 6272, side view, x 86.	
12–14	*Bulimina subacuminata* Cushman & R. E. Stewart	63
	12, CPC 6275, side view; 13, top view, both x 61.	
	14, CPC 6276, side view, x 109.	
15–17	*Bulimina subornata* Brady	64
	15, CPC 6278, side view; 16, top view, both x 58.	
	17, CPC 6279, side view, x 58.	
18–21	*Bulimina ampliapertura*, sp.nov.	65
	18–19, holotype, CPC 6282. 18, side view; 19, top view, both x 120	
	20, paratype A, CPC 6283, side view, x 120.	
	21, paratype B, CPC 6284, side view, x 120.	

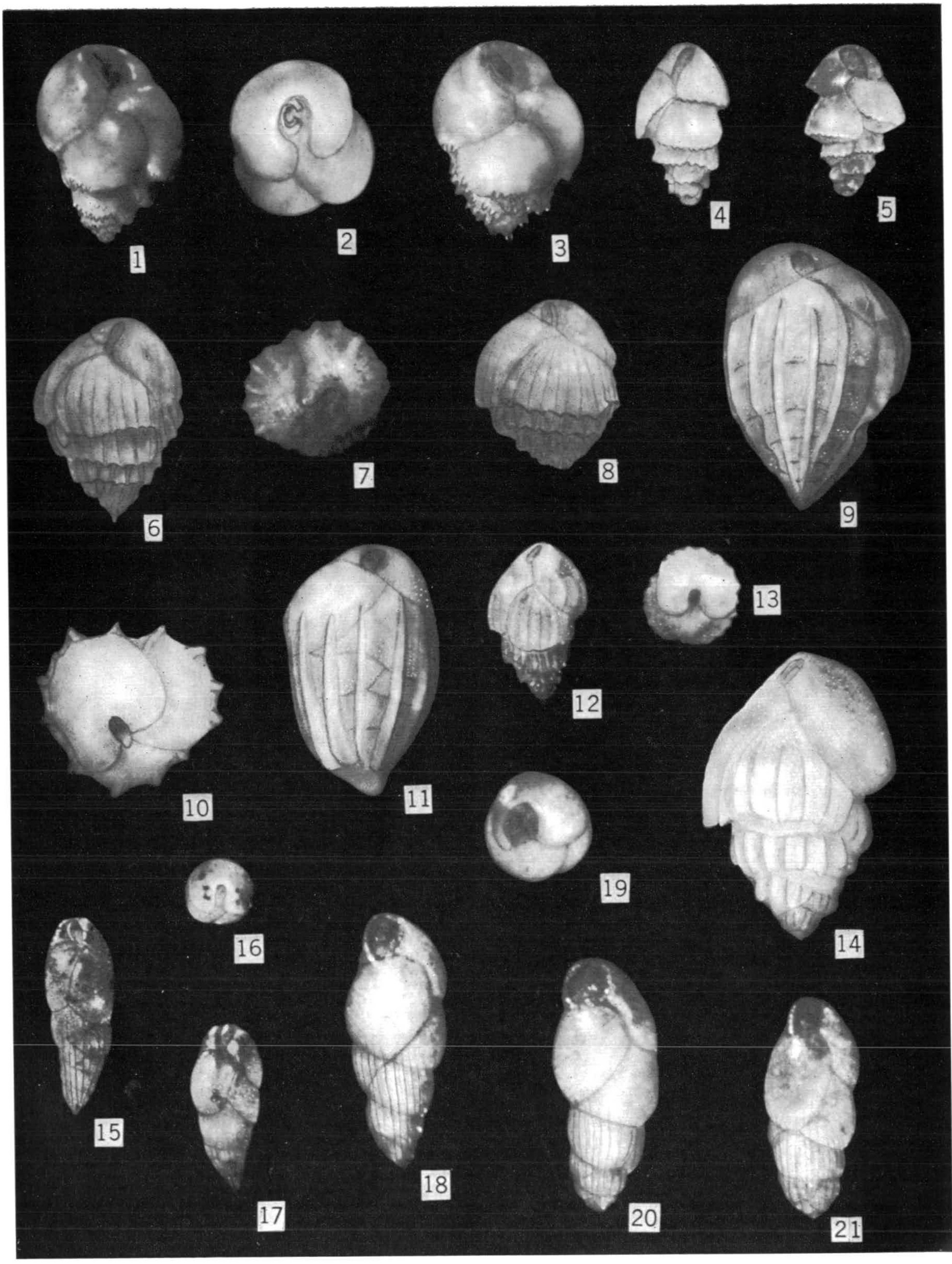

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

PLATE 6

Figures		Page
1–3	*Bulimina senta* Finlay	65
	1, CPC 6286, side view; 2, top view, both x 57.	
	3, CPC 6287, side view, x 57.	
4–5	*Protoglobobulimina pupoides* (d'Orbigny)	67
	4, CPC 6292, side view, x 31.	
	5, CPC 6293, side view, x 31.	
6–9	*Protoglobobulimina ovata* (d'Orbigny)	68
	6, CPC 6296, side view, x 49.	
	7, CPC 6297, side view, x 45.	
	8 CPC 6298, side view, x 55.	
	9, CPC 6299, side view, x 98.	
10–13	*Protoglobobulimina* sp. A.	71
	10, CPC 6312, side view, x 50.	
	11, CPC 6313, side view, x 50.	
	12, CPC 6314, side view, x 50.	
	13, CPC 6315, side view, x 50.	
14–16	*Protoglobobulimina affinis* (d'Orbigny).	69
	14, CPC 6303, side view; 15, top view, both x 52.	
	16, CPC 6304, side view, x 52.	
17–18	*Protoglobobulimina microlongistriata* (LeRoy)	70
	17, CPC 6308, side view, x 50.	
	18, CPC 6309, side view, x 50.	
19–21	*Praeglobobulimina spinescens* (Brady)	73
	19, CPC 6318, side view; 20, top view, both x 44.	
	21, CPC 6319, side view, x 44.	
22–24	*Buliminella* sp. cf. *B. tenuata* Cushman	16
	22, CPC 6149, side view, x 78.	
	23, CPC 6150, side view, x 78.	
	24, CPC 6151, side view, showing a twisted test, x 50.	

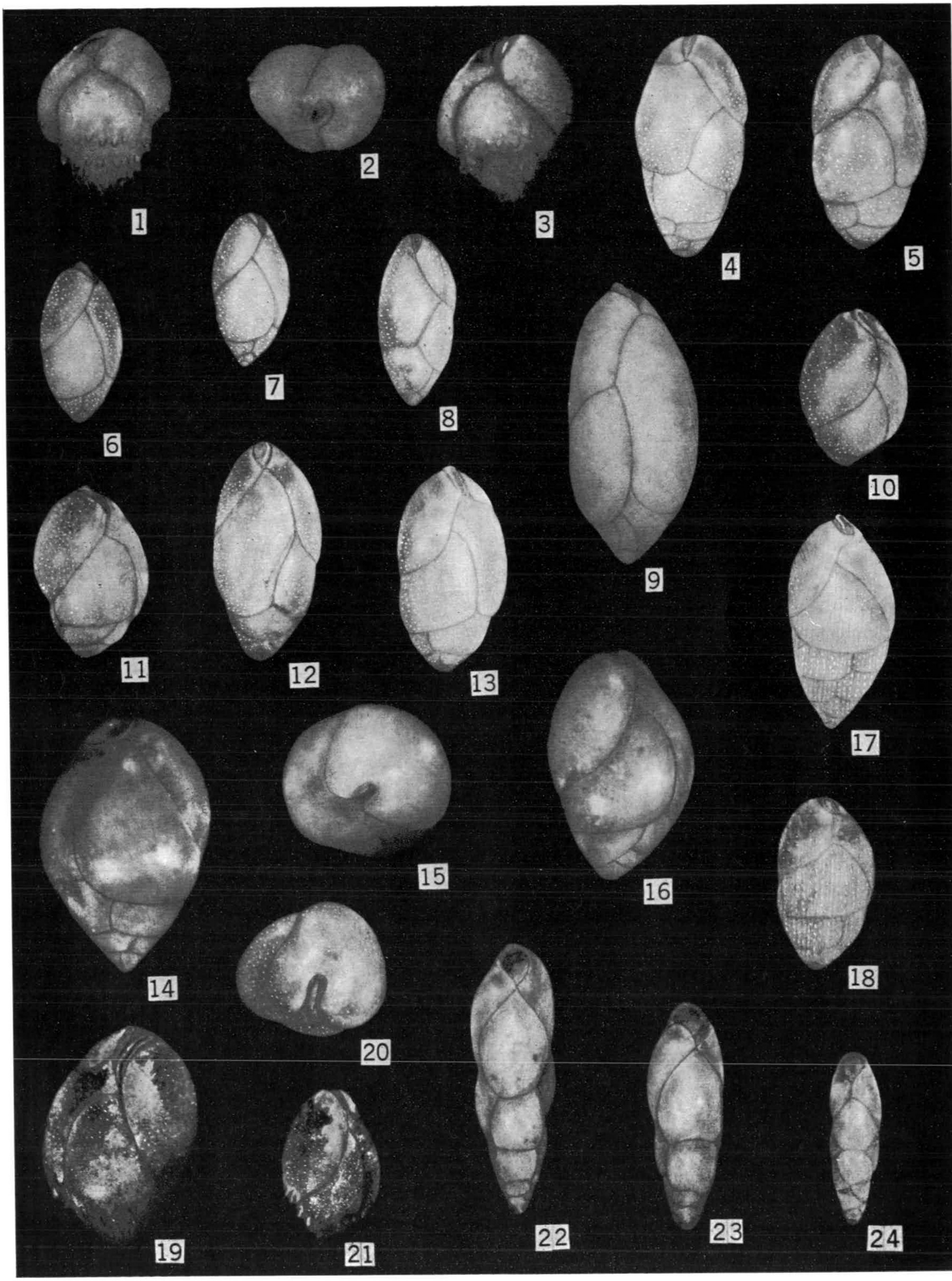

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

PLATE 7

Figures		Page
1–2	*Globobulimina* sp. A.	66
	1, CPC 6290, side view, x 53.	
	2, CPC 6291, side view, x 53.	
3–7	*Euuvigerina peregrina* (Cushman)	75
	3, CPC 6322, side view; 4, top view, both x 61. Specimen with costae replaced by spinose ornament on the last two chambers.	
	5, CPC 6323, side view, x 61. Ornament as for the previous specimen.	
	6, CPC 6324, side view, x 52. Wholly striate specimen.	
	7, CPC 6325, side view, x 52. Wholly striate specimen.	
8–13	*Euuvigerina aculeata* (d'Orbigny)	78
	8, CPC 6326, side view; 9, top view, both x 57.	
	10, CPC 6327, side view, x 57.	
	11, CPC 6328, side view, x 57.	
	12, CPC 6329, side view; 13, top view, both x 57.	
14–16	*Euuvigerina hispida* (Schwager)	78
	14, CPC 6330, side view; 15, top view, both x 37.	
	16, CPC 6331, side view, x 37.	
17–20	*Euuvigerina crassicostata* (Schwager)	79
	17–18, CPC 6332, side view; 18, top view, both x 44.	
	19, CPC 6333, side view, x 44.	
	20, CPC 6334, side view, x 44.	
21–23	*Euuvigerina flinti* (Cushman)	80
	21–22, CPC 6335. 21, side view; 22, top view, both x 59.	
	23, CPC 6336, side view, x 59.	

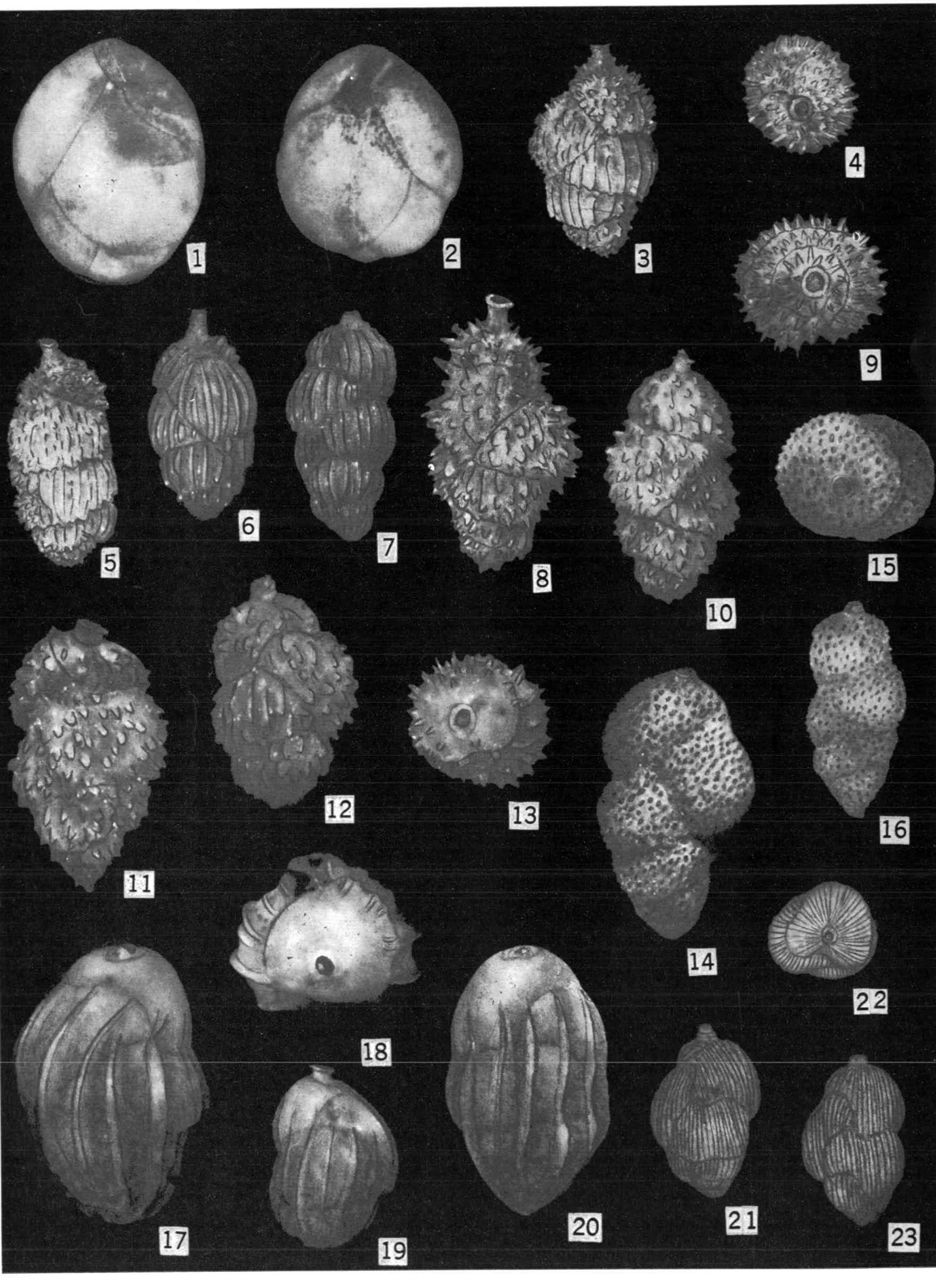

1
2
3
4
9
5
6
7
8
10
15
11
12
13
14
16
22
17
18
19
20
21
23

PLATE 8

Figures		Page
1–5	*Euuvigerina schwageri* (Brady)	81
	1–2, CPC 6337. 1, side view; 2, top view, both x 57.
	3, CPC 6338, side view, x 57.
	4, section, CPC 6339, megalospheric specimen, x 75.
	5, section, CPC 6340, microspheric specimen, x 75.
6–8	*Euuvigerina*? *nitidula* (Schwager)	82
	6–7. CPC 6341. 6, side view; 7, top view, both x 51.
	8, CPC 6342, side view, x 51.
9–11	*Siphouvigerina interrupta* (Brady)	86
	9, CPC 6350, side view, x 74.
	10, CPC 6351, side view, x 74.
	11, CPC 6332, side view, x 74.
12–18	*Siphouvigerina proboscidea* (Schwager)	87
	12–13, CPC 6353. 12, side view; 13, top view, both x 51. Strongly hispid specimen.
	14, CPC 6354, side view, x 51. Strongly hispid specimen.
	15, CPC 6355, side view, x 51. Strongly hispid specimen.
	16–17, CPC 6356. 16, side view; 17, top view, both x 64. Weakly hispid specimen.
	18, CPC 6357, side view, x 74. Weakly hispid specimen.
19–21	*Siphouvigerina*? sp. cf. *S.*? *uniserialis* (LeRoy)	88
	19–20, CPC 6358. 19, side view; 20, top view, both x 71.
	21, CPC 6359, side view, x 71.
22–24	*Euuvigerina reineri*, sp.nov.	82
	22–23, holotype, CPC 6343. 22, side view; 23, top view, both x 46.
	24, CPC 6344, paratype, x 46.
25	*Rectuvigerina* sp. A.	84
	CPC 6347, side view, x 43.

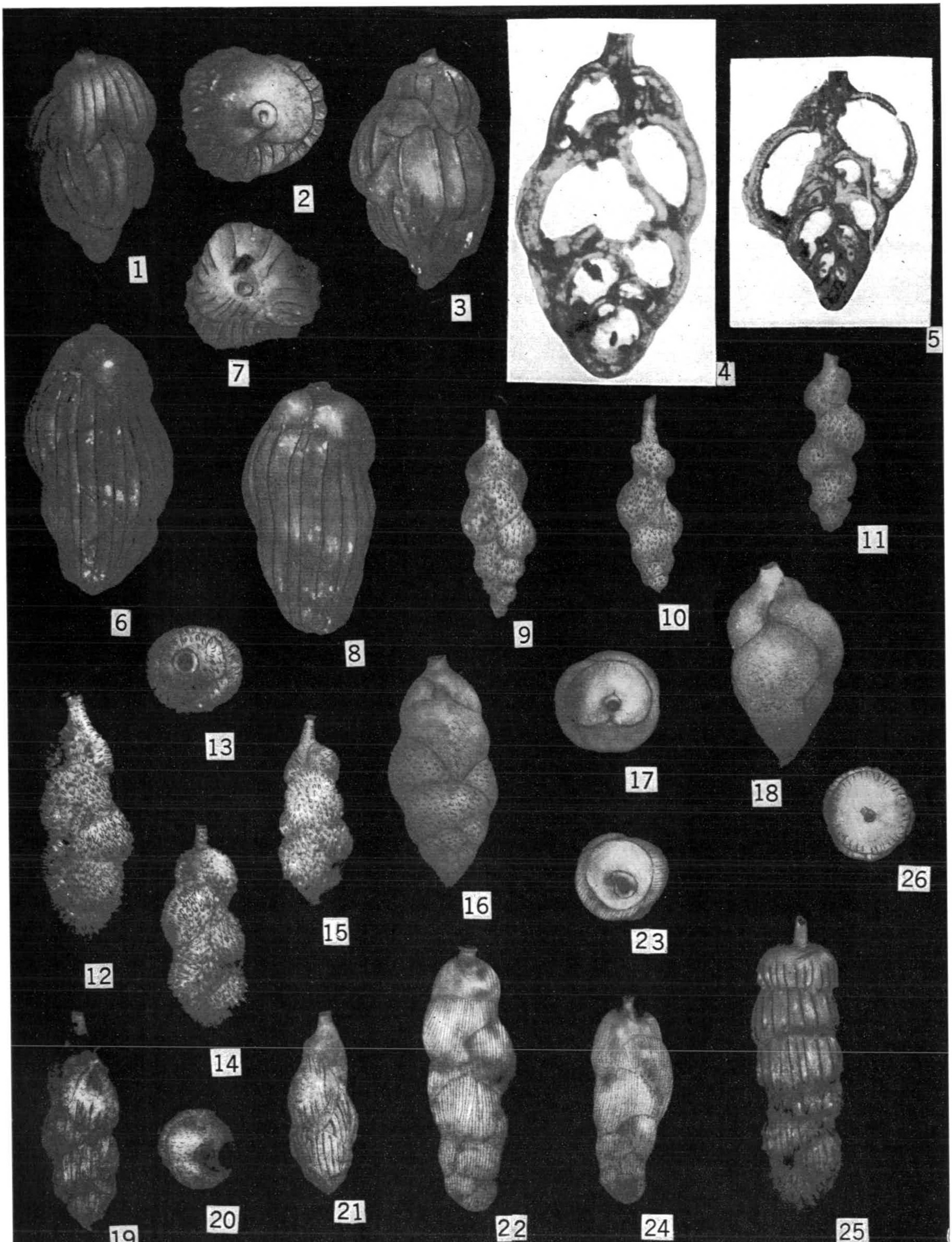

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

PLATE 9

Figures		Page
1–2	*Rectuvigerina striata* (Schwager)	84
	1, CPC 6345, side view, x 48.	
	2, CPC 6346, side view, x 48.	
3–4	*Siphogenerina costata* Schlumberger	86
	3, CPC 6398, side view, x 48.	
	4, CPC 6349, side view, x 48.	
5–6	*Rectobolivina indica* (LeRoy)	46
	5, CPC 6221, side view, x 49.	
	6, CPC 6222, side view, x 49.	
7–8	*Rectobolivina dimorpha* (Parker & Jones)	47
	7, CPC 6223, side view, x 100.	
	8, CPC 6224, side view, x 100.	
9–12	*Rectobolivina columellaris* (Brady)	47
	9, CPC 6225, side view, x 37. Smooth megalospheric specimen.	
	10, CPC 6226, side view, x 37. Slightly striate megalospheric specimen.	
	11, CPC 6227, side view, x 37. Striate microspheric specimen.	
	12, CPC 6228, side view, x 37. Smooth microspheric specimen.	
13–14	*Rectobolivina bifrons* (Brady)	45
	13, CPC 6219, side view, x 37.	
	14, CPC 6220, side view, x 37.	
15	*Reussella aculeata* Cushman	75
	CPC 6321, side view, x 36.	
16–17	*Trifarina bradyi* Cushman	88
	16, CPC 6360, side view, x 72.	
	17, CPC 6361, side view, x 72.	
18–21	*Fursenkoina schreibersiana* (Czjzek)	136
	18–20, CPC 6515. 18, 19, side views from opposite sides; 20, edge view, all x 58.	
	21, CPC 6516, x 58.	
22–23	*Sigmavirgulina tortuosa* (Brady)	137
	CPC 6517. 22, side view; 23, edge view, both x 108.	


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

PLATE 10

Figures		Page
1–6	*Planulina wuellerstorfi* (Schwager)	120
	1–3, CPC 6456. 1, ventral view; 2, dorsal view; 3, edge view, all x 32.	
	4–5, CPC 6457. 4, ventral view; 5, dorsal view, both x 32.	
	6, part of horizontal section, CPC 6458, showing bilamellid septa. x 64.	
7–13	*Planulina ungeriana* (d'Orbigny)....	121
	7–9, CPC 6459. 7, ventral view; 8, dorsal view; 9, edge view, all x 73.	
	10–11, CPC 6460. 10, ventral view; 11, dorsal view, both x 73.	
	12, 13, part of horizontal sections, CPC 6461, 6462, showing bilamellid septa. 12, x 150; 13, x 140.	
14–19	*Planulina plana*, sp.nov.	122
	14–16, holotype, CPC 6463. 14, ventral view; 15, dorsal view; 16, edge view, all x 60.	
	17–18, paratype, CPC 6464. 17, ventral view; 18, dorsal view, both x 60.	
	19, part of horizontal section, CPC 6465, showing bilamellid septa, x 289.	

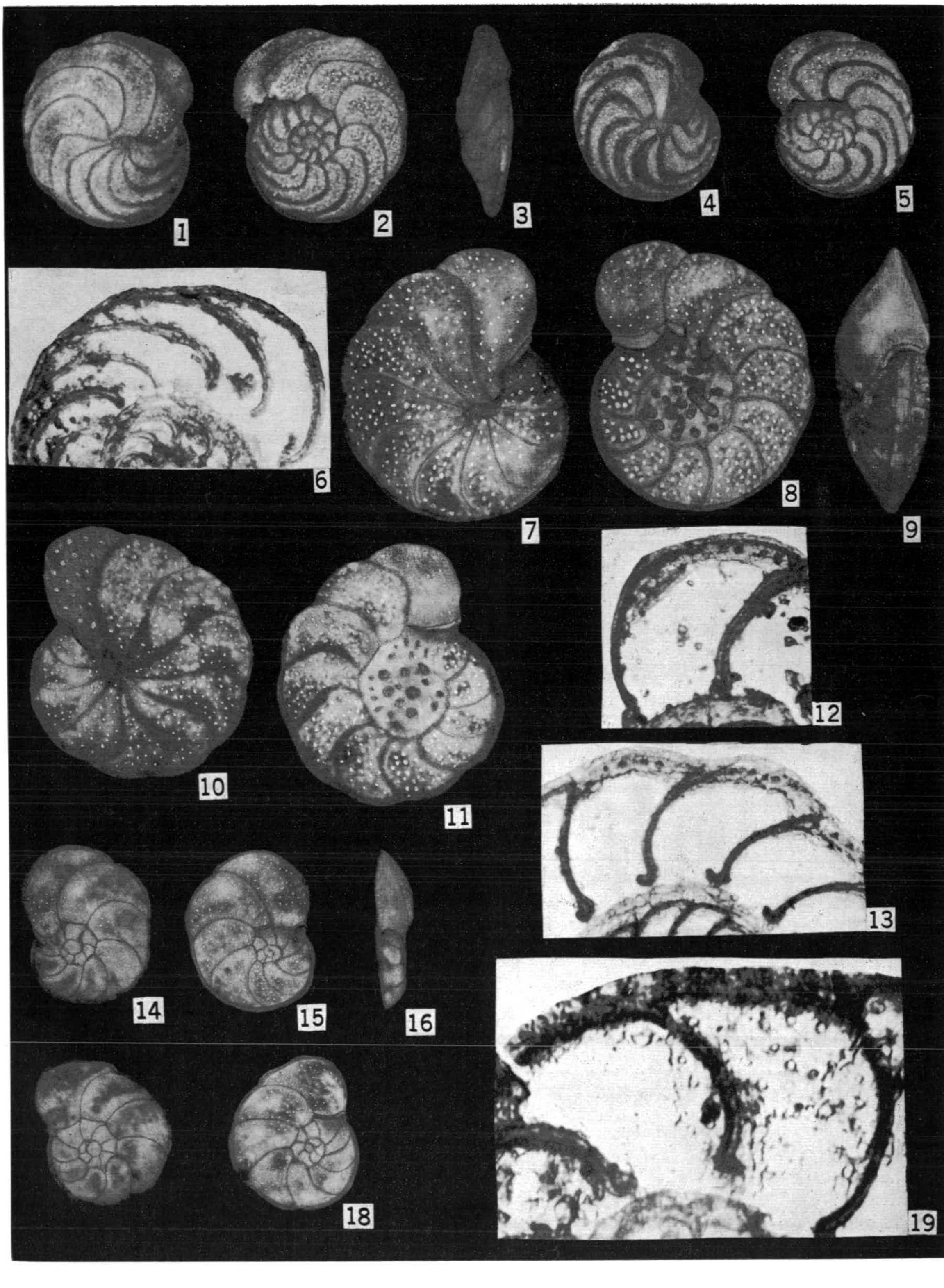

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
18
19

PLATE 11

Figures		Page
1–9	*Planulina retia,* sp.nov.	123
	1–3, holotype, CPC 6466. 1 ventral view; 2, dorsal view; 3, edge view, all x 66.	
	4–6, paratype A., CPC 6467. 4, dorsal view; 5, edge view; 6, ventral view, all x 66.	
	7, paratype B., CPC 6468. ventral view, x 66.	
	8, 9, part of horizontal sections, CPC 6469, 6476, showing bilamellid septa. 8, x 135; 9, x 156.	
10–19	*Parrelloides bradyi* (Trauth)	100
	10–12, CPC 6388. 10, ventral view; 11, dorsal view; 12, edge view, all x 66.	
	13–14, CPC 6389. 13, ventral view; 14, edge view, both x 66.	
	15, ventral view; 16, edge view, both x 54.	
	17, horizontal section, CPC 6391, x 75.	
	18, part of horizontal section in figure 17, showing single septa, x 208.	
	19, vertical section, CPC 6392, x 105.	

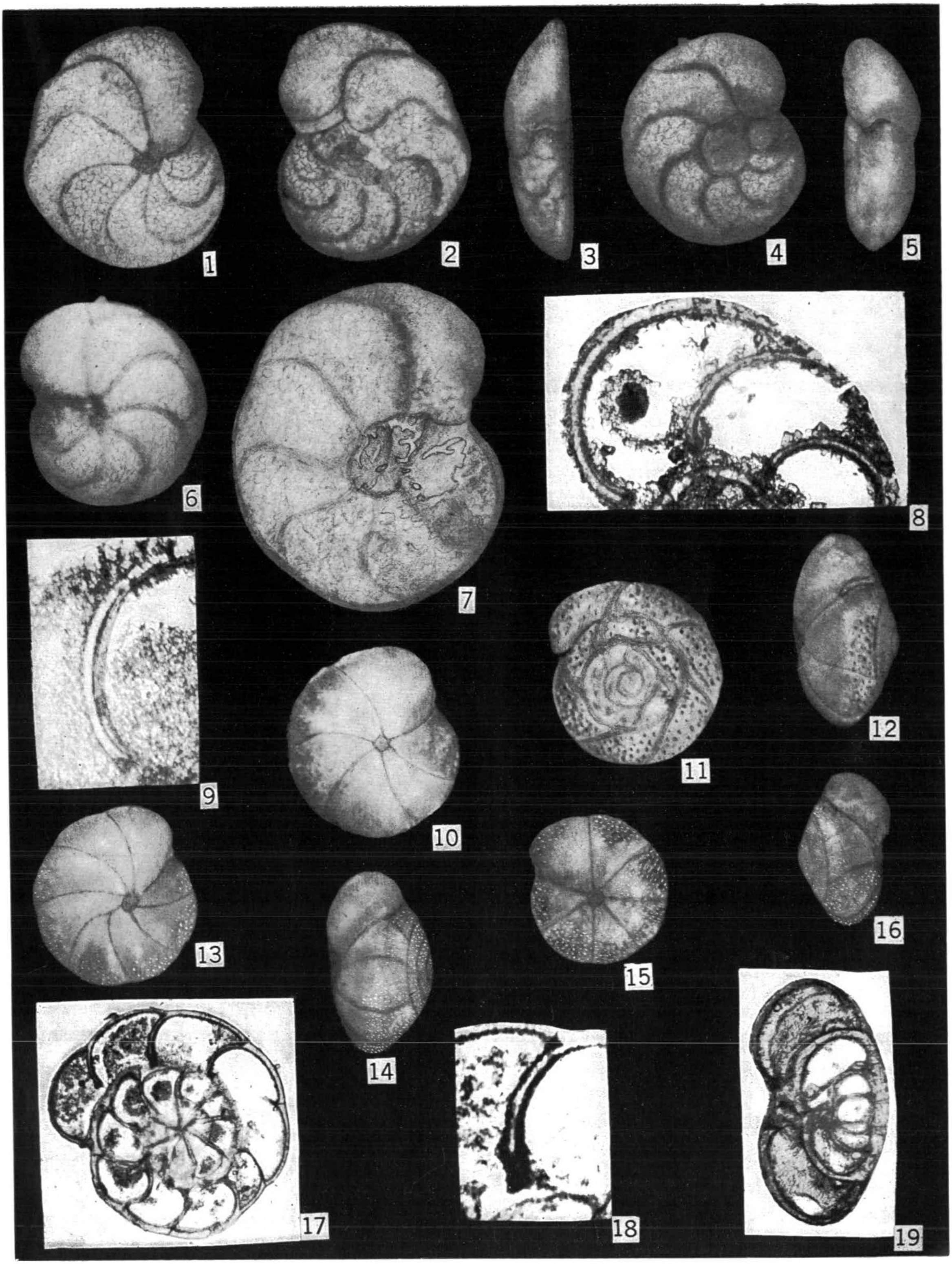

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

PLATE 12

Figures		Page
1–7	*Parrelloides soendaensis* (LeRoy)	102
	1–3, CPC 6393. 1, ventral view; 2, dorsal view; 3, edge view, all x 65.	
	4–5, CPC 6394. 4, ventral view; 5, edge view, both x 65.	
	6, CPC 6396, ventral view, x 65.	
	7, part of horizontal section, CPC 6396, showing single septa, x 107.	
8–14	*Parrelloides okinawaensis* (LeRoy)	103
	8–10, holotype, CPC 6397. 8, ventral view; 9, dorsal view; 10, edge view, all x 65.	
	11–12, paratype A, CPC 6398. 11, ventral view; 12, edge view, both x 65.	
	13, paratype B, CPC 6399; ventral view, x 65.	
	14, part of horizontal section, CPC 6400, showing single septa, x 107.	
15–22	*Discorbinella bertheloti* (d'Orbigny)	90
	15–17, CPC 6362. 15, ventral view; 16, dorsal view; 17, edge view, all x 51.	
	18–20, CPC 6363. 18, ventral view; 19, dorsal view; 20, edge view, all x 51.	
	21, CPC 6364, ventral view, x 51.	
	22, part of horizontal section, CPC 6365, showing single septa, x 132.	

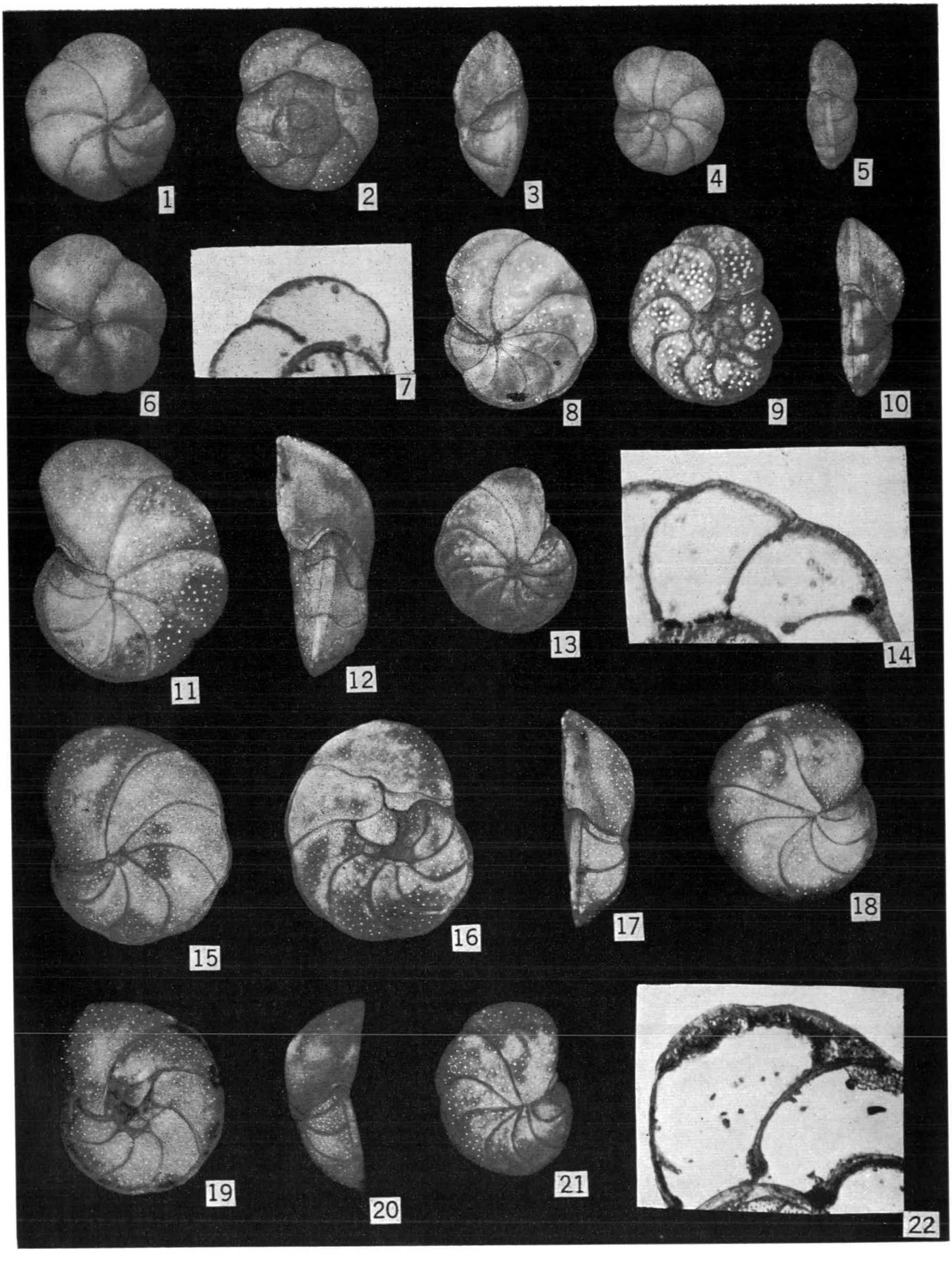

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 13

Figures		Page
1–5	*Discorbinella subbertheloti* (Cushman)	91
	1–3, CPC 6367. 1, ventral view; 2, dorsal view; 3, edge view, all x 68.	
	4–5, CPC 6368. 4, ventral view; 5, dorsal view, both x 68.	
6–11	*Bueningia creeki* Finlay	99
	6–8, CPC 6385. 6, ventral view; 7, dorsal view; 8, edge view, all x 59.	
	9–10, CPC 6386. 9, ventral view; 10, edge view, both x 65.	
	11, horizontal section, CPC 6387, x 96.	
12–16	*Rosalina ponticulus*, sp.nov.	94
	12–14, holotype, CPC 6373. 12, ventral view; 13, dorsal view; 14, edge view, all x 73.	
	15–16, paratype, CPC 6374. 15, ventral view; 16, dorsal view, both x 73.	

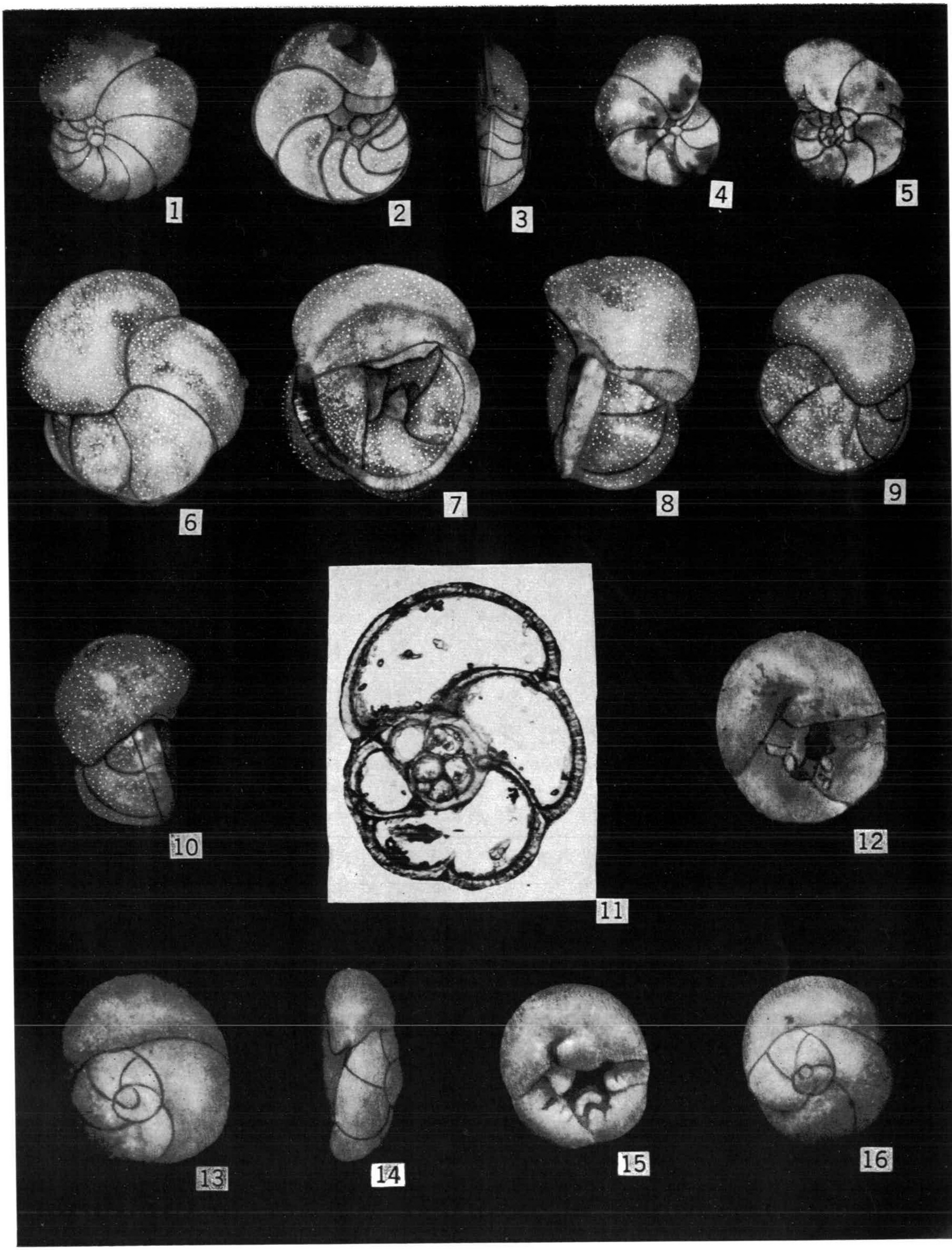

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

PLATE 14

Figures		Page
1–8	*Hyalinea balthica* (Gmelin)	124
	1–3, CPC 6473. 1, dorsal view; 2, ventral view; 3, edge view, all x 126.	
	4–5, CPC 6474. 4, ventral view; 5, dorsal view, both x 126.	
	6, horizontal section, CPC 6475, x 126.	
	7, 8, part of horizontal sections, CPC 6475, 6476, showing indistinctly bilamellid septa. 7, x 154; 8, x 130.	
9–13	*Laticarinina pauperata* (Parker & Jones)	92
	9–10, CPC 6369. 9, dorsal view; 10, ventral view, both x 38.	
	11–12, CPC 6370. 11, dorsal view; 12, ventral view, both x 38.	
	13, vertical section, CPC 6371, x 77.	
14–16	*Parvicarinina altocamerata* (Heron-Allen & Earland)	93
	CPC 6372. 14, dorsal view; 15, ventral view; 16, edge view, all x 78.	

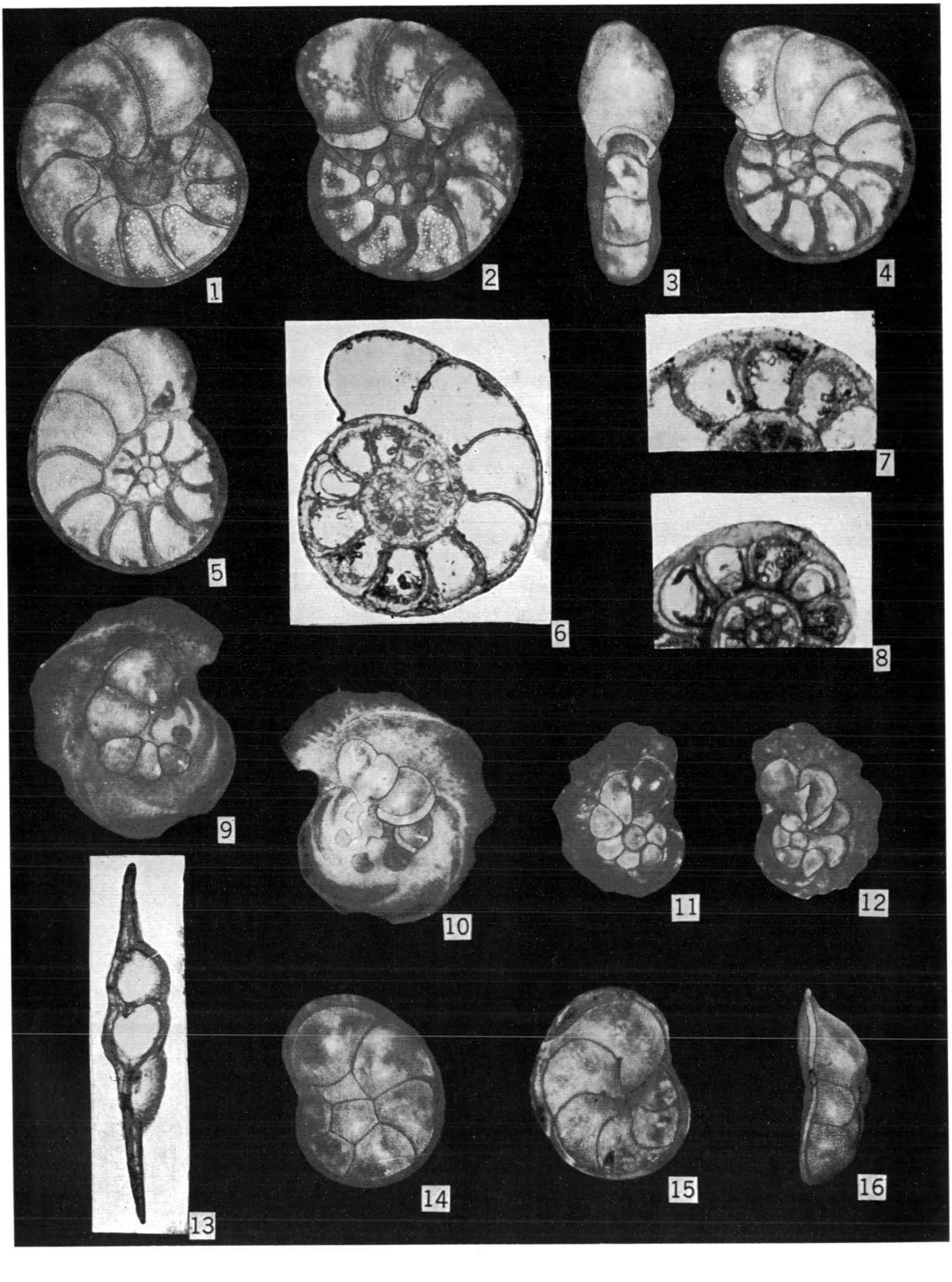

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

PLATE 15

Figures		Page
1–5	*Cancris auriculus* (Fichtel & Moll)	96
	1–3, CPC 6379. 1, ventral view; 2, dorsal view; 3, edge view, all x 62. 4–5, CPC 6380. 4, ventral view; 5, edge view, both x 62.	
6–9	*Cancris bodjongensis* (LeRoy)	97
	6–8, CPC 6381. 6, ventral view; 7, dorsal view; 8, edge view, all x 66. 9, CPC 6382, ventral view, x 66.	
10–14	*Baggina indica* (Cushman)	96
	10–12, CPC 6377. 10, ventral view; 11, dorsal view; 12, edge view, all x 61. 13–14, CPC 6378. 13, ventral view; 14, edge view, both x 61.	
15–21	*Asterigerina tentoria* Todd & Post	106
	15–17, CPC 6406. 15, ventral view; 16, dorsal view; 17, edge view, all x 45. 18–19, CPC 6407. 18, ventral view; 19, edge view, both x 45. 20, part of horizontal section, CPC 6408, x 228. 21, section across partitions dividing chambers, CPC 6409, showing two layers of shell material, x 97.	

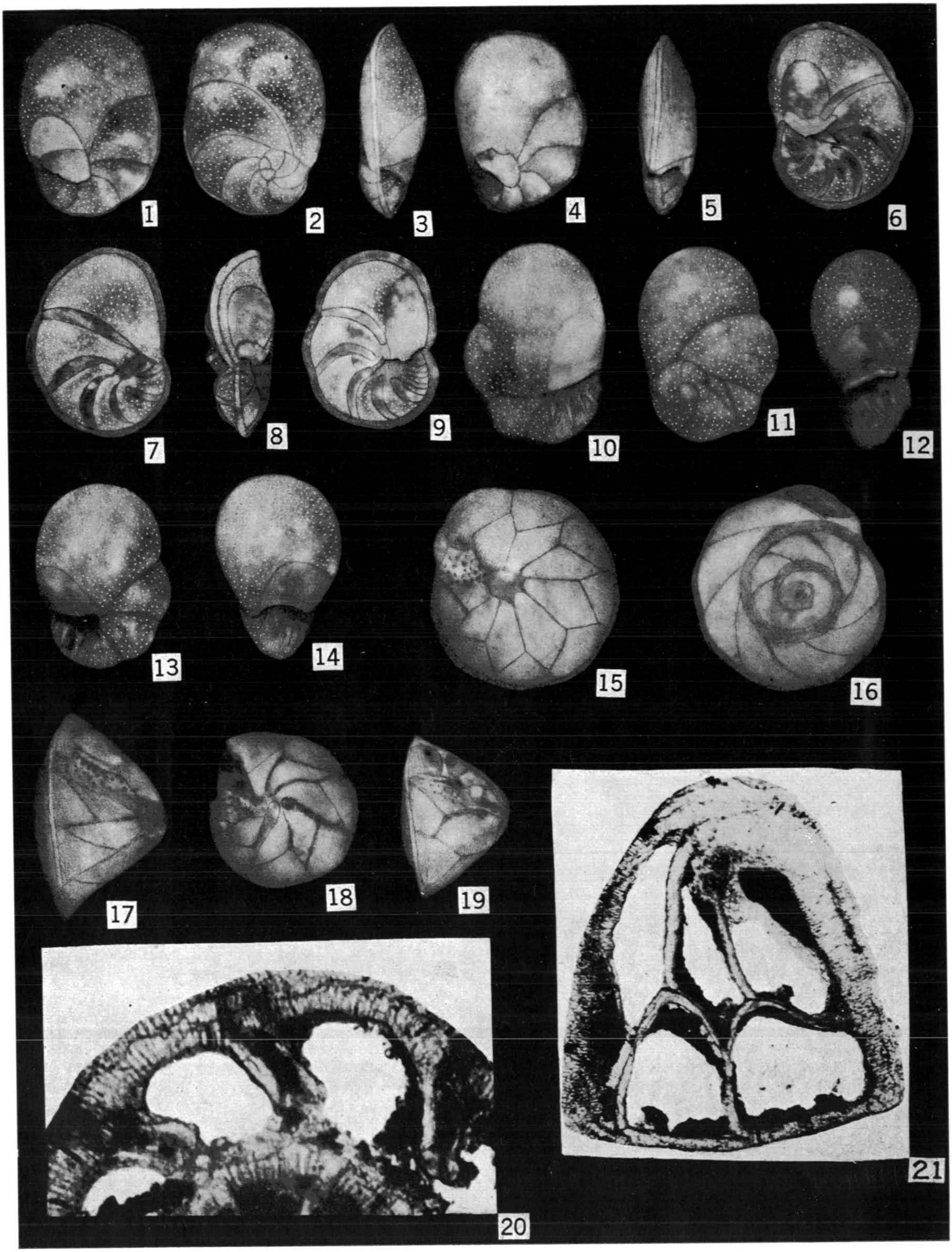

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

PLATE 16

Figures		Page
1–6	'*Eponides*' *praecinctus* (Karrer)	125
	1–3, CPC 6477. 1, ventral view; 2, dorsal view; 3 edge view, all x 34. 4–5, CPC 6478. 4, ventral view; 5, edge view, both x 34. 6, part of horizontal section, CPC 6479, x 142.	
7–13	'*Eponides*' *subhaidingeri* (Parr).	129
	7–9, CPC 6490. 7, ventral view; 8, dorsal view; 9, edge view, all x 40. 10, CPC 6491, ventral view, x 40. 11–12, CPC 6492. 11, ventral view; 12, edge view, both x 43. 13, part of horizontal section, CPC 6493, showing bilamellid septa, x 176.	
14–22	'*Eponides*' sp. cf. '*E.*' *subhaidingeri* (Parr).	130
	14–16, CPC 6494. 14, ventral view; 15, dorsal view; 16, edge view, all x 36. 17–18, CPC 6495. 17, ventral view; 18, edge view, both x 36. 19–20, CPC 6496. 19, ventral view; 20, dorsal view; 21, edge view, all x 43. 22, part of horizontal section, CPC 6497, showing bilamellid septa, x 141.	

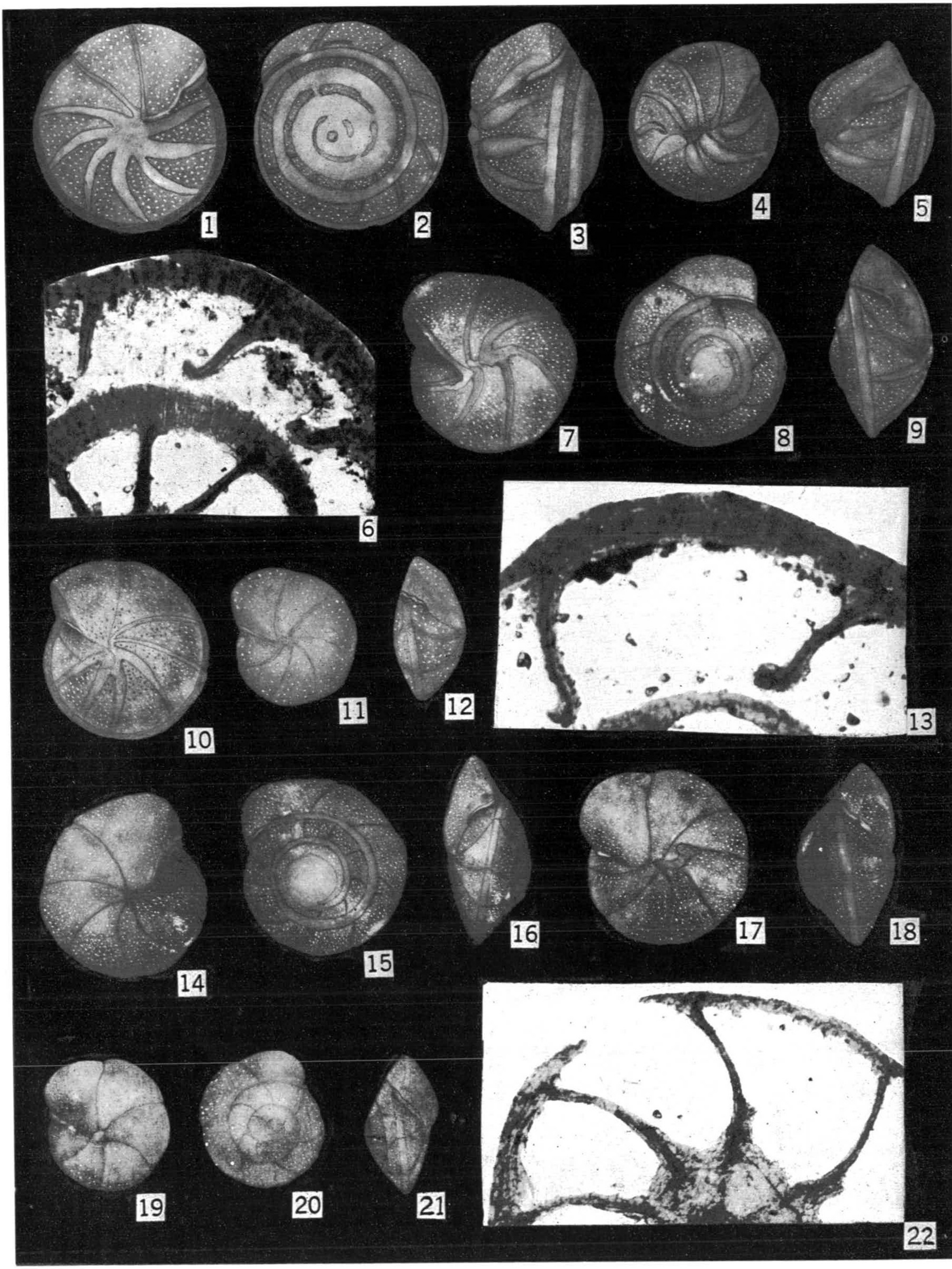

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 17

Figures		Page
1–6	*Neoeponides berthelotianus* (d'Orbigny)	117
	1–3, CPC 6447. 1, ventral view; 2, dorsal view; 3, edge view, all x 50.	
	4–5, CPC 6448. 4, ventral view; 5, edge view, both x 50.	
	6, part of horizontal section, CPC 6449, showing bilamellid septa, x 59.	
7–12	*Neoeponides subornatus* (Cushman)	118
	7–9, CPC 6450. 7, ventral view; 8, dorsal view; 9, edge view, all x 25.	
	10–11, CPC 6451. 10, ventral view; 11, edge view; both x 25.	
	12, part of horizontal section, CPC 6452; showing bilamellid septa, x 56.	
13–15	*Neoeponides parantillarum* (Galloway & Heminway)	118
	CPC 6453. 13, ventral view; 14, dorsal view; 15, edge view, all x 30.	

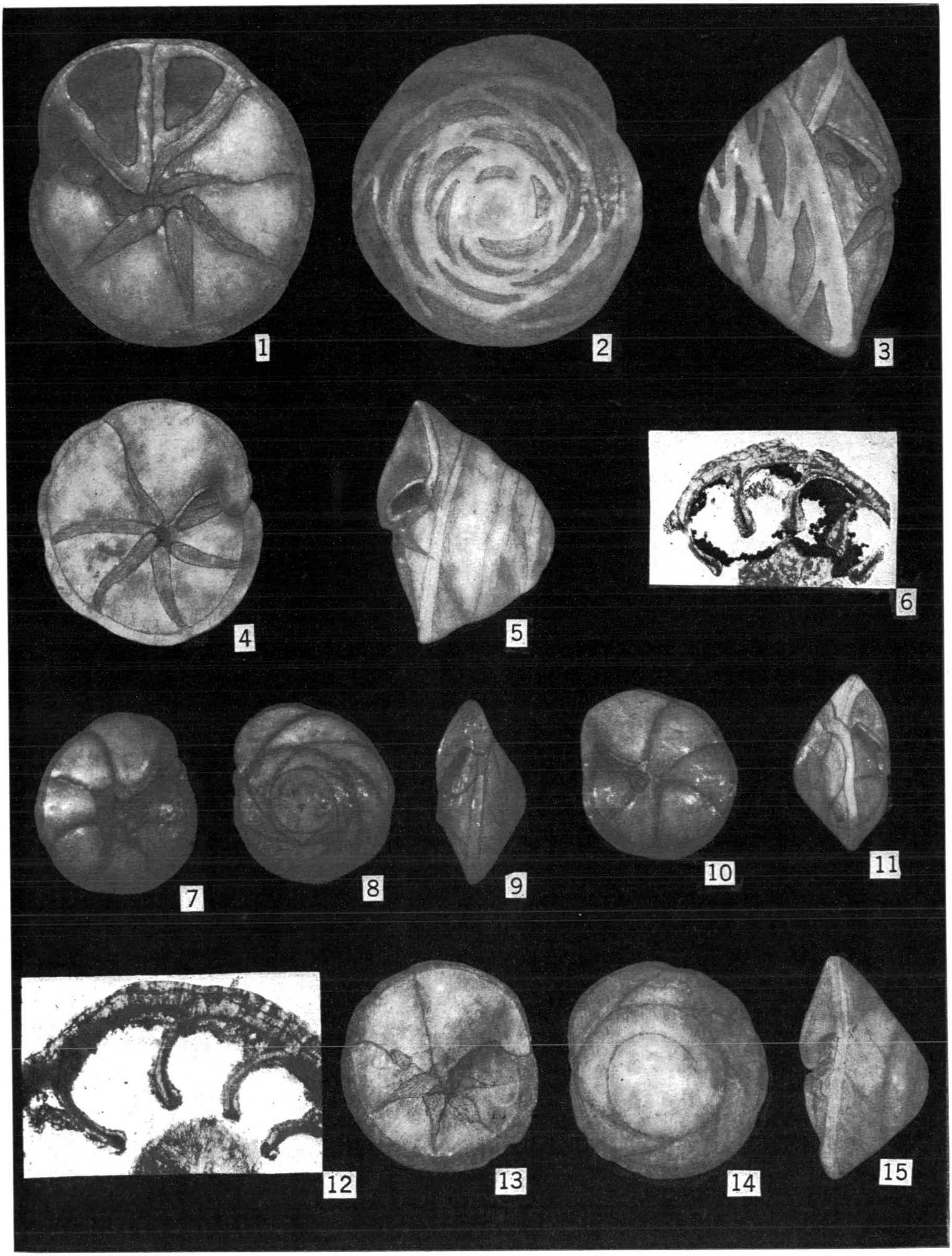

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE 18

Figures		Page
1–3	*Neoeponides parantillarum* (Galloway & Heminway)	118
	1–2, CPC 6454. 1, ventral view; 2, edge view, both x 30.	
	3, part of horizontal section, CPC 6455, showing bilamellid septa, x 49.	
4–10	'*Eponides*' *labricrassus* sp.nov.	127
	4–6, holotype, CPC 6483. 4, ventral view; 5, dorsal view; 6, edge view, all x 26.	
	7–8, paratype A, CPC 6484. 7, ventral view; 8, edge view, both x 26.	
	9, paratype B, CPC 6485, ventral view, x 26.	
	10, part of horizontal section, CPC 6486, showing bilamellid septa, x 188.	
11–16	'*Eponides*' *margaritiferus* (Brady)	126
	11–13, CPC 6480. 11, ventral view; 12, dorsal view; 13, edge view, all x 26.	
	14–15, CPC 6481. 14, ventral view; 15, edge view, both x 26.	
	16, part of horizontal section, CPC 6482, showing bilamellid septa, x 88.	
17–21	'*Eponides*' *suturicrassus* sp.nov.	128
	17–19, holotype, CPC 6487. 17, ventral view; 18, dorsal view; 19, edge view, all x 26.	
	20–21, paratype, CPC 6488. 20, ventral view; 21, dorsal view, both x 26.	

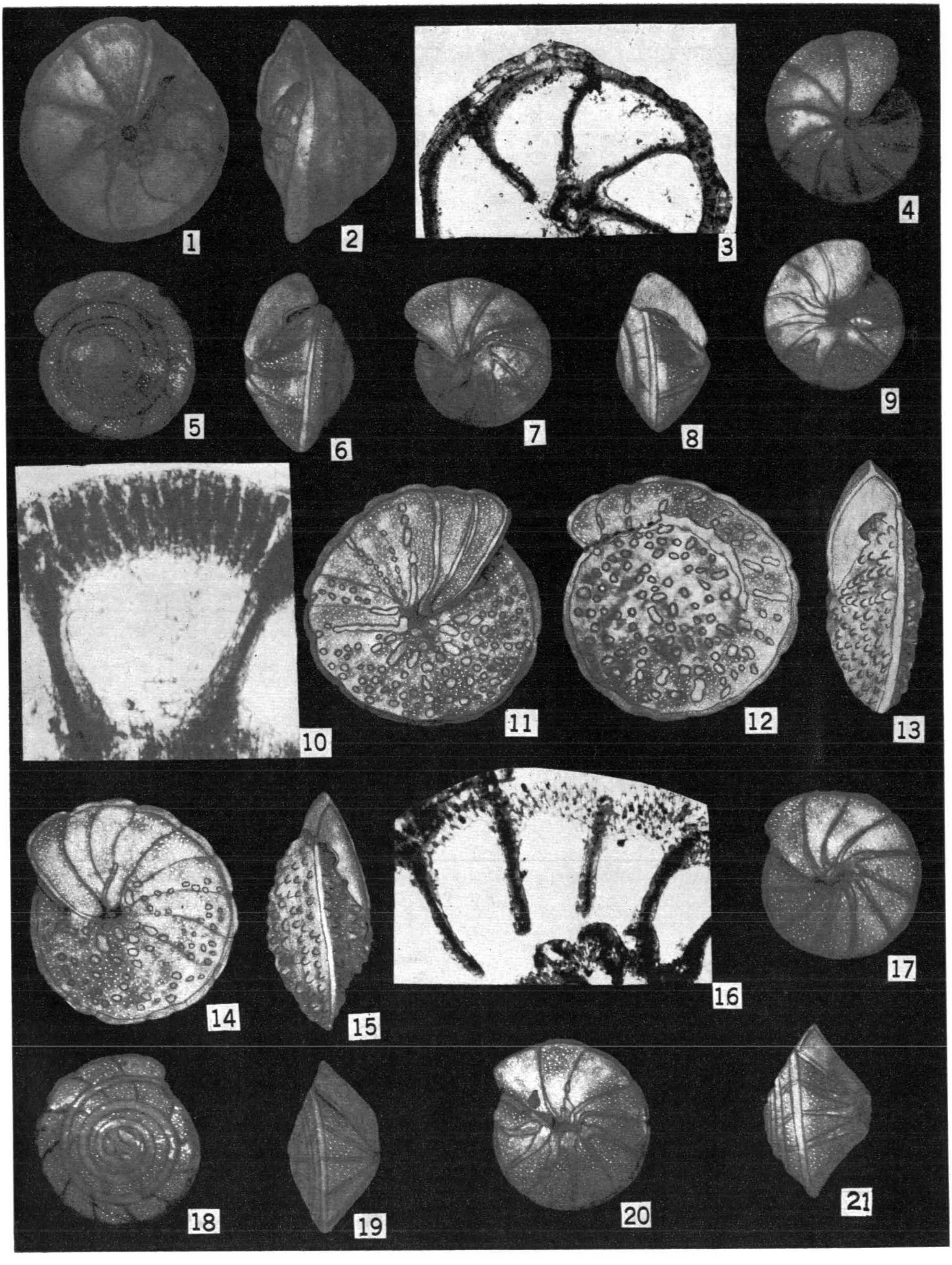

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

PLATE 19

Figures		Page
1	*'Eponides' suturicrassus* sp.nov.	128
	Part of horizontal section, CPC 6489, showing bilamellid septa, x 176.	
2–8	*Ammonia beccarii* (*Linn.*)	108
	2–4, CPC 6412. 2, ventral view; 3, dorsal view; 4, edge view, all x 65.	
	5–6, CPC 6413. 5, ventral view; 6, edge view, both x 65.	
	7, vertical section, CPC 6414, x 132.	
	8, part of horizontal section, CPC 6415, showing septal flap at periphery and internal structure, x 314.	
9–16	*Ammonia maculosa* sp.nov.	110
	9–11, holotype, CPC 6416. 9, ventral view; 10, dorsal view; 11, edge view, all x 68.	
	12–13, paratype, CPC 6417. 12, ventral view; 13, edge view, both x 68.	
	14, 15, vertical sections, CPC 6418, 6419. 14 x 130; 15 x 141.	
	16, horizontal section, CPC 6420, showing septal flap at the periphery, x 130.	
17–19	*Ammonia supera* sp.nov.	111
	Holotype, CPC 6421. 17, ventral view; 18, dorsal view; 19, edge view, all x 64.	

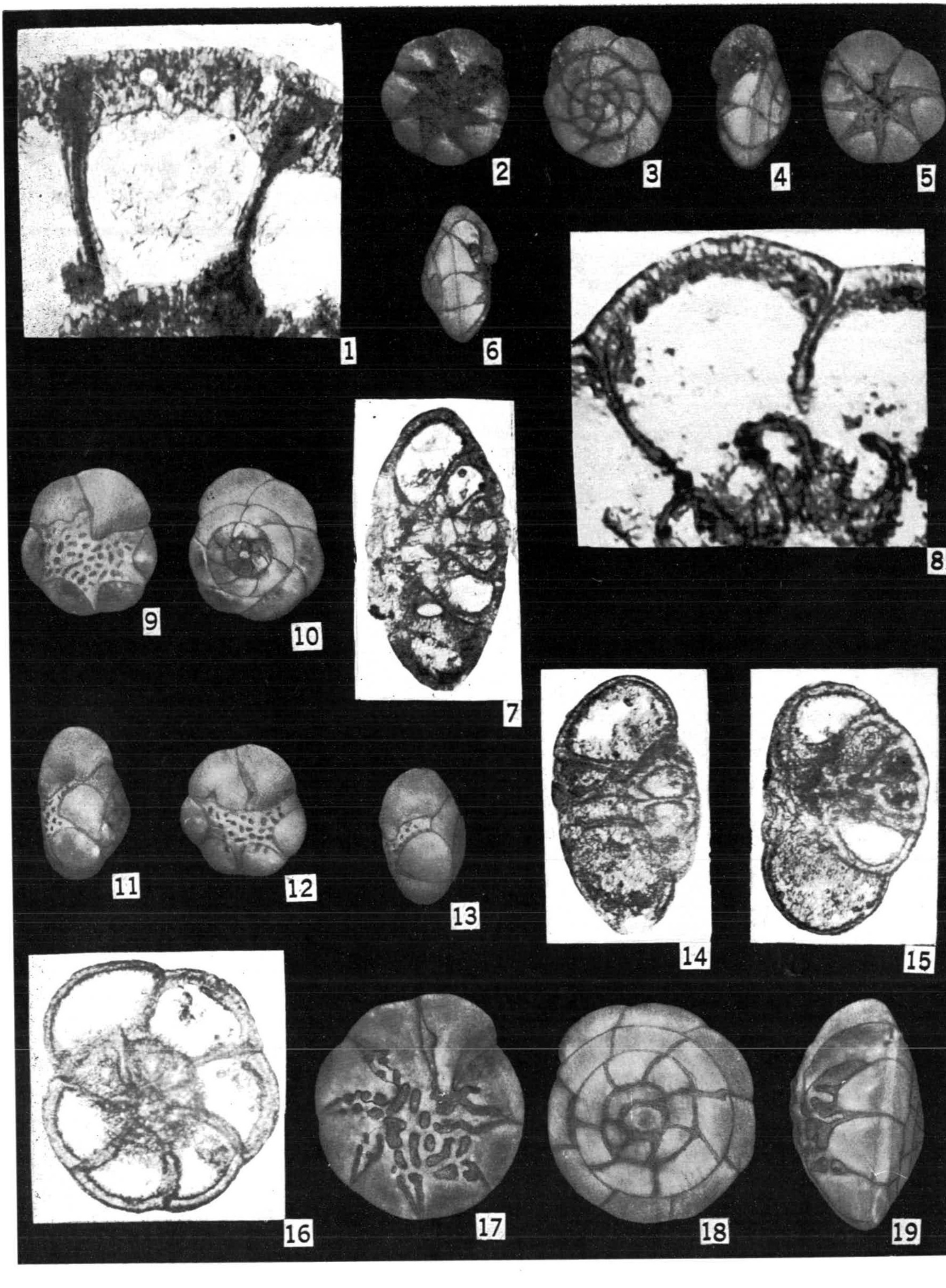

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

PLATE 20

Figures		Page
1–4	*Ammonia supera* sp.nov.	111
	1–2, paratype, CPC 6422. 1, ventral view; 2, dorsal view, both x 63.	
	3, part of horizontal section, CPC 6423, showing indistinct septal flap, x 91.	
	4, vertical section, CPC 6424, x 87.	
5–11	*Pseudorotalia gaimardi* (d'Orbigny)	115
	5–7, CPC 6434. 5, ventral view; 6, dorsal view; 7, edge view, all x 30.	
	8–9, CPC 6435. 8 ventral view; 9, edge view; both x 30.	
	10, horizontal section, CPC 6436, x 29.	
	11, vertical section, CPC 6437, x 29.	
12–16	*Pseudorotalia schroeteriana* (Parker & Jones)	114
	12–14, CPC 6425. 12, ventral view; 13, dorsal view; 14, edge view, all x 36.	
	15–16, CPC 6426. 15, ventral view; 16, edge view, both x 36.	

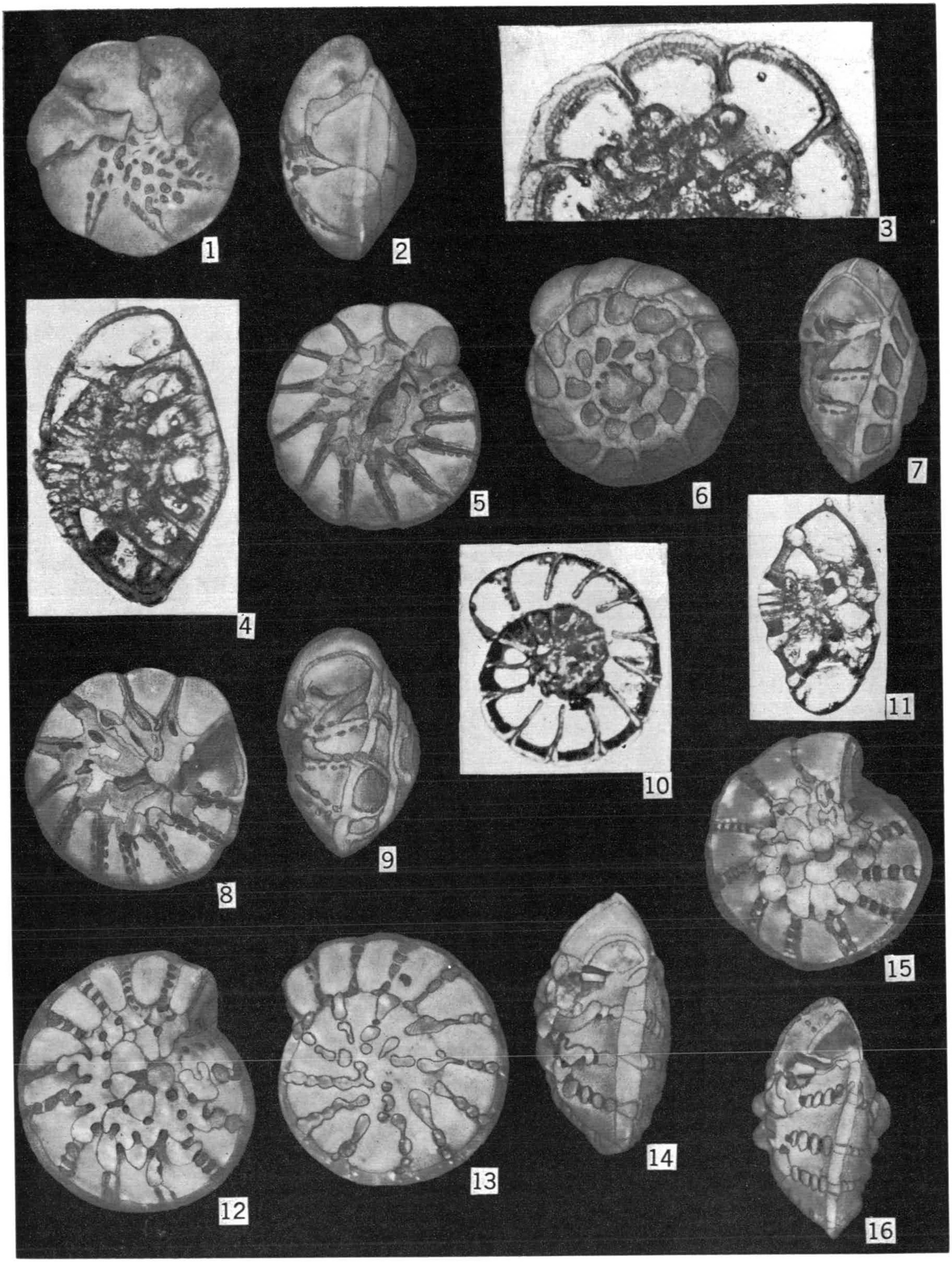

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

PLATE 21

Figures		Page
1–3	*Pseudorotalia schroeteriana* (Parker & Jones)	114
	1, vertical section, CPC 6427, x 36.	
	2, horizontal section, CPC 6428, x 39.	
	3, part of horizontal section, CPC 6429, showing bilamellid apertural face, with septal flap distally from it, x 200.	
4–10	*Pseudorotalia catilliformis* (Thalmann)	114
	4–6, CPC 6430. 4, ventral view; 5, dorsal view; 6, edge view, all x 18.	
	7–8, CPC 6431. 7, ventral view; 8, edge view, both x 18.	
	9, vertical section, CPC 6432, 26.	
	10, part of horizontal section, CPC 6433, showing septal flap and bilamellid apertural face, x 153.	
11–13	*Pseudorotalia papuanensis* sp.nov.	116
	Holotype, CPC 6438. 11, ventral view; 12, dorsal view; 13, edge view; all x 28.	

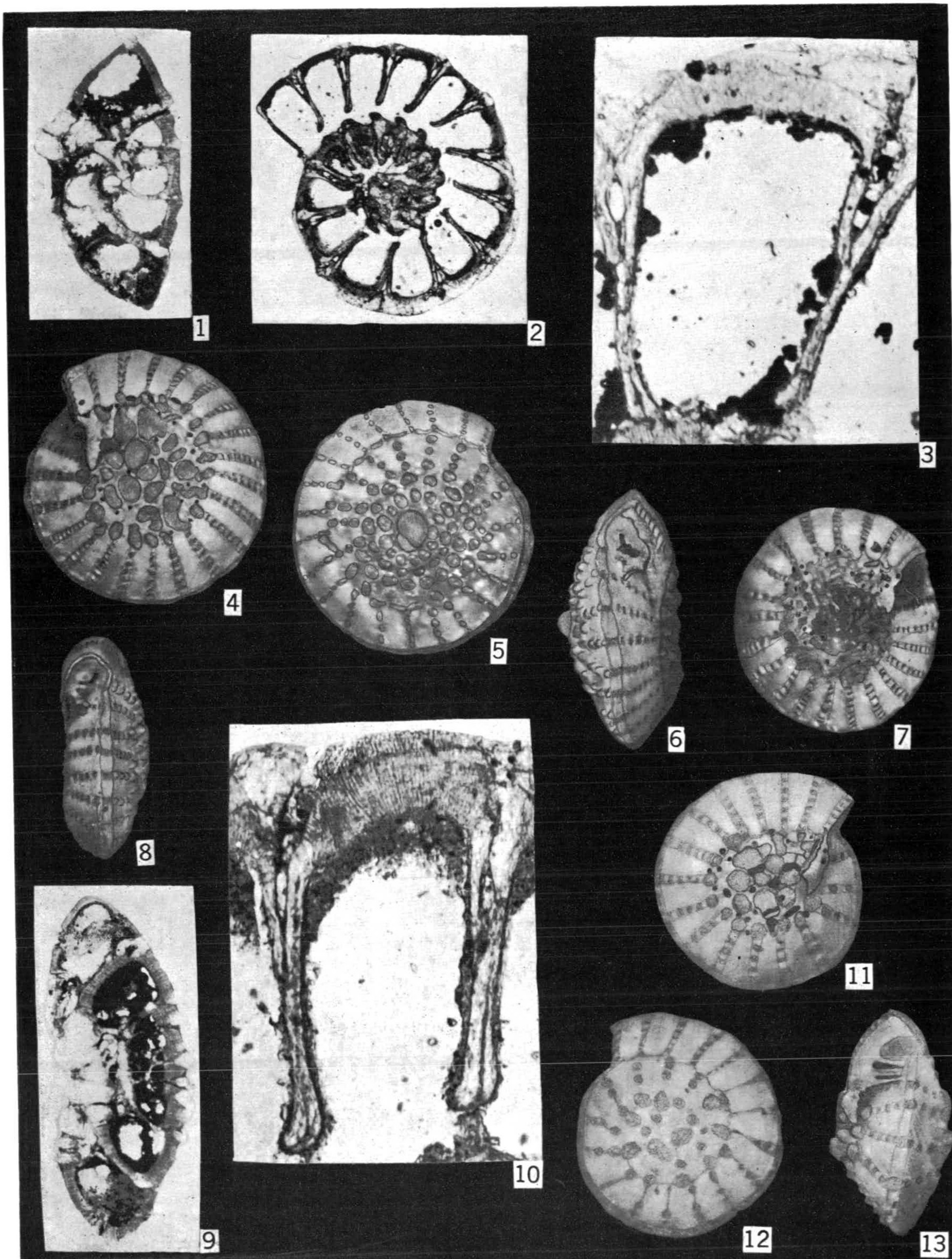

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 22

Figures		Page
1–6	*Pseudorotalia papuanensis* sp.nov.	116
	1–2, paratype, CPC 6439. 1, ventral view; 2, edge view, both x 28.	
	3, vertical section, CPC 6440, x 40.	
	4, part of horizontal section, CPC 6441, showing septal flap and bilamellid apertural face, x 162.	
	5, 6, sections across the umbilical area, CPC 6442, 6443, showing the septal flap continuous with the inner lining of the apertural face. 5, x 162; 6, x 172.	
7–11	*Pseudorotalia* sp. A.	117
	7–9, CPC 6444. 7, ventral view; 8, dorsal view; 9, edge view, all x 27.	
	10, vertical section, CPC 6445, x 38.	
	11, part of horizontal section, CPC 6446, showing septal flap and bilamellid apertural face, x 162.	

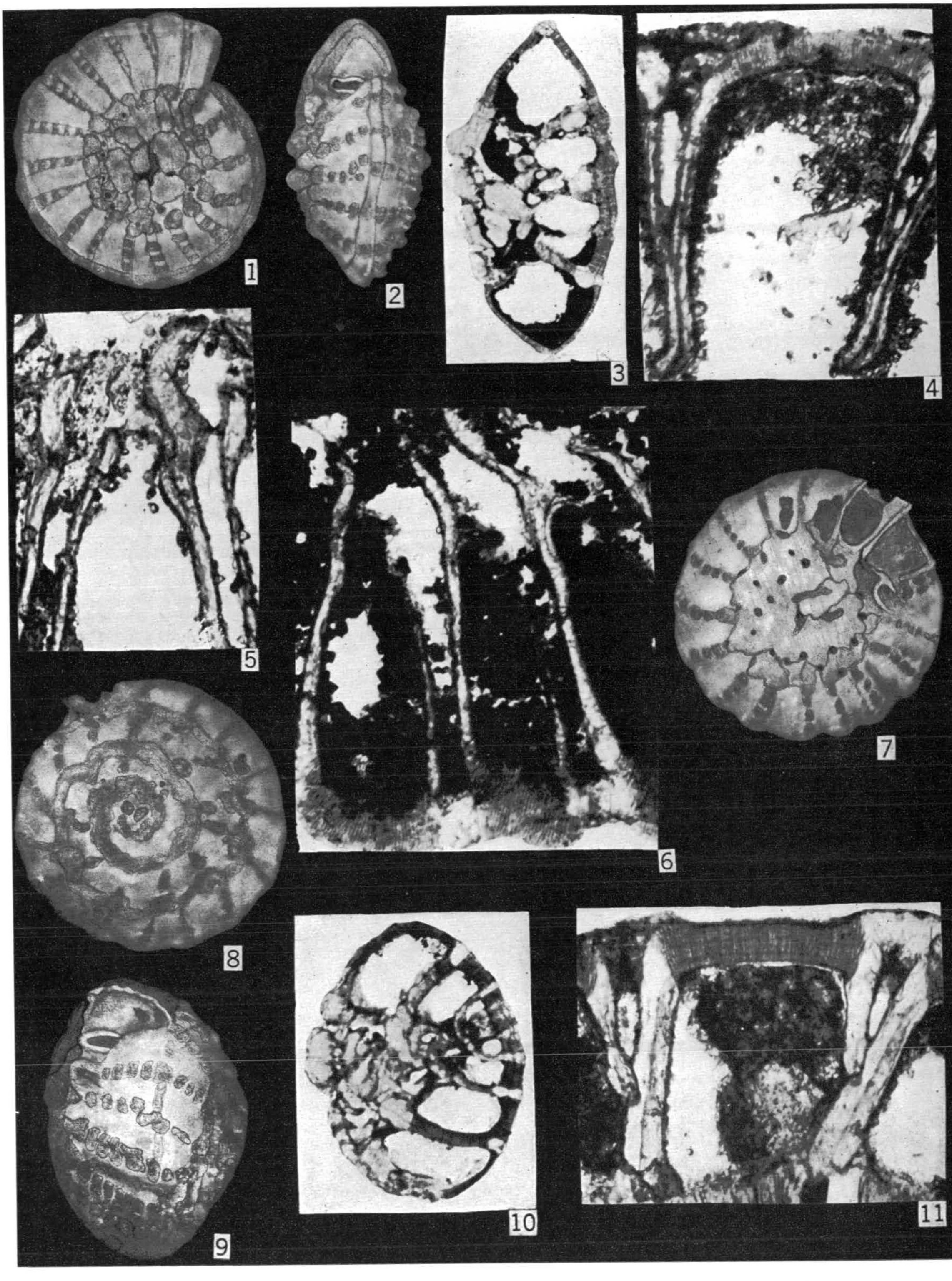

1
2
3
4
5
6
7
8
9
10
11

PLATE 23

Figures		Page
1–6	*Cibicides* sp. cf. *C. refulgens* Montfort .... 1–3, CPC 6500. 1, ventral view; 2, dorsal view; 3, edge view, both x 107. 4–5, CPC 6501. 4, ventral view, 5, edge view, both x 107. 6, part of horizontal section, CPC 6502, showing bilamellid septa, x 328.	133
7–9	*Cibicides tenuimargo* (Brady) .... 7–8, CPC 6511. 7, ventral view; 8, edge view, both x 66. 9, part of horizontal section, CPC 6512, showing bilamellid septa, x 210.	135
10–14	*Heterolepa mediocris* (Finlay) .... 10–12, CPC 6666. 10, ventral view; 11, dorsal view; 12, edge view, all x 45. 13, CPC 6667, ventral view, x 45. 14, part of horizontal section, CPC 6668, showing bilamellid septa, x 181.	181

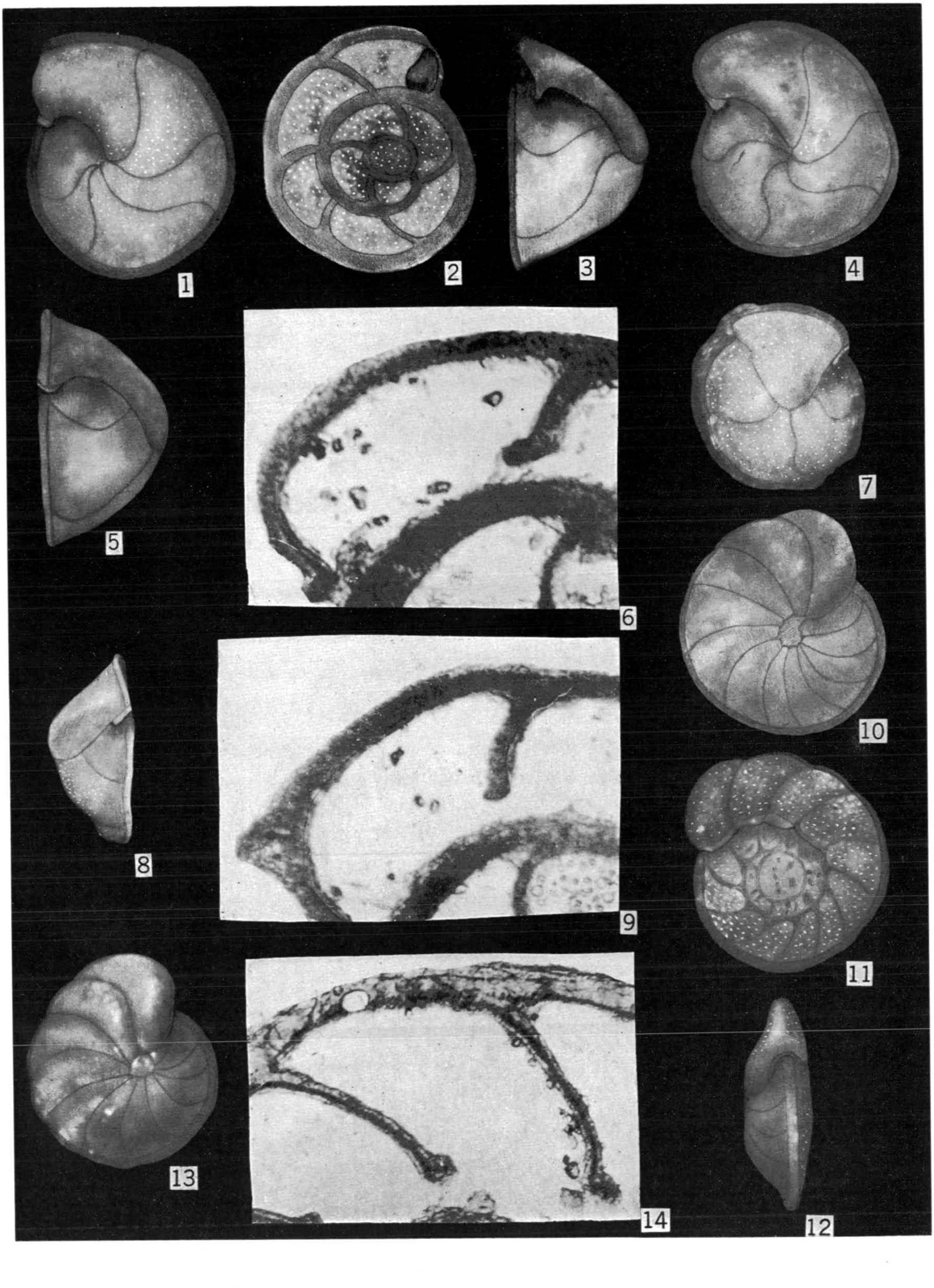

1
2
3
4
5
6
7
8
9
10
11
12
13
14

PLATE 24

Figures		Page
1–4	*Cassidulina laevigata* d'Orbigny .... 1–3, CPC 6519. 1, 2, opposite sides; 3, edge view, all x 70. 4, CPC 6520, side view, x 70.	138
5–10	*Cassidulina delicata* Cushman .... 5–7, CPC 6522. 5, 7, opposite sides; 6, edge view, all x 90. 8–10, CPC 6523. 8, 9, opposite sides; 10, edge view, all x 90.	140
11–14	*Cassidulina sulcata* sp.nov. .... 11, 12, holotype, CPC 6525, opposite sides, both x 97. 13, 14, paratype, CPC 6526, opposite sides, both x 97.	142
15–18	*Cassidulina quasisulcata* sp.nov. .... 15–17, holotype, CPC 6528. 15, 16, opposite sides; 17, edge view, all x 118. 18, paratype, CPC 6529, side view, x 118.	144
19–21	*Globocassidulina ornata* (Cushman) .... 19–20, CPC 6535. 19, side view; 20, front view, both x 72. 21, CPC 6536, side view, x 72.	146
22–25	*Globocassidulina gemma* (Todd) .... 22–24, CPC 6538. 22, side view; 23, front view; 24, rear view, all x 70. 25, CPC 6539, side view, x 70.	147

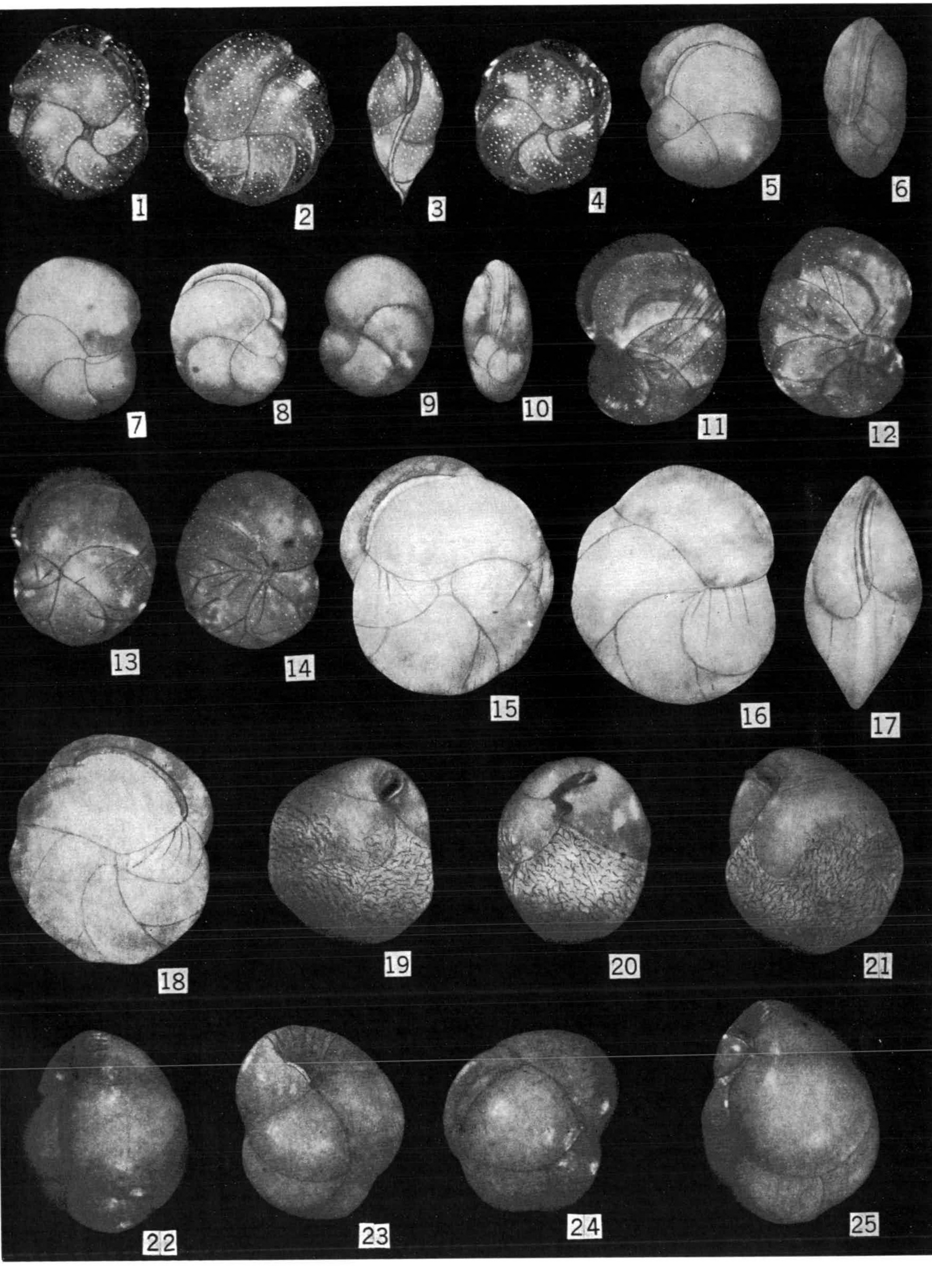

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

PLATE 25

Figures		Page
1–5	*Globocassidulina oriangulata* sp.nov.	148
	1–3, holotype, CPC 6541. 1, side view; 2, front view; 3, rear view, all x 72.	
	4–5, paratype, CPC 6542. 4, side view; 5, front view, both x 72.	
6–10	*Globocassidulina oribunda* sp.nov.	148
	6–8, holotype, CPC 6544. 6, side view; 7, front view; 8, rear view. 6 x 34; 7, 8, x 36.	
	9–10, paratype, CPC 6545. 9, side view; 10, front view, both x 36.	
11–16	*Globocassidulina subglobosa* (Brady)	149
	11–13, CPC 6547. 11, oblique side view; 12, front view; 13, rear view, all x 59.	
	14–16, CPC 6548. 14, front view; 15, 16, side views, all x 59.	
17–18	*Globocassidulina bicornis* (Brady)	154
	CPC 6567. 17, front view; 18, top view, both x 67.	

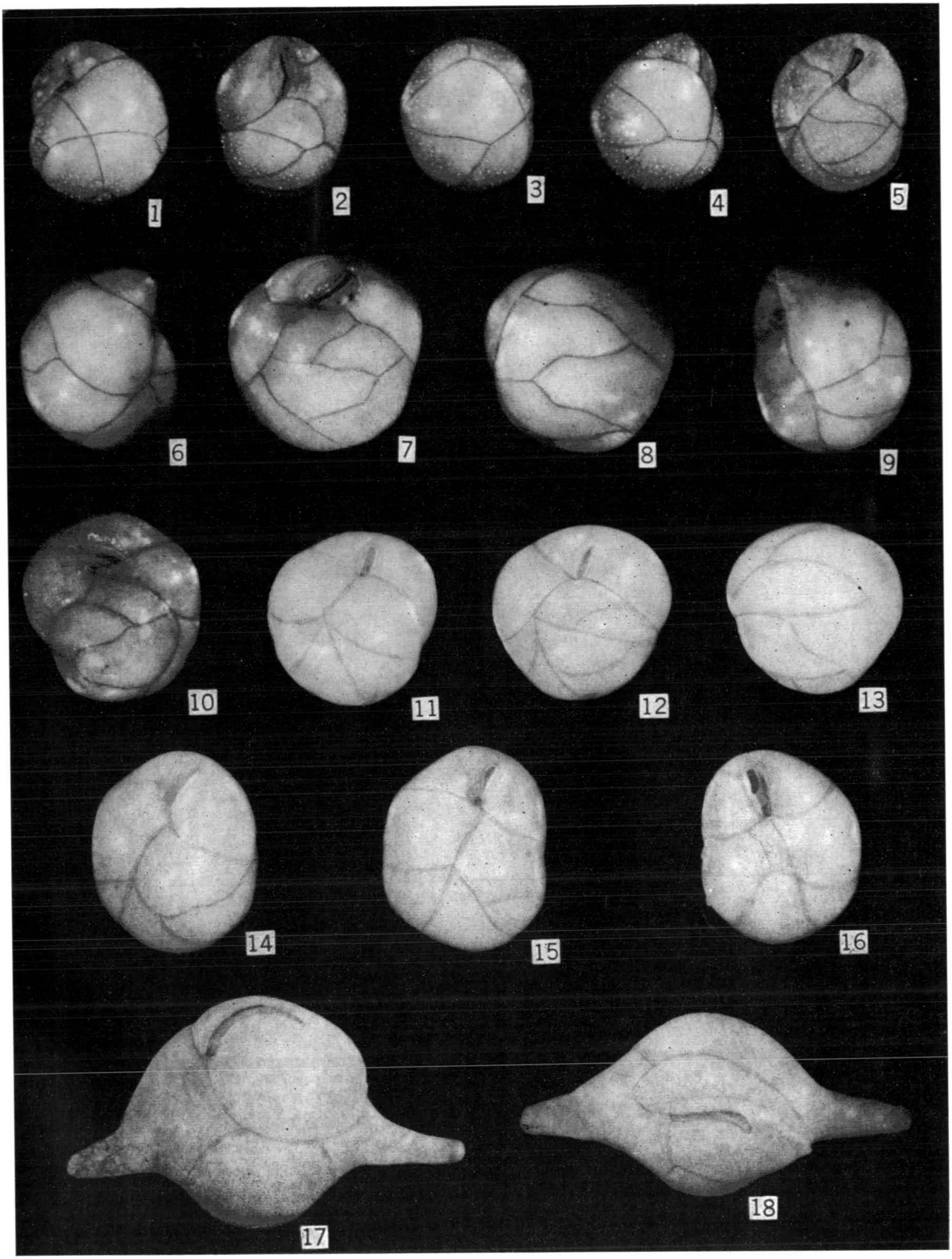

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

PLATE 26

Figures		Page
1–4	*Globocassidulina oblonga* (Reuss) .... 1–3, CPC 6556. 1, 2, opposite sides; 3, edge view, all x 74. 4, CPC 6557, edge view, x 74.	150
5–9	*Globocassidulina crassa* (d'Orbigny) .... 5–7, CPC 6559. 5, 6, opposite sides; 7, edge view, all x 117. 8, 9, CPC 6560, opposite sides, x 117.	151
10–13	*Globocassidulina murrhyna* (Schwager) .... 10–12, CPC 6562. 10, front view, 11, side view; 12, rear view, all x 72. 13, CPC 6563, oblique front view, x 72.	152
14–17	*Cassidulinoides inflatus* (LeRoy) .... 14–16, CPC 6250. 14, 16, opposite sides; 15, edge view, all x 50. 17, CPC 6251, side view, x 50.	54
18–21	*Cassidulinoides seranensis* Germeraad .... 18–20, CPC 6253. 18, side view; 19, front view; 20, rear view, all x 55. 21, CPC 6254, side view, x 42.	55
22–27	*Cassidulinoides bradyi* (Norman) .... 22–24, CPC 6246. 22, 23, opposite sides; 24, edge view, all x 88. 25–27, CPC 6247. 25, 26, opposite sides; 27, edge view, all x 88.	53
28–31	*Favocassidulina favus* (Brady) .... 28–29, CPC 6531, 28, side view; 29, edge view, both x 43. 30, CPC 6532, side view, x 43. 31, section, CPC 6533, x 80.	145

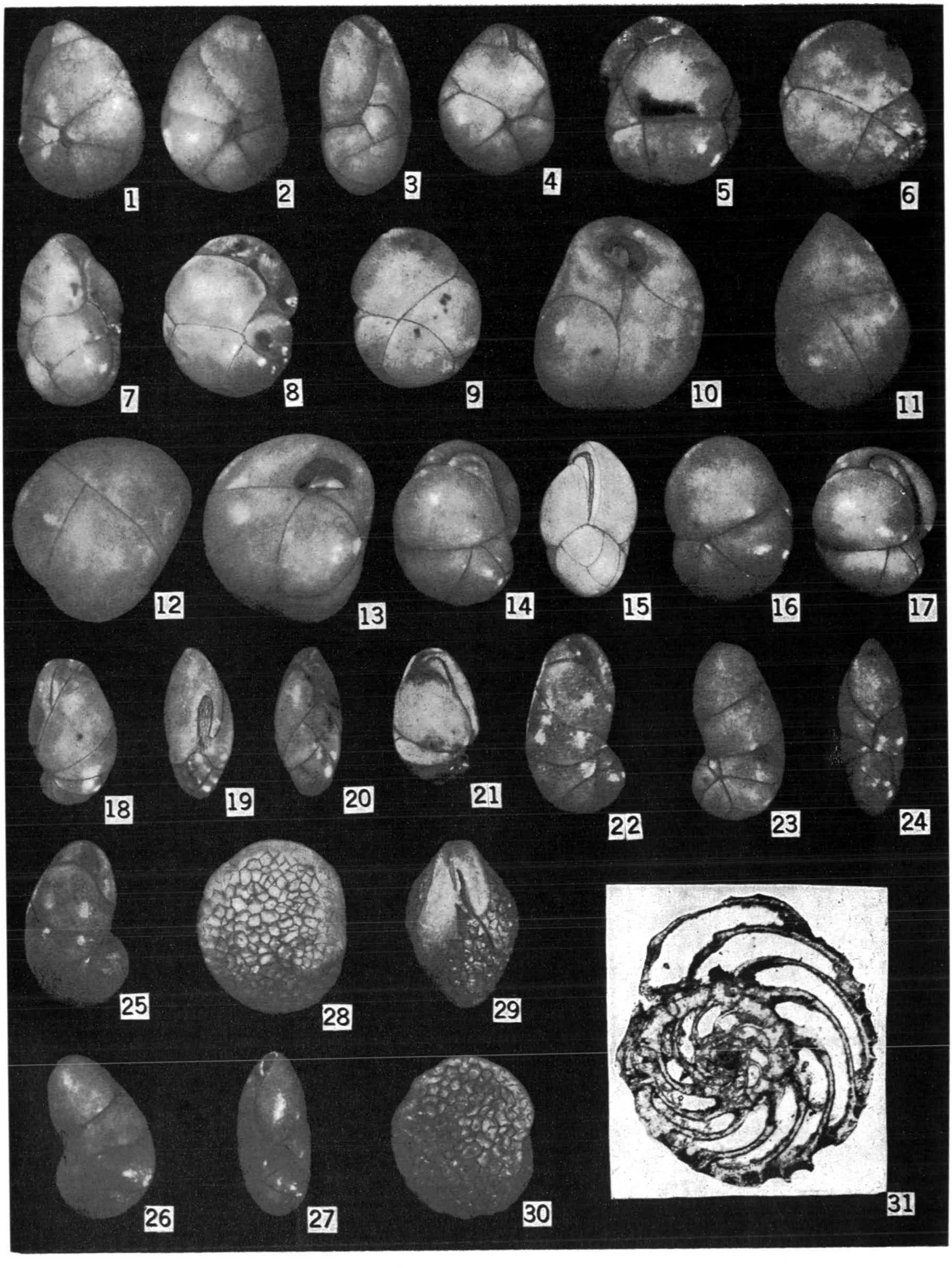

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
28
29
31
26
27
30

PLATE 27

Figures		Page
1–6	*Alabamina tubulifera* (Heron-Allen & Earland)	160
	1–3, CPC 6583. 1, ventral view; 2, dorsal view; 3, edge view, all x 73.	
	4, CPC 6584, ventral view, x 73.	
	5, horizontal section, CPC 6585, showing coarsely granular test, x 110.	
	6, part of horizontal section, CPC 6586, showing apertural face drawn back to form an infundibulum, x 114.	
7–14	*Gyroidina orbicularis* d'Orbigny	164
	7–9, CPC 6593. 7, ventral view; 8, dorsal view; 9, edge view, all x 48.	
	10, CPC 6594, ventral view, x 48.	
	11, CPC 6595, ventral view, x 48.	
	12, CPC 6596, horizontal section, showing coarsely granular test and infundibulum, x 80.	
	13, CPC 6597, vertical section, x 80.	
	14, part of horizontal section in figure 12, showing bilamellid septa and infundibulum, x 211.	

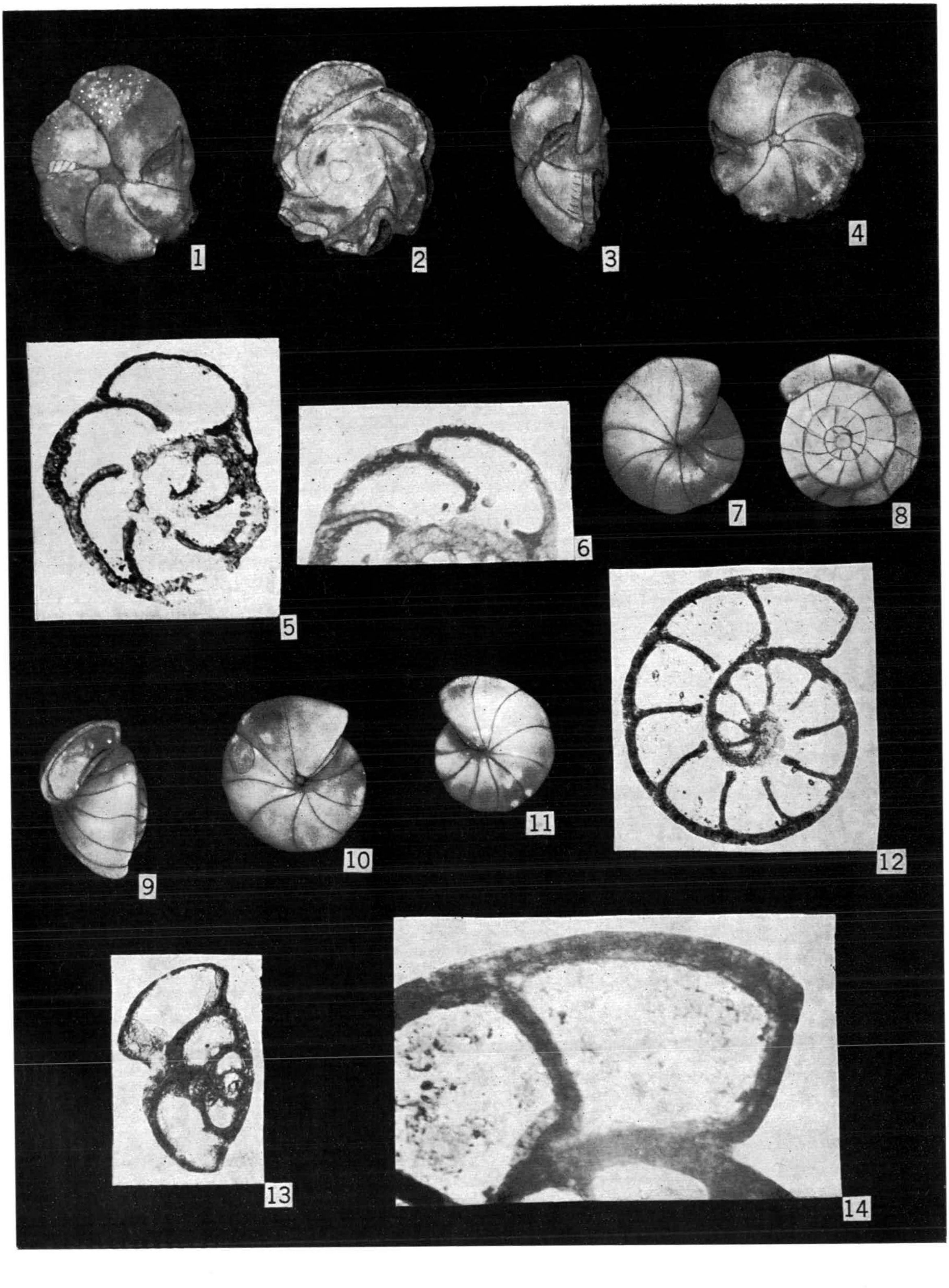

1
2
3
4
5
6
7
8
9
10
11
12
13
14

PLATE 28

Figures		Page
1–9	*Gyroidina acuta* Boomgaart	165
	1–3, CPC 6602. 1, ventral view; 2, dorsal view; 3, edge view, all x 53.	
	4–5, CPC 6603. 4, ventral view; 5, dorsal view, 6, edge view. 4, x 50; 5, 6, x 56.	
	7, horizontal section, CPC 6604, x 74.	
	8, vertical section, CPC 6605, x 100.	
	9, part of the horizontal section in figure 7, showing the infundibulum, bilamellid structure indistinct, x 288.	
10–20	*Gyroidina torulus* sp.nov, ...	168
	10–12, holotype, CPC 6614. 10, ventral view; 11, dorsal view; 12, edge view, all x 51.	
	13–14, paratype A, CPC 6615. 13, ventral view; 14, dorsal view, both x 51.	
	15–17, paratype B, CPC 6616. 15, ventral view; 16, dorsal view; 17, edge view, all x 21.	
	18, vertical section, CPC 6617, x 34.	
	19, horizontal section, CPC 6618, showing thick perforate wall and bilamellid septa, x 40.	
	20, part of the horizontal section in figure 10, x 150.	

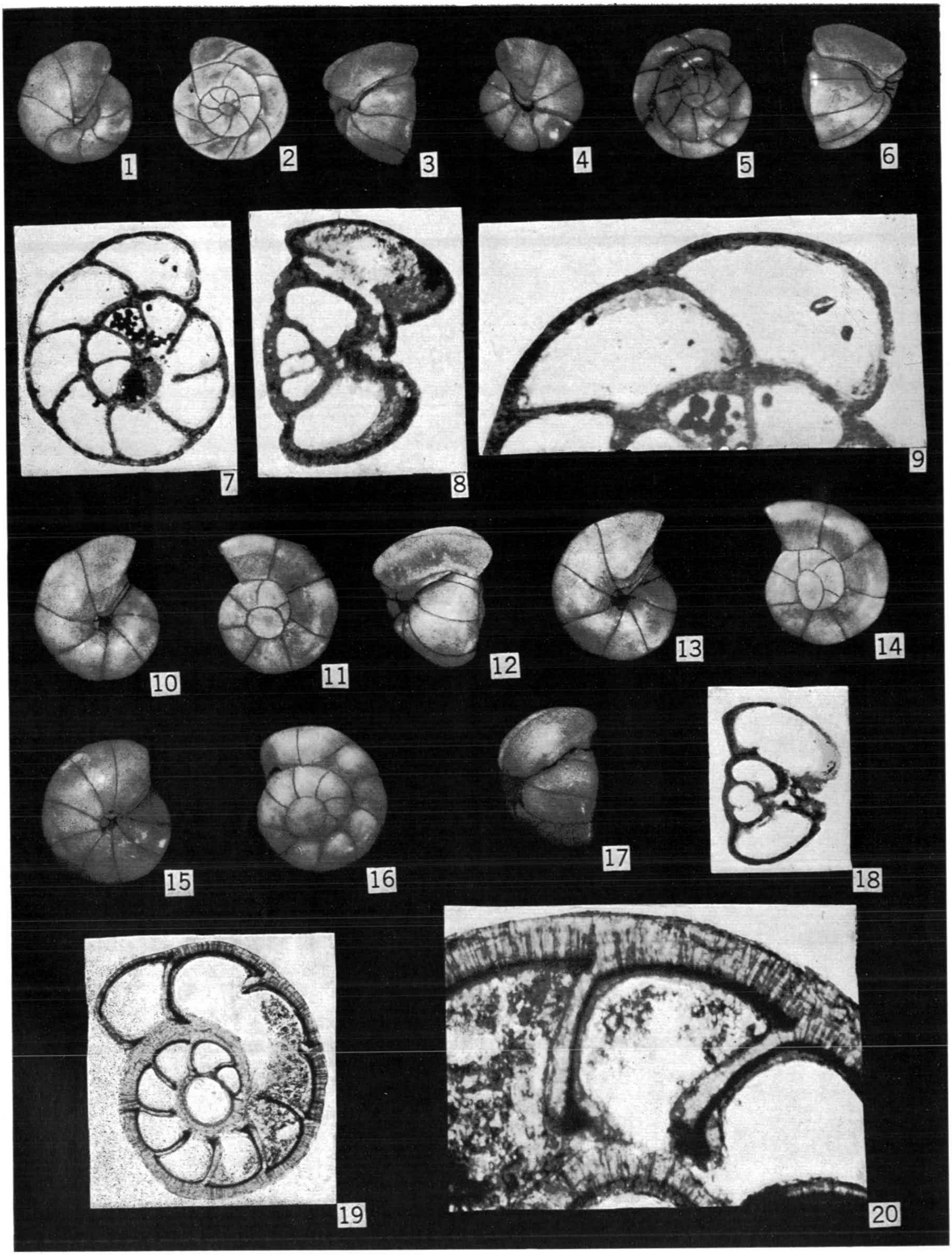

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

PLATE 29

Figures		Page
1–7	*Gyroidina broeckhiana* (Karrer)	167
	1–3, CPC 6608. 1, ventral view; 2, dorsal view; 3, edge view, all x 48.	
	4–5, CPC 6609. 4, ventral view; 5, edge view, both x 48.	
	6, horizontal section, CPC 6610, showing bilamellid septa, x 85.	
	7, vertical section, CPC 6611, x 85.	
8–16	*Gyroidina cushmani* Boomgaart	169
	8–10, CPC 6621. 8, ventral view; 9, dorsal view; 10, edge view, all x 56.	
	11–12, CPC 6622. 11, ventral view; 12, edge view, both x 56.	
	13–14, CPC 6623. 13, ventral view; 14, edge view, both x 56.	
	15, horizontal section, CPC 6624, showing well developed infundibulum in the last chamber, x 110.	
	16, vertical section, CPC 6625, x 110.	
17–23	*Oridorsalis variapertura* sp.nov.	171
	17–19, holotype, CPC 6628. 17, ventral view; 18, dorsal view; 19, edge view, all x 42.	
	20–21, paratype, CPC 6629. 20, ventral view; 21, edge view, both x 42.	
	22, horizontal section, CPC 6630, x 49.	
	23, part of horizontal section, CPC 6631, photographed by reflected light, showing bilamellid septa, x 124.	

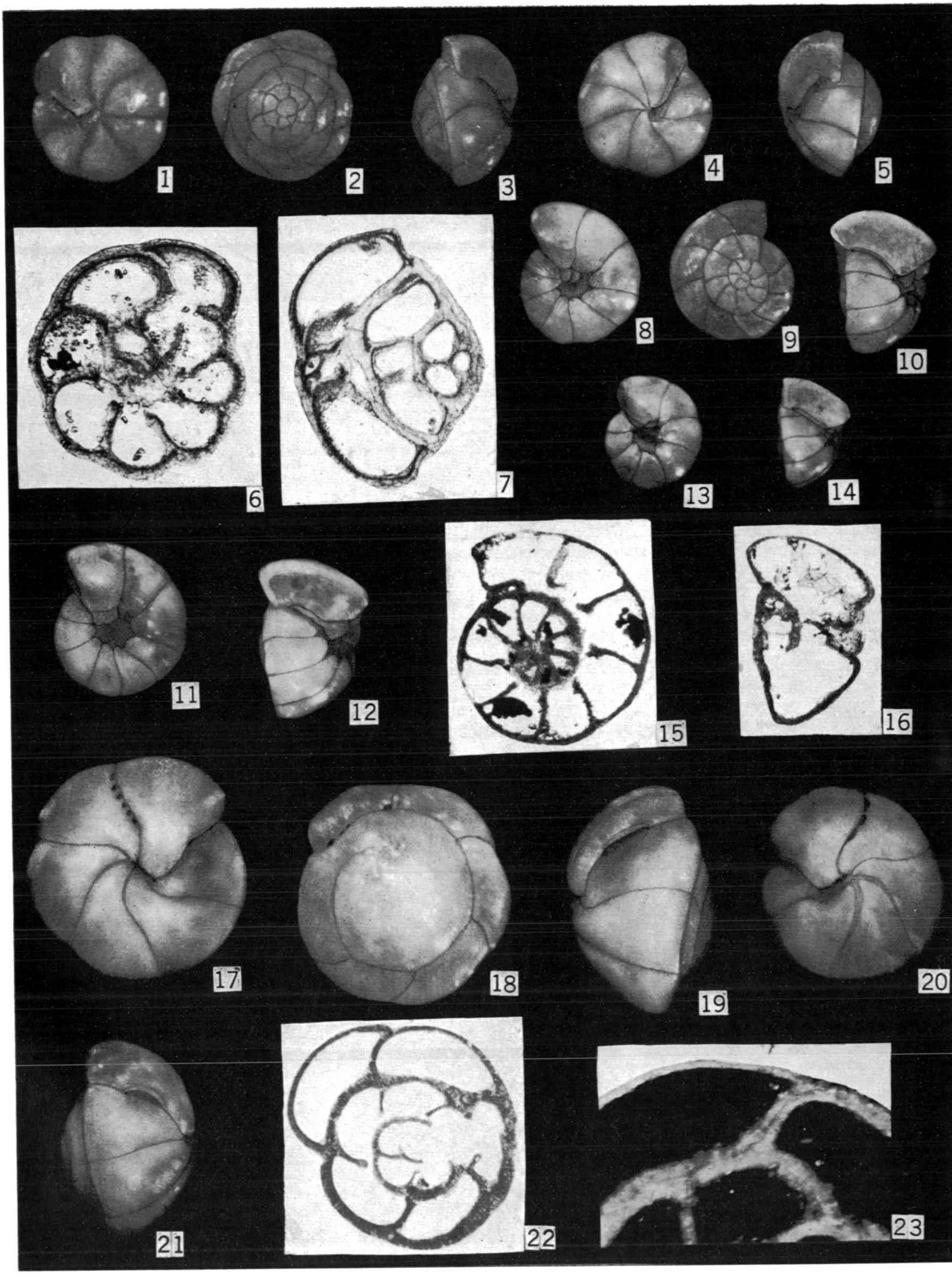

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

PLATE 30

Figures		Page
1–6	*Oridorsalis umbonatus* (Reuss)	172
	1–3, CPC 6634. 1, ventral view; 2, dorsal view; 3, edge view, all x 50.	
	4–5, CPC 6635. 4, ventral view; 5, edge view, both x 50.	
	6, horizontal section, CPC 6636, x 76.	
7–13	*Oridorsalis pauciapertura* sp.nov.	173
	7–9, holotype, CPC 6639. 7, ventral view; 8, dorsal view; 9, edge view, all x 42.	
	10–11, paratype, CPC 6640. 10, ventral view, 11, edge view, both x 42.	
	12, horizontal section, CPC 6641, x 83.	
	13, part of the horizontal section in figure 12, showing coarsely granular wall, x 118.	
14–16	*Allomorphina pacifica* Hofker	154
	CPC 6568. 14, ventral view; 15, dorsal view; 16, edge view, all x 79.	
17–20	*Melonis pompilioides* (Fichtel & Moll)	183
	17–18, CPC 6673. 17, side view; 18, edge view, both x 65.	
	19, CPC 6674, edge view, x 65.	
	20, part of horizontal section, CPC 6675, showing bilamellid structure at inner end of the septa, x 133.	

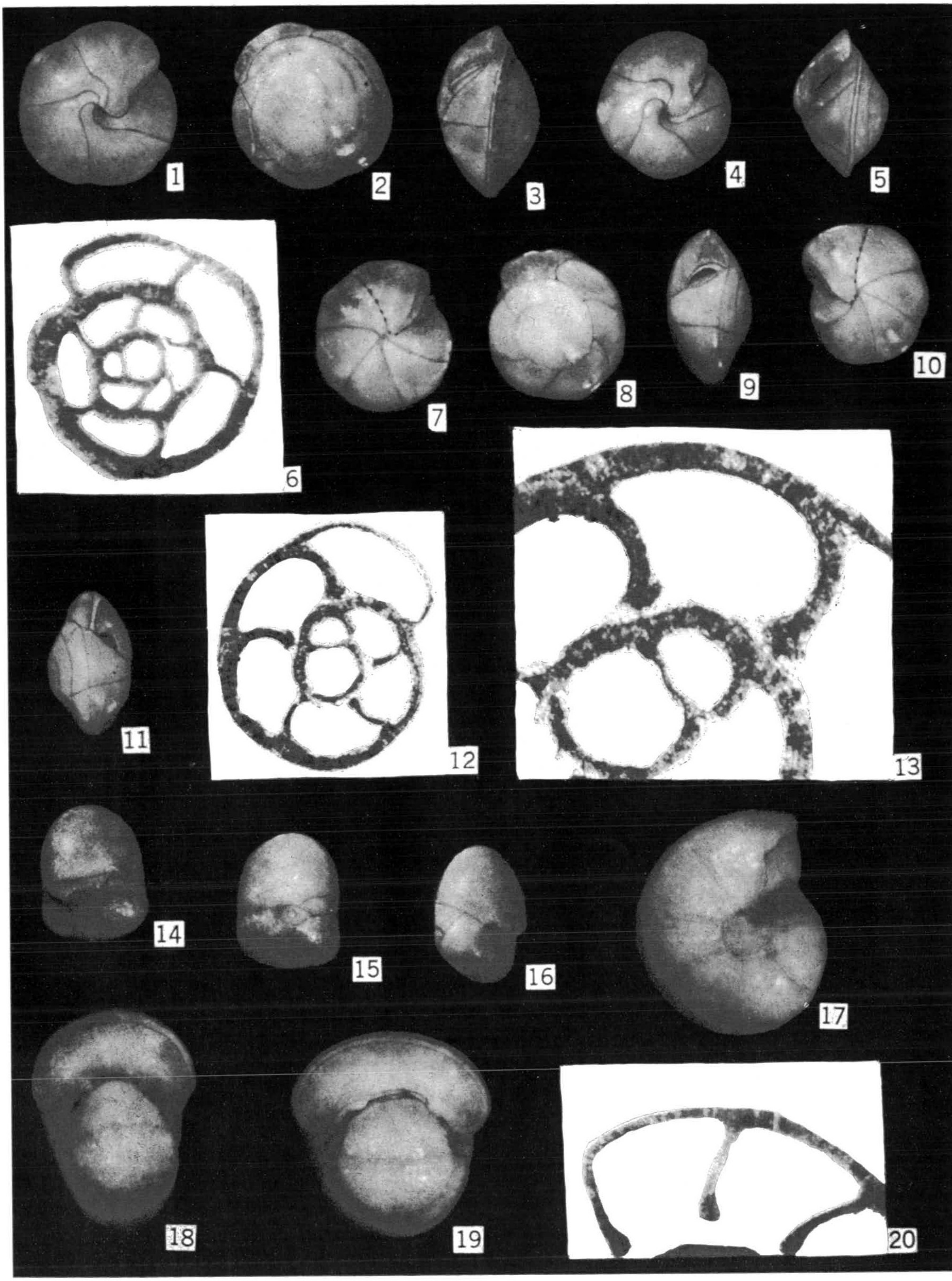

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

PLATE 31

Figures		Page
1–4	*Melonis affinis* (Reuss)	184
	1–2, CPC 6676. 1, side view; 2, edge view, both 65.	
	3, CPC 6677, side view, x 65.	
	4, part of horizontal section, CPC 6678, showing bilamellid septa, x 136.	
5–7	*Florilus incisus* (Cushman)	157
	5–6, CPC 6573. 5, side view; 6, edge view, both x 66.	
	7, CPC 6574, side view, x 77.	
8–12	*Florilus elongatus* (d'Orbigny)	158
	8–9, CPC 6575. 8, side view; 9, edge view, both x 66.	
	10, CPC 6576, side view, x 66.	
	11–12, CPC 6577. 11, side view; 12, edge view, both x 66.	
13–15	*Florilus subturgidus* (Cushman)	158
	13–14, CPC 6578. 13, side view; 14, edge view, both x 66.	
	15, CPC 6579, side view, x 66.	
16–20	*Nonionella amplilabrata* sp.nov.	159
	16–18, holotype, CPC 6580. 16, 17, opposite sides; 18, edge view, all x 132.	
	19–20, paratype, CPC 6581. 19, side view; 20, edge view, both x 132.	
21–23	*Nonionella* sp. A.	160
	CPC 6582. 21, 22, from opposite sides; 23, edge view. 21, 22, x 66; 23, x 101.	

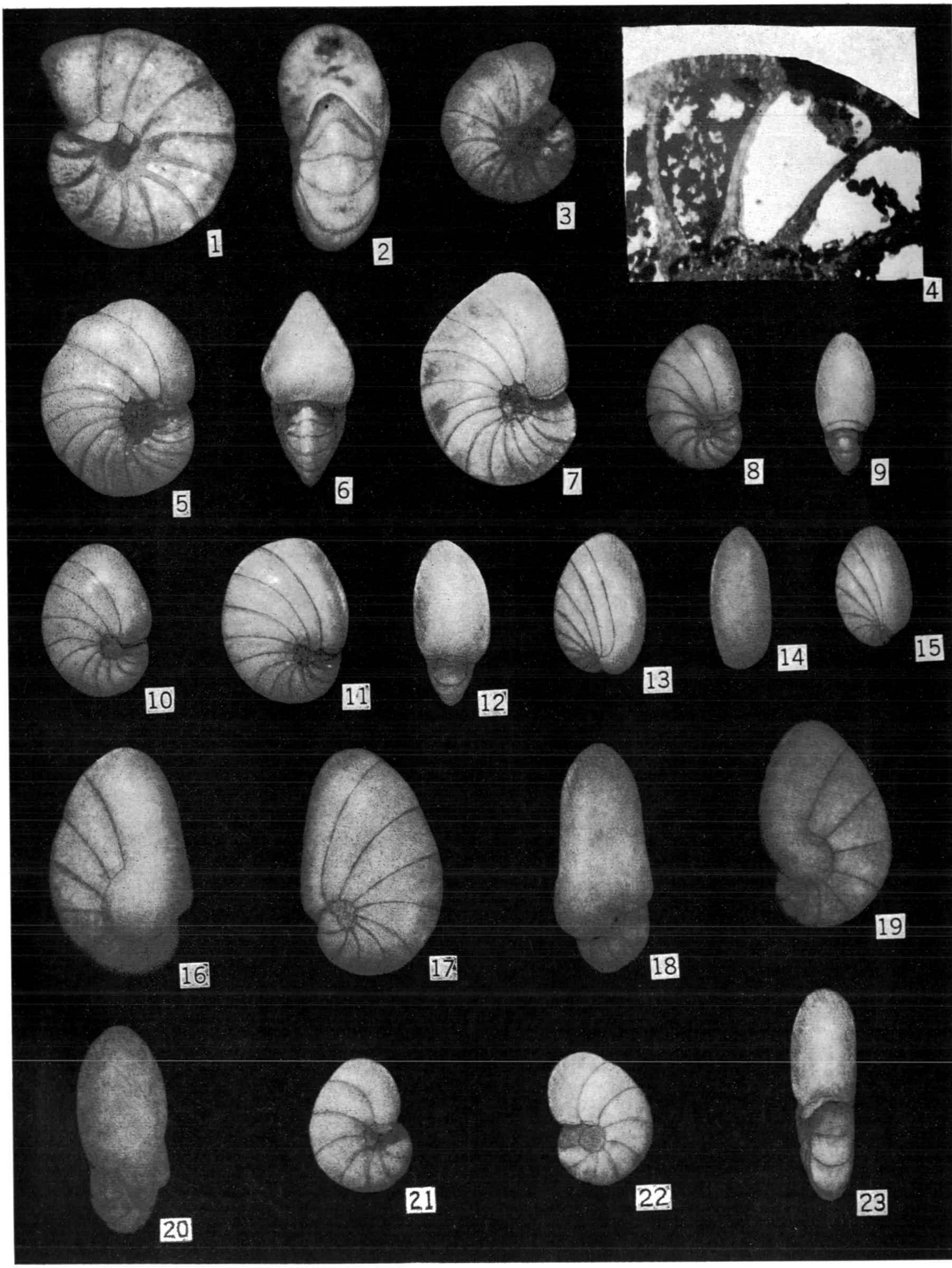

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

PLATE 32

Figures		Page
1–7	*Anomalina glabrata* Cushman	177
	1–3, CPC 6645. 1, ventral view; 2, dorsal view; 3, edge view, all x 70.	
	4–5, CPC 6648. 4, ventral view; 5, dorsal view, both x 70.	
	6, horizontal section, CPC 6649, x 135.	
	7, part of horizontal section, CPC 6650, showing indistinct bilamellid structure at inner end of apertural face of last chamber, x 167.	
8–15	*Anomalinoides colligerus* (Chapman & Parr)	178
	8–10, CPC 6653. 8, ventral view; 9, dorsal view; 10, edge view, all x 34.	
	11–12, CPC 6654. 11, ventral view, 12, dorsal view, both x 34.	
	13, part of horizontal section, CPC 6656, showing bilamellid septa, x 114.	
	14, 15, vertical sections, CPC 6656, 6657, showing dorsal aperture. 14, x 61; 15, x 56.	

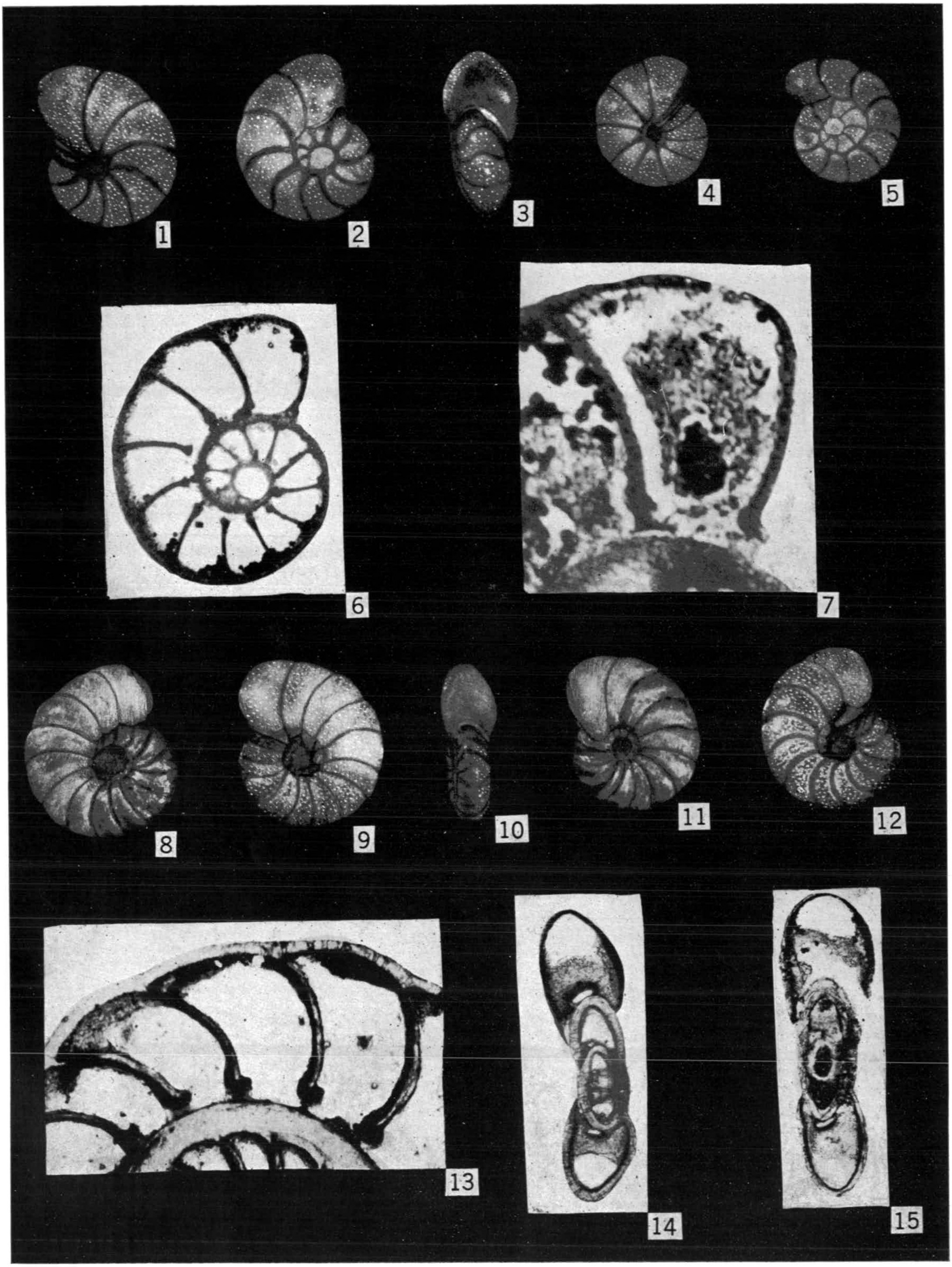

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE 33

Figures		Page
1–8	*Anomalinoides cavus* sp.nov.	180
	1–3, holotype, CPC 6661. 1, ventral view; 2, dorsal view; 3, edge view, all x 54.	
	4–5, paratype, CPC 6662. 4, ventral view; 5, dorsal view, both x 54.	
	6, vertical section, CPC 6663, x 113.	
	7, 8, part of horizontal sections, CPC 6664, 6665, showing bilamellid structure at inner ends of septa. 7, x 260; 8, x 183.	
9–13	*Anomalinella rostrata* (Brady)	185
	9–11, CPC 6679. 9, side view; 10, edge view, both x 45.	
	11, side view, x 45.	
	12, part of horizontal section, CPC 6680, showing bilamellid septa, x 75.	
	13, vertical section, CPC 6681, showing lamellar test, x 52.	

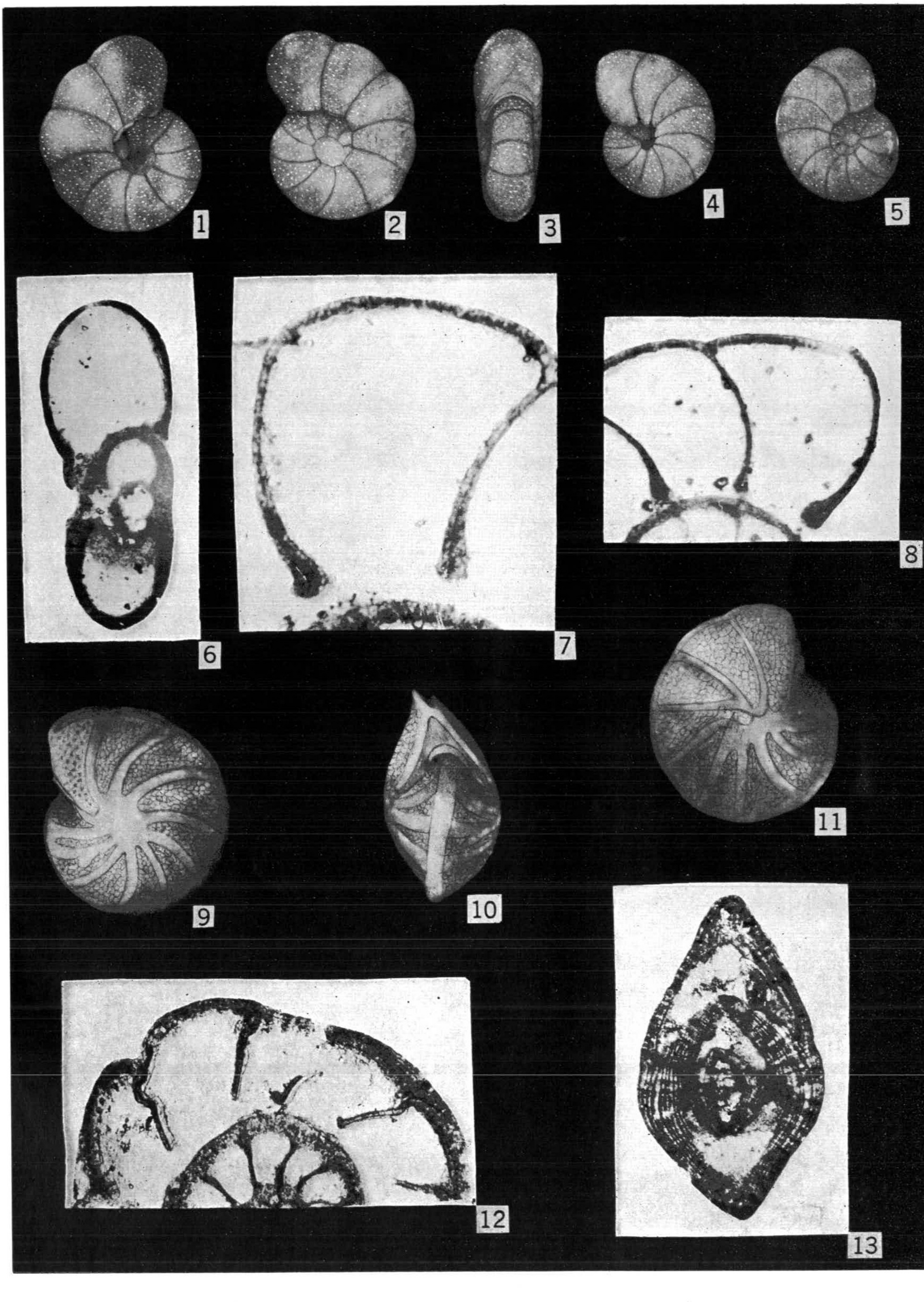

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 34

Figures		Page
1–6	*Anomalinoides evolutus* sp.nov.	179
	1–3, holotype, CPC 6658. 1, ventral view; 2, dorsal view; 3, edge view, all x 74.	
	4–5, paratype, CPC 6659. 4, ventral view; 5, dorsal view, both x 74.	
	6, part of horizontal section, CPC 6660, showing bilamellid septa, x 274.	
7–13	*Heterolepa cavata* sp.nov.	182
	7–9, holotype, CPC 6670. 7, ventral view; 8, dorsal view; 9, edge view, all x 39.	
	10–12, paratype, CPC 6671. 10, ventral view; 11, dorsal view; 12, edge view, all x 39.	
	13, part of horizontal section, CPC 6672, showing bilamellid septa, x 200.	

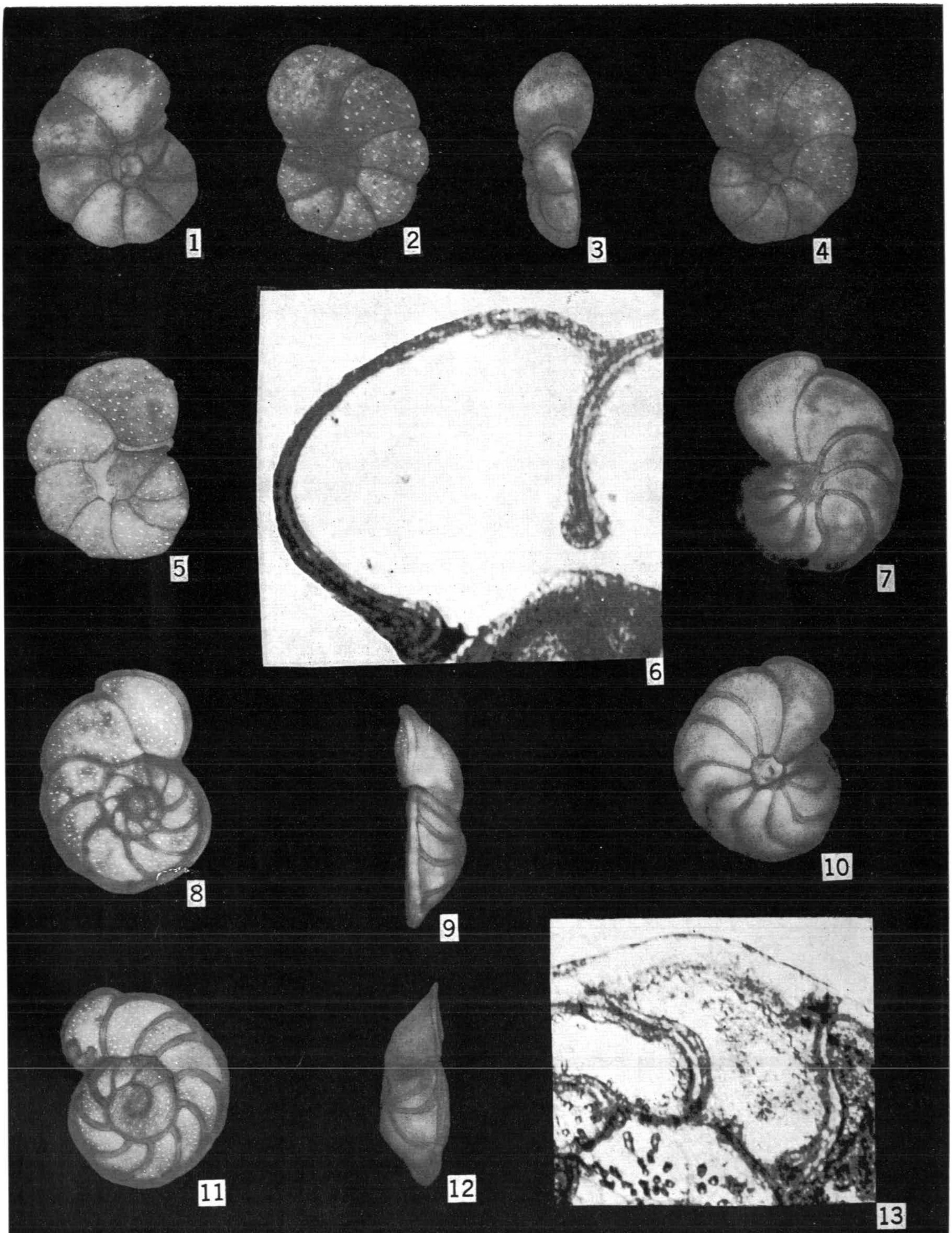

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 35

Figures		Page
1–5	*Osangularia culter* (Parker & Jones)	175
	1–3, CPC 6643. 1, ventral view; 2, dorsal view; 3, edge view, all x 75.	
6–9	*Osangularia bengalensis* (Schwager)	176
	6–8, CPC 6645. 6, ventral view; 7, dorsal view; 8, edge view, all x 52.	
	9, horizontal section, CPC 6646, showing aperture near the umbilicus remaining open in early chambers, x 90.	
10–14	*Lamarckina ventricosa* (Brady)	189
	10–12, CPC 6690. 10, ventral view; 11, dorsal view; 12, edge view, all x 100.	
	13–14, CPC 6691. 13, ventral view; 14, edge view, both x 100.	
15–17	*Lamarckina scabra* (Brady)	189
	CPC 6688. 15, ventral view; 16, dorsal view; 17, edge view, all x 108.	

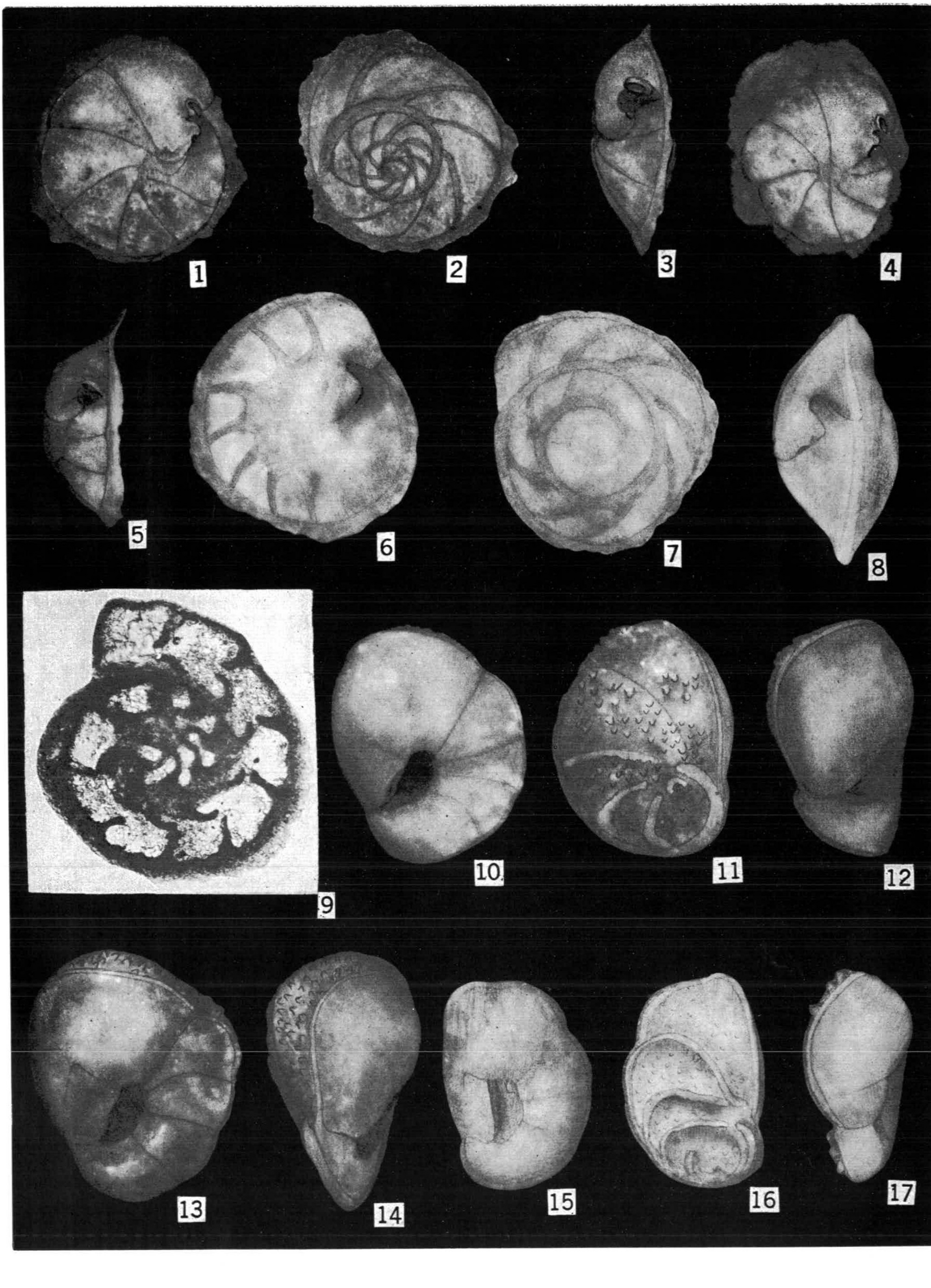

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

PLATE 36

Figures		Page
1–7	*Ceratobulimina pacifica* Cushman & Harris	186
	1–3, CPC 6682. 1, ventral view; 2, edge view; 3, dorsal view; all x 43.	
	4, CPC 6683, ventral view, x 43.	
	5, horizontal section, CPC 6684, showing bilamellid septa and internal structure formed by infolding of outer wall, x 116.	
	7, part of section across last chamber, CPC 6686, passing through junction of internal structure and dorsal chamber wall, x 183.	
8–13	*Hoeglundina elegans* (d'Orbigny)	190
	8–10, CPC 6692. 8, ventral view; 9, dorsal view; 10, edge view, all x 47.	
	11, CPC 6693, ventral view, x 47.	
	12, CPC 6694, vertical section, x 40.	
	13, part of vertical section in figure 12, showing bilamellid structure and internal structure formed by infolding of the wall, x 120.	

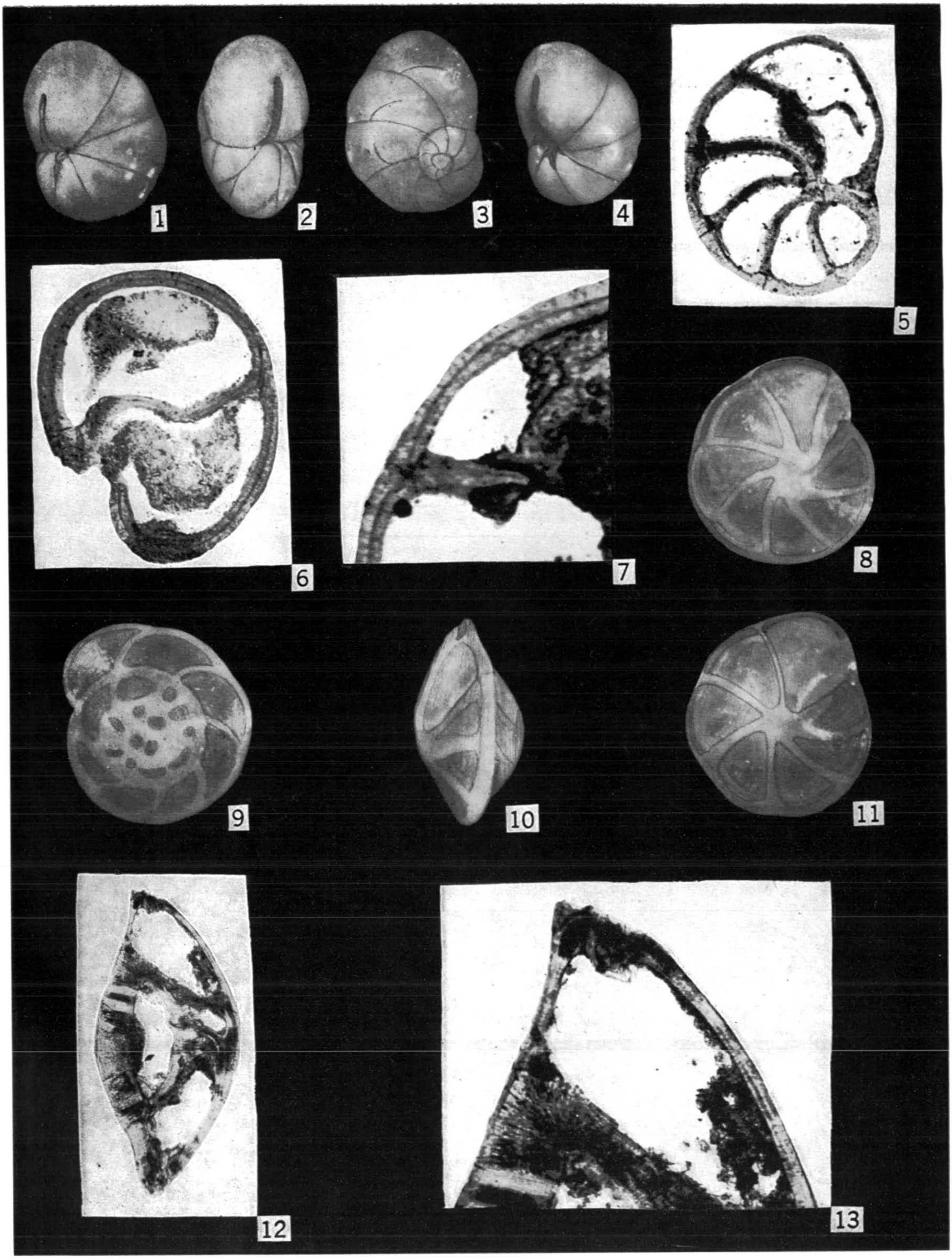

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 37

Figures		Page
1–7	*Geminospira bradyi* Bermudez	193
	1–2, CPC 6695. 1, ventral view; 2, dorsal view, both x 61.	
	3–4, CPC 6696. 3, ventral view; 4, dorsal view, both showing beginning of secondary chambers, x 61.	
	5–6, CPC 6697. 5, ventral view; 6, dorsal view, specimen without secondary chambers, x 61.	
	7, horizontal section, CPC 6698, showing primary and secondary chambers, x 128.	
8–10	*Robertinoides oceanicus* (Cushman & Parker)	195
	8–9, CPC 6702. 8, front view; 9, rear view, both x 80.	
	10, CPC 6703, front view, x 80.	
11–15	*Rotamorphina minuta* (Schubert)	156
	11–13, CPC 6571. 11, ventral view; 12, dorsal view; 13, edge view, all x 78.	
	14–15, CPC 6572. 14, ventral view; 15, edge view, both x 78.	
16–20	*Valvulineria javana* LeRoy	98
	16–18, CPC 6383. 16, ventral view; 17, dorsal view; 18, edge view, all x 67.	
	19–20, CPC 6384. 19, ventral view; 20, edge view, both x 67.	
21–25	*Quadrimorphina laevigata* (Phleger & Parker)	155
	21–23, CPC 6569. 21, ventral view; 22, dorsal view; 23, edge view, all x 77.	
	24–25, CPC 6570. 24, ventral view; 25, edge view, both x 77.	

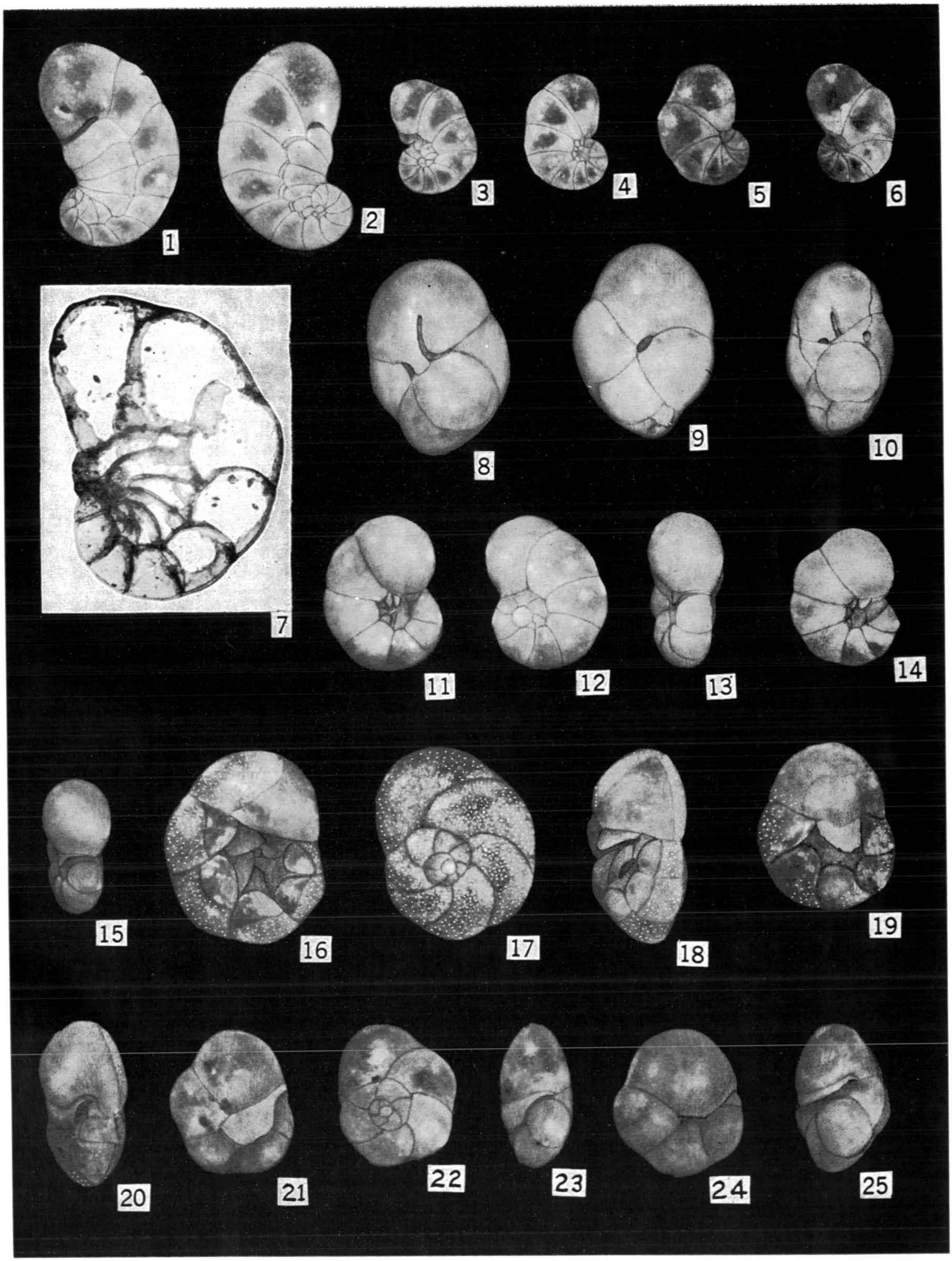

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

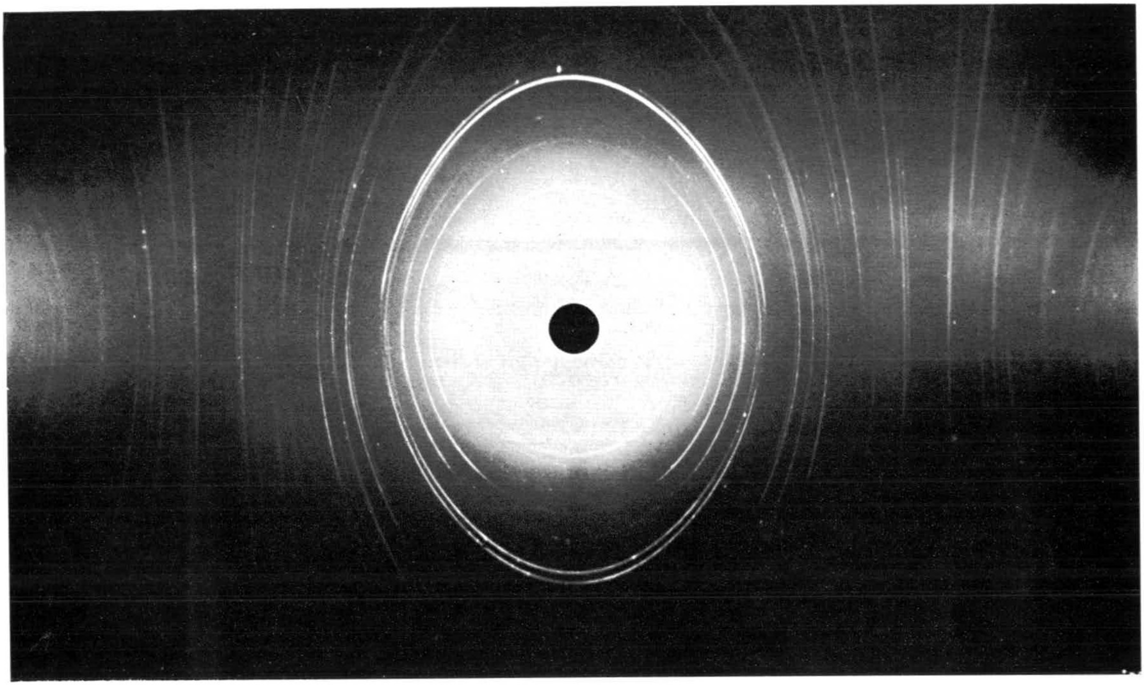
PLATE 38

Laue photographs of the test wall

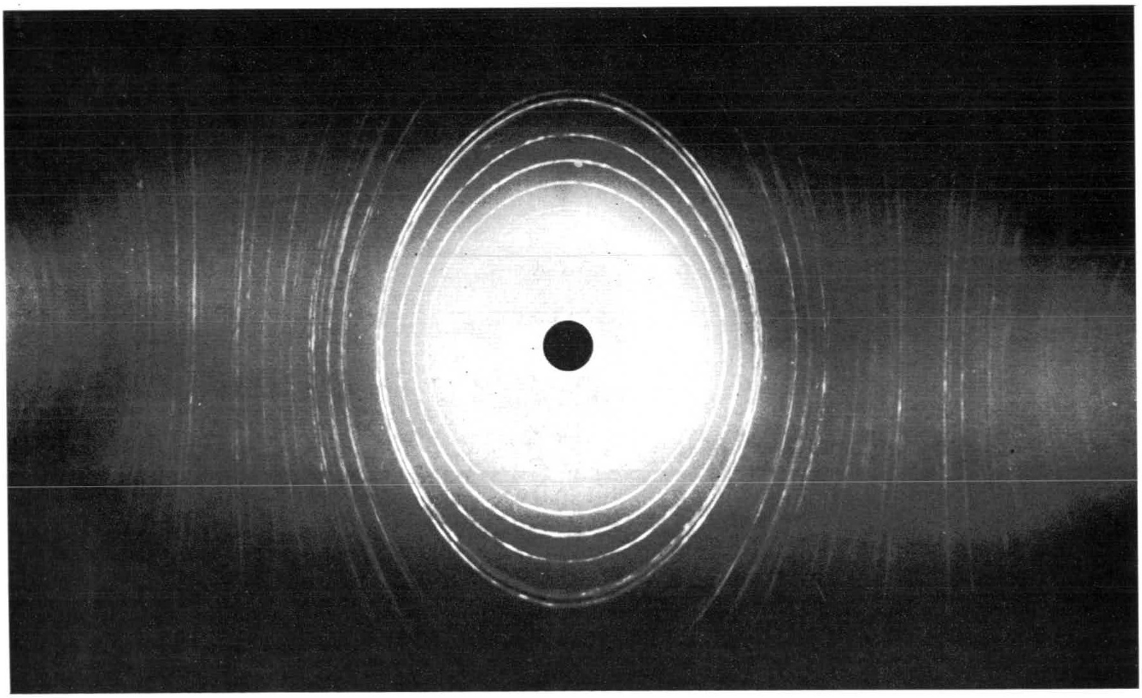
1. *Orbulina universa* d'Orbigny, 'Goldseeker' haul 211, 59° 59′ N., 06° 38′ W. at 505 metres. Fragment of the test wall oriented with the c-axes of the calcite crystals perpendicular to the direction of the X-ray beam, that is, with the surface of the fragment parallel to the beam.

2. *Cibicides refulgens* Montfort, 'Goldseeker' haul 211. Fragment of the test wall oriented with the surface parallel to the direction of the X-ray beam.

Target: Cu.
Filter: Ni.
Fragments stationary.



1



2

INDEX OF ILLUSTRATED SPECIES

95044—(16)

INDEX OF ILLUSTRATED SPECIES

aculeata, Bulimina, 58, pl. 5
Euuvigerina, 78, pl. 7
Reussella, 75, pl. 9
acuta, Gyroidina, 165, pl. 28
affinis, Protoglobobulimina, 69, pl. 6
affinus, Melonis, 184, pl. 31
Alabamina tubulifera, 160, pl. 27
alata, Brizalina, 24, pl. 1
alazanensis, Bulimina, 62, pl. 5
Allomorphina pacifica, 154, pl. 30
altocamerata, Parvicarinina, 93, pl. 14
Ammonia beccarii, 108, pl. 19
maculosa, 110, pl. 19
supera, 111, pls. 19, 20
ampliapertura, Bulimina, 65, pl. 5
amplilabrata, Nonionella, 159, pl. 31
Anomalina glabrata, 177, pl. 32
Anomalinella rostrata, 185, pl. 33
Anomalinoides cavus, 180, pl. 33
colligerus, 178, pl, 32
evolutus, 179, pl. 34
Asterigerina tentoria, 106, pl. 15
auriculus, Cancris, 96, pl. 15
Baggina indica, 96, pl. 15
balthica, Hyalinea, 124, pl. 14
beccarii, Ammonia, 108, pl. 19
bengalensis, Osangularia, 176, pl. 35
bertheloti, Discorbinella, 90, pl. 12
berthelotianus, Neoeponides, 117, pl. 17
bicornis, Globocassidulina, 154, pl. 25
bifrons, Rectobolivina, 45, pl. 9
bodjongensis, Cancris, 97, pl. 15
Bolivina robusta, 21, pl. 1
Bolivinita compressa, 19, pl. 4
quadrilatera, 18, pl. 4
subangularis, 19, pl. 3
bradyi, Cassidulinoides, 53, pl. 26
Geminospira, 193, pl. 37
Parrelloides, 100, pl. 11
Trifarina, 88, pl. 9
Brizalina alata, 24, pl. 1
capitata, 26, pl. 1
catenula, 39, pl. 3
hastula, 38, pl. 2
karreriana, 39, pl. 2
macella, 33, pl. 2
massula, 40, pl. 3
multilineata, 31, pl. 2
patula, 37, pl. 2
plicatella, 26, pl. 1
pseudobeyrichi, 28, pl. 1
sp.cf. pygmaea, 31, pl. 1
semicarinata, 42, pl. 3
semilineata, 35, pl. 2
subreticulata, 29, pl. 1
tuberosa, 41, pl. 3
sp.cf. variabilis, 27, pl. 1
vescistriata, 34, pl. 2
sp.A, 43, pl. 3
broeckhiana, Gyroidina, 167, pl. 27
Bueningia creeki, 99, pl. 13
Bulimina aculeata, 58, pl. 5
alazanensis, 62, pl. 5
ampliapertura, 65, pl. 5
marginata, 55, pl. 5
senta, 65, pl. 6
striata, 59, pl. 5
subacuminata, 63, pl. 5
subornata, 64, pl. 5
Buliminella sp.cf. tenuata, 16, pl. 6
Cancris auriculus, 96, pl. 15
bodjongensis, 97, pl. 15
capitata, Brizalina, 26, pl. 1
carinata, Rectobolivina sp.cf., 51, pl. 4
Cassidulina delicata, 140, pl. 24
laevigata, 138, pl. 24
quasisulcata, 144, pl. 24
sulcata, 142, pl. 24
Cassidulinoides bradyi, 53, pl. 26
inflatus, 54, pl. 26
seranensis, 55, pl. 26
catenula, Brizalina, 39, pl. 3
catilliformis, Pseudorotalia, 114, pl. 21
cavata, Heterolepa, 182, pl. 34
cavus, Anomalinoides, 180, pl. 33
Ceratobulimina pacifica, 186, pl. 36
Cibicides sp.cf. refulgens, 133, pl. 23
tenuimargo, 135, pl. 23
colligerus, Anomalinoides, 178, pl. 32
columellaris, Rectobolivina, 47, pl. 9
compressa, Bolivinita, 19, pl. 4
costata, Siphogenerina, 86, pl. 9
crassa, Globocassidulina, 151, pl. 26
crassicostata, Euuvigerina, 79, pl. 7
creeki, Bueningia, 99, pl. 13
culter, Osangularia, 175, pl. 35
cushmani, Gyroidina, 169, pl. 29
delicata, Cassidulina, 140, pl. 24
dimorpha, Rectobolivina, 47, pl. 9
Discorbinella bertheloti, 90, pl. 12
subbertheloti, 91, pl. 13
elegans, Hoeglundina, 190, pl. 36
elongatus, Florilus, 158, pl. 31
'Eponides' labricrassus, 127, pl. 18
margaritiferus, 126, pl. 18
praecinctus, 125, pl. 16
subhaidingeri, 129, pl. 16
sp.cf. subhaidingeri, 130, pl. 16
suturicrassus, 128, pls. 18, 19
Euuvigerina aculeata, 78, pl. 7
crassicostata, 79, pl. 7
flinti, 80, pl. 7
hispida, 78, pl. 7
nitidula, 82, pl. 8
peregrina, 75, pl. 7
reineri, 82, pl. 8
schwageri, 81, pl. 8

evolutus, Anomalinoides, 179, pl. 34
fasciata, Rectobolivina, 52, pl. 4
Favocassidulina favus, 145, pl. 26
favus, Favocassidulina, 145, pl. 26
flinti, Euuvigerina, 80, pl. 7
Florilus elongatus, 158, pl. 31
incisus, 157, pl. 31
subturgidus, 158, pl. 31
Fursenkoina schreibersiana, 136, pl. 9
gaimardi, Pseudorotalia, 115, pl. 20
Geminospira bradyi, 193, pl. 37
gemma, Globocassidulina, 147, pl. 24
glabrata, Anomalina, 177, pl. 32
Globobulimina sp. A, 66, pl. 7
Globocassidulina bicornis, 154, pl. 25
crassa, 151, pl. 26
gemma, 147, pl. 24
murrhyna, 152, pl. 26
oblonga, 150, pl. 26
oriangulata, 148, pl. 25
oribunda, 148, pl. 25
ornata, 146, pl. 24
subglobosa, 149, pl. 25
Gyroidina acuta, 165, pl. 28
broeckhiana, 167, pl. 29
cushmani, 169, pl. 29
orbicularis, 164, pl. 27
torulus, 168, pl. 28
hastula, Brizalina, 38, pl. 2
Heterolepa cavata, 182, pl. 34
mediocris, 181, pl. 23
hispida, Euuvigerina, 78, pl. 7
Hoeglundina elegans, 190, pl. 36
Hyalinea balthica, 124, pl. 14
incisus, Florilus, 157, pl. 31
indica, Baggina, 96, pl. 15
Rectobolivina, 47, pl. 9
inflatus, Cassidulinoides, 54, pl. 26
interrupta, Siphouvigerina, 86, pl. 8
javana, Valvulineria, 98, pl. 37
karreriana, Brizalina, 39, pl. 2
labricrassus, 'Eponides', 127, pl. 18
laevigata, Cassidulina, 138, pl. 24
Quadrimorphina, 155, pl. 37
Lamarckina scabra, 189, pl. 35
ventricosa, 189, pl. 35
Laterostomella voluta, 44, pl. 3
Laticarinina pauperata, 92, pl. 14
limbata, Rectobolivina, 49, pl. 4
macella, Brizalina, 33, pl. 2
maculosa, Ammonia, 110, pl. 19
margaritiferus, 'Eponides', 126, pl. 18
marginata, Bulimina, 55, pl. 5
massula, Brizalina, 40, pl. 3
mediocris, Heterolepa, 181, pl. 23
Melonis affinis, 184, pl. 31
pompilioides, 183, pl. 30
microlongistriata, Protoglobobulimina, 70, pl. 6
minuta, Rotamorphina, 156, pl. 37
multilineata, Brizalina, 31, pl. 2
murrhyna, Globocassidulina, 152, pl. 26
Neoeponides berthelotianus, 117, pl. 17
parantillarum, 118, pls. 17, 18
subornatus, 118, pl. 17
nitidula, Euuvigerina (?), 82, pl. 8
Nonionella amplilabrata, 159, pl. 31
sp. A, 160, pl. 31
oblonga, Globocassidulina, 150, pl. 26
oceanicus, Robertinoides, 195, pl. 37
okinawaensis, Parrelloides, 103, pl. 12
orbicularis, Gyroidina, 164, pl. 27
oriangulata, Globocassidulina, 148, pl. 25
oribunda, Globocassidulina, 148, pl. 25
Oridorsalis pauciapertura, 173, pl. 30
umbonatus, 172, pl. 30
variapertura, 171, pl. 29
ornata, Globocassidulina, 146, pl. 24
Osangularia bengalensis, 176, pl. 35
culter, 175, pl. 35
ovata, Protoglobobulimina, 68, pl. 6
pacifica, Allomorphina, 154, pl. 30
Ceratobulimina, 186, pl. 36
papuanensis, Pseudorotalia, 116, pls. 21, 22
papula, Rectobolivina, 50, pl. 4
parantillarum, Neoeponides, 118, pls. 17, 18
Parrelloides bradyi, 100, pl. 11
okinawaensis, 103, pl. 12
soendaensis, 102, pl. 12
Parvicarinina altocamerata, 93, pl. 14
patula, Brizalina, 37, pl. 2
pauciapertura, Oridorsalis, 173, pl. 30
pauperata, Laticarinina, 92, pl. 14
peregrina, Euuvigerina, 75, pl. 7
plana, Planulina, 122, pl. 10
Planulina plana, 122, pl. 10
retia, 123, pl. 11
ungeriana, 121, pl. 10
wuellerstorfi, 120, pl. 10
plicatella, Brizalina, 26, pl. 1
pompilioides, Melonis, 183, pl. 30
ponticulus, Rosalina, 94, pl. 13
praecinctus, 'Eponides', 125, pl. 16
Praeglobobulimina spinescens, 73, pl. 6
proboscidea, Siphouvigerina, 87, pl. 8
Protoglobobulimina affinis, 69, pl. 6
microlongistriata, 70, pl. 6
ovata, 68, pl. 6
pupoides, 67, pl. 6
sp. A, 71, pl. 6
pseudobeyrichi, Brizalina, 28, pl. 1
Pseudorotalia catilliformis, 114, pl. 21
gaimardi, 115, pl. 20
papuanensis, 116, pls, 21, 22
schroeteriana, 114, pls. 20, 21
sp. A, 117, pl. 22
pupoides, Protoglobobulimina, 67, pl. 6
pygmaea, Brizalina sp.cf., 31, pl. 1
quadrilatera, Bolivinita, 18, pl. 4

Quadrimorphina laevigata, 155, pl. 37
quasisulcata, Cassidulina, 144, pl. 24
Rectobolivina bifrons, 45, pl. 9
sp.cf. carinata, 51, pl. 4
columellaris, 47, pl. 9
dimorpha, 47, pl. 9
fasciata, 52, pl. 4
indica, 46 pl. 9
limbata, 49, pl. 4
papula, 50, pl. 4
tenuicostata, 48, pl. 4
Rectuvigerina striata, 84, pl. 9
sp. A, 84, pl. 8
refulgens, Cibicides sp.cf., 133, pl. 23
reineri, Euuvigerina, 82, pl. 8
retia, Planulina, 123, pl. 11
Reussella aculeata, 75, pl. 9
Robertinoides oceanicus, 195, pl. 37
robusta, Bolivina, 21, pl. 1
Rosalina ponticulus, 94, pl. 13
rostrata, Anomalinella, 185, pl. 33
Rotamorphina minuta, 156, pl. 37
scabra, Lamarckina, 189, pl. 35
schreibersiana, Fursenkoina, 136, pl. 9
schroeteriana, Pseudorotalia, 114, pls. 20, 21
schwageri, Euuvigerina, 81, pl. 8
semicarinata, Brizalina, 42, pl. 3
semilineata, Brizalina, 35, pl. 2
senta, Bulimina, 65, pl. 6
seranensis, Cassidulinoides, 55, pl. 26
Sigmavirgulina tortuosa, 137, pl. 9
Siphogenerina costata, 86, pl. 9
Siphouvigerina interrupta, 86, pl. 8
proboscidea, 87, pl. 8
sp.cf. uniserialis, 88, pl. 8
soendaensis, Parrelloides, 102, pl. 12
spinescens, Praeglobobulimina, 73, pl. 6
striata, Bulimina, 59, pl. 5
Rectuvigerina, 84, pl. 9
subacuminata, Bulimina, 63, pl. 5
subangularis, Bolivinita, 19, pl. 3
subbertheloti, Discorbinella, 91, pl. 13
subglobosa, Globocassidulina, 149, pl. 25
subhaidingeri, 'Eponides', 129, pl. 16
'Eponides' sp.cf., 130, pl. 16
subornata, Bulimina, 64, pl. 5
subornatus, Neoeponides, 118, pl. 17
supera, Ammonia, 111, pl. 19
subreticulata, Brizalina, 29, pl. 1
subturgidus, Florilus, 158, pl. 31
sulcata, Cassidulina, 142, pl. 24
suturicrassus, 'Eponides', 128, pls. 18, 19
tentoria, Asterigerina, 106, pl. 15
tenuata, Buliminella sp.cf., 16, pl. 6
tenuicostata, Rectobolivina, 48, pl. 4
tenuimargo, Cibicides, 135, pl. 23
torulus, Gyroidina, 168, pl. 28
tortuosa, Sigmavirgulina, 137, pl. 9
Trifarina bradyi, 88, pl. 9
tuberosa, Brizalina, 41, pl. 3
tubulifera, Alabamina, 160, pl. 27
umbonatus, Oridorsalis, 172, pl. 30
ungeriana, Planulina, 121, pl. 10
uniserialis, Siphouvigerina sp.cf., 88, pl. 8
Valvulineria javana, 98, pl. 37
variabilis, Brizalina sp.cf., 27, pl. 1
variapertura, Oridorsalis, 171, pl. 29
ventricosa, Lamarckina, 189, pl. 35
vescistriata, Brizalina, 34, pl. 2
voluta, Laterostomella, 44, pl. 3
wuellerstorfi, Planulina, 120, pl. 10

ALEX. B. DAVIES, Government Printer, Western Australia