CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

SPECIAL PUBLICATION NO. 34

THE GENERIC REVISION OF FIVE FAMILIES OF ROTALIINE FORAMINIFERA

PART I
THE BOLIVINITIDAE CUSHMAN, 1927

by

STEFAN A. REVETS
KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN
DEPARTEMENT PALEONTOLOGIE
VAUTIERSTRAAT 29
B1000 BRUSSEL
BELGIUM

TABLE OF CONTENTS

Cushman Foundation Special Publication No. 34 p. 1-55, 1996

THE GENERIC REVISION OF THE BOLIVINITIDAE CUSHMAN, 1927

STEFAN A. REVETS
Koninklijk Belgisch Instituut voor Natuurwetenschappen
Departement Paleontologie
Vautierstraat 29, B1000 Brussel, Belgium

ABSTRACT

The type species of the majority of biserial toothplate-bearing genera are restudied using the SEM to investigate the morphological details of the apertural complex. A rationalisation of the classification is proposed based on overall morphology complemented by toothplate type. The Bolivinitidae are herein recognised as a family of the Buliminacea. The family is subdivided into the Bolivinitinae, Fursenkoininae, and the newly proposed Parabrizalininae and Sagrininae.

The Bolivinitinae include the genera *Bolivinita*, *Afrobolivina*, *Bolivina*, *Bolivinoides*, *Brizalina*, *Coryphostoma*, *Loxostomoides*, *Lugdunum*, *Sagrinella*, *Saidovina*, and *Sigmavirgulina*. A neotype is designated for *Bolivina plicata* to stabilise the position of *Bolivina*, as compared to *Brizalina*. The genera *Latibolivina* and *Parabolivina* are synonymised into *Bolivina*.

The Fursenkoininae include the genera *Fursenkoina*, *Galliherina* and *Hopkinsinella*. Details are discussed of a proposal submitted to the ICZN in order to stabilise the position of *Fursenkoina* in the light of the difficulties surrounding *Cassidella*. The species *Virgulina tegulata* Reuss is deemed unrecognisable. To further stabilise the position of *Fursenkoina*, a neotype for *Virgulina squammosa* is designated.

The Parabrizalininae are created for the genera *Parabrizalina*, *Euloxostoma* and *Loxostomina*.

The Sagrininae are proposed to cover the genera *Sagrina*, the newly proposed *Alectinella*, *Pseudobrizalina*, *Virgulinopsis*, and *Virgulopsis*.

The genera *Eouvigerina* and *Tappanina* are removed to the Eouvigerinidae, while *Grimsdaleinella* and *Zeauvigerina* are removed to the Loxostomatidae, Pavoninacea.

The bilamellar nature of the toothplate-like structure in *Stainforthia*, in conjunction with the deviating internal architecture leaves the genus *incertae sedis* within the Rotaliina. The genus *Francesita* is removed from the Caucasininae and left *incertae sedis* as well. Structural similarities between *Francesita* and *Stainforthia* are shown, but the creation of a suprageneric taxon to accommodate them is judged to be premature.

The genus *Tortoplectella* is shown to be an agglutinating taxon and it is consequently removed from the Rotaliina to the Textulariina. Because of the turmoil in the classification of agglutinating forms, *Tortoplectella* is considered *incertae sedis* within the Textulariina.

INTRODUCTION

The classification of the biserial toothplate-bearing Foraminifera has undergone a marked centrifugal development. Early in the history of foraminiferology, most of these taxa were assembled in the Textulariidae, but from the more comprehensive studies by Cushman onwards, the situation grew quickly more complex. Despite numerous reclassifications and rapid growth of the number of generally accepted new genera, many of the central species are not well known. This has contributed to the sometimes drastic reclassification of one or the other genus following a more detailed study of it. The gaps in our knowledge continue to cause much confusion in the literature, because generic attribution of a species is seldom determined by the availability of clear-cut diagnoses, but more often by habit or for historical reasons.

The monographic study by Cushman (1937) of the subfamily Virgulininae revised the systematics of, amongst others, the genera *Bolivina*, *Brizalina*, *Loxostoma*, *Virgulina*, *Virgulinella*. The ensuing classification was based exclusively on outer morphological features. Most of the biserial genera were put in either the newly proposed Bolivinitinae or in the Virgulininae.

In the Siboga Monograph, Hofker (1951) also studied many biserial genera, for which he made and proposed some drastic rearrangements in their classification.

Loeblich & Tappan (1964) put forth a rationalisation of many of the past proposals into a comprehensive and more logical classification. Using the optical nature of the test wall as an important characteristic, they proposed the Fursenkoininae alongside the Bolivinitidae and Buliminnae, the latter also harbouring some biserial taxa amongst their members.

Reyment (1959, 1983) discussed the status of *Bolivina* when creating *Afrobolivina* and helped to alleviate some of the confusion surrounding the type species of *Bolivina*.

Reiss (1957) and Zweig-Strykowski & Reiss (1975) studied a number of *Brizalina*-like taxa and proposed a series of new genera in an attempt to clarify the situation concerning the position of *Bolivina* and *Brizalina*.

Scott (1977, 1978) showed SEM photographs of the toothplate morphology in different *Bolivinita* species and analysed their affinities and differences.

Haynes (1981) proposed a simplified classification, in which he included biserial toothplate-bearing forms in the Buliminidae, Buliminacea and Bolivinitidae, Bolivinitacea.

Loeblich & Tappan (1987) presented a major overhaul of the classification, in the process raising an important number of taxa to higher ranks. Many of the biserial toothplate-bearing taxa were reclassified in a variety of families, many of them new or reinstated.

Whittaker (1988) illustrated an important number of *Bolivina* and *Brizalina* species from the Neogene of Ecuador, pointing out the great difficulties still surrounding the identification of these stratigraphically useful genera.

Previous studies of a variety of toothplate-bearing taxa have shown the utility of the apertural complex in delineating taxa on the generic level. Some of these features, in conjunction with the more classical characteristics such as overall shape and seriality, contributed considerably to the elucidation of the familial relations between these taxa. Therefore, the more important biserial, supposedly toothplate-bearing taxa were restudied using the same methodology.

DISCUSSION

The results obtained from the revisional study of the type species of the majority of bolivinitid taxa further support the usefulness of the apertural complex in the definition of not only genera but also taxa of familial rank. The taxa investigated here all fall well within the concept of the Buliminacea, i.e., high trochospiral forms with toothplates running from aperture to foramen. The earlier proposal to recognise the Pavoninacea is here reinforced by the exclusion of genera such as *Bolivinella*, *Aragonia* and *Loxostoma* from the Buliminacea. Although they appear at first sight to stand closer to the bolivinitids than, e.g., *Pavonina* or *Chrysalidinella* stand to the buliminids (Revets, 1991a), this view proves to be erroneous.

The adoption of biseriality as one of the major elements in defining the Bolivinitidae along with the other toothplate-bearing taxa within the Buliminacea underlines the validity of seriality as a characteristic worthy of taxonomic attention. As eloquently pointed out by Haynes (1990), seriality is generally spurned as a characteristic of taxonomic weight, but nevertheless keeps haunting systematists in their attempts to improve classification. In the case of the buliminids *sensu lato*, seriality appears to be linked to other characteristics and in particular the apertural complex, allowing clear demarcations to be drawn, and thus somewhat redeem it as a useful characteristic. All taxa here investigated are basically biserial, but some show a tendency of arranging their chambers in almost rectilinear series, rather than in opposition. Although tentative at this point in time, there seems to be no relation between reproductive dimorphism and mixed chamber arrangement, and this in contrast to the situation in, e.g., the pavoninids or even some siphogenerinoidids.

The Bolivinitidae are thus defined as biserial buliminaceans which possess an attached toothplate that may, in a few isolated cases, become free in late ontogeny but will then remain decidedly asymmetric. This puts them well apart from the Siphogenerinoididae, since the latter possess an entirely free toothplate which is bilaterally symmetric, except perhaps in the very earliest stages. Interestingly, and underlining the point made earlier about coiling, the siphogenerinoids all have a major part of the test with chambers arranged in rectilinear series. Although they have often been dealt with together with the bolivinitids, they should be kept apart and will be fully discussed in a forthcoming, separate study. In those bolivinitid taxa where the toothplate becomes free, this seems to be linked to a tendency of organising chambers in a rectilinear arrangement. Apparently, this correlation is a general one within the Buliminacea.

In contrast to the other buliminids, the shape of the aperture is very similar within the bolivinitids but, counterbalancing this uniformity, the richness of the varying shapes of the toothplate has no equal. This variety provides an excellent tool to separate the multitude of taxa. The apertures of *Parabrizalina* and *Alectinella* are rather similar and leave one unprepared for the radically different shapes of their respective toothplates. Unfortunately, the relative apertural uniformity means that the aperture is not a trustworthy guide to the internal anatomy, thus necessitating the preparation of half-sections.

The toothplate morphologies range from the rather simple, narrow clinging plate as in *Bolivina* or *Bolivinoides*, over the more and more flaring forms in *Bolivinita*, *Saidovina* and *Lugdunum*, to the complexly contorted plates in *Alectinella* and *Sagrina*.

Two of the subfamilies can be recognised immediately from the others. The vertically elongated chambers define the Fursenkoininae, and the convoluted toothplate shape separates the Sagrininae. The Bolivinitinae contain taxa with horizontally drawn-out chambers and an asymmetric toothplate with always one border attached. In contrast, the Parabrizalininae possess a toothplate which becomes completely free in the latest stages of ontogeny, but remains asymmetric. Its chambers are more or less equidimensional. The Fursenkoininae are more bulimine in their structure, especially in the form of the toothplate.

One of the major difficulties within the bolivinids has been the attribution of species to *Bolivina* or *Brizalina*. Cushman never recognised *Brizalina* as a separate genus. It received this status only with the publication of the 'Treatise' volume on Foraminifera (Loeblich & Tappan, 1964). *Brizalina* was defined as being laterally compressed, usually with a marginal carina and lacking retral processes, while these retral processes were the hallmark of *Bolivina*. However, over the years it became obvious that the differentiation between *Bolivina* and *Brizalina* became more and more hazardous. *Bolivina* species kept being assigned to *Brizalina* because the 'retral processes' failed to show up in a great many species. An analogous problem occurs in the differentiation of *Bolivinoides* from *Bolivina* species. The term 'retral process' is often applied quite inappropriately, especially in the context of the bolivinitids.

Retral processes are to be differentiated from crenulations of the chamber delimitation. As pointed out by Hansen & Lykke Andersen (1976), retral processes are to be found at the inside of the chamber, usually though not necessarily inside ponticuli spanning the suture. Retral processes are a characteristic feature in elphidiid taxa, but they have been encountered in *Virgulinella* as well (Revets, 1991b). The crenulations of the basal part of the chamber found in many bolivinids are not comparable to retral processes as defined. True retral processes are delimited by bilamellar chamber wall, while the crenulations in bolivinids are at the most partially separated by keel-like extensions from the chamber wall into the chamber lumen. Since these extensions are made up of inner lining, they are structurally very different from the retral processes concept (e.g., *Bolivina* and even more so in *Afrobolivina*, see Reyment, 1983, pl. 2, fig. 3, pl. 4, figs. 1 & 2). The presence of these extensions is apparently also a matter of degree, rather than of kind. As a result, the use of the term retral process should be applied with due caution in the context of bolivinitid taxa. However, retral processes do occur. The sections of *Bolivinioides* here presented of show true retral processes, very likely related to the peculiar surface ornamentation, which can be interpreted as some kind of ponticuli (pl. 4, fig. 3). Hence, *Bolivinoides* is here regarded as distinct from *Bolivina*, notwithstanding the otherwise great similarities, including toothplate shape.

The lectotypification of *Brizalina aenariensis* by Sgarella (1992) and redescription of *Bolivina* compounded the already existing confusion by once again failing to differentiate between true retral processes and purely external features of the chamber wall. Sgarella did not prepare any sections and hence could not observe the presence or absence of retral processes. Her synonymising of *Brizalina* into *Bolivina* had the unfortunate consequence of leaving many *Brizalina* species without generic affiliation which eventually led to the creation of the genus *Aphelophragmina* by Loeblich & Tappan (1994), with *Textularia variabilis* var. *spathulata* Williamson, 1858 as type species. The latter authors did not illustrate nor discuss the morphological features of the type species of the new genus, proposed to rescue the concept of *Brizalina*, but reclassified three other species in it, all three without description or discussion. The fact that none of these seem to fit the original *Brizalina* concept nor are similar to the type species of the new genus as far as the illustrations provided allow us to judge, only furthers the already rampant confusion.

Brizalina is to be differentiated from *Bolivina* through the different form of the aperture and the differences in toothplate morphology. Contrary to *Bolivina* species, the aperture in *Brizalina* is never surrounded by raised lips: the edges of the aperture are rather delimited by a lateral thickening, flush with the outline of the test. The toothplate is more prominent in the aperture, that is, it is present over almost the entire length of the opening and remains fairly straight. Inside the lumen, it fuses with the foramen at its very upper part while slightly crossing it through the attaching of the free border. In *Bolivina*, the presence of the toothplate is less pronounced in the aperture and it fuses with the upper edge of the foraminal toothplate, often running along for about half the foramen length. Although a full revision is necessary to resolve this difficult issue, the following *Bolivina* species very likely belong in *Brizalina*: *adelaidana, alata, aliformis, argentea, beyrichi, cochei, furcata, horizontalis, marginata, mexicana, pisciformis, spissa*, and *subaenariensis*.

The most striking difference between *Bolivinoides* and *Bolivina* is to be found in what seems to be surface ornamentation in *Bolivinoides*. However, quite a number of non-Cretaceous *Bolivina* species show a superficially similar arrangement of 'beaded costae'. As ornamentation is not acceptable as a taxonomic character above species level, it would seem that few grounds are available to separate *Bolivinoides* from *Bolivina*, as was earlier pointed out by Hofker (1951) and Reyment (1959). The finding of true retral processes in *Bolivinoides*, as here reported, points towards a different point of view altogether. The so-called ornamentation of beaded costae is better seen as some kind of ponticuli. It does seem to be the case that these ponticuli receive knob-like extensions in some species of *Bolivinoides* but this does not diminish the fact that the retral processes occur within these structures. As such, they are quite different from the lobed extensions of the chamber wall in *Bolivina* and even more so in *Afrobolivina*. As far as the apertural complex is concerned, the only difference between *Bolivinoides* and *Bolivina* is the less pronounced lip in the former. Beside these differences, the overall shape of the test and the individual chambers are also different, albeit less clear cut in some of the species. *Bolivinoides* species are by and large more flaring and rhombohedral with much more laterally elongated chambers, but some of the later species could be mistaken for *Bolivina* species if only overall shape was considered. Nevertheless, the structural differences suffice to retain *Bolivinoides* as a genus in its own right. What makes the genus intriguing is the fact that it seems to have tried to converge to *Bolivina* but failed to do so and became extinct. Seen as such, it is another rather enigmatic case for students of the evolutionary process.

Sigmavirgulina is removed from the Fursenkoininae because of the overwhelming similarities with *Bolivina*, including, besides the apertural complex, the shape of the chambers. The twisted nature of its test is no closer to *Fursenkoina* than it is to *Bolivina*. Since the optical nature of the test wall has been thoroughly discredited as a usable character above species rank, the last vestige for retaining *Sigmavirgulina* close to *Fursenkoina* has fallen as well.

Fursenkoina as a genus was proposed by Loeblich & Tappan to rescue *Virgulina* d'Orbigny, 1826, found to be a preoccupied name. A tangle of disregard of the rules laid down by the ICZN further compounded by misunderstandings of morphological features necessitated the help of the ICZN to provide stability and better understanding (Revets, 1994, 1995). Architecturally speaking, of all bolivinitids *Fursenkoina* stands closest to the buliminids, except perhaps for *Galliherina*. The not quite exact biserial coiling, the elongated and well rounded chambers distinguish it easily from the other bolivinitids. The fairly elongated aperture, well rounded at the extremities with the thickened, barely everted lip, just closing above the basal suture reminds one of *Bulimina*. The cristate upper part of the toothplate protrudes into the apertural opening and is visible in the upper third, again quite bulimine. The toothplate is rather straight and fuses partly with the top of the foraminal toothplate, partly over the foraminal sulcus. This is somewhat different from *Bulimina*, where the toothplate fuses past the foraminal sulcus, against the lateral wall (Revets, 1989).

The other apparently very bulimine genus, *Galliherina*, is here for the first time analysed through sectioning. As a result, it now transpires that this genus has variously been misunderstood. From the description of its type species onwards, it has always been described as triserial (Cushman & Kleinpell, 1934; Kleinpell & Tipton, 1980; Loeblich & Tappan, 1987; Whittaker, 1988) whereas the sections show it to be biserial, albeit somewhat twisted. The toothplate is similar to the one in *Fursenkoina*, and differs from the bulimine one in fusing on top of the foraminal toothplate rather than adjacent to it. Its top features more prominently in the aperture and it is more concave than the fursenkoine toothplate, especially so late in ontogeny. The way in which the free border hovers over the foramen is well in keeping with the other taxa here investigated, further strengthening the case for its reclassification in the Fursenkoininae, Bolivinitidae.

Hopkinsinella is a very problematic genus. The striking difference between aperture and foramina can only be explained as the result of resorption and rebuilding of the intercameral opening. The possibility that the differences are due to reproduction are excluded. The very large type series was thoroughly checked and all specimens, including obvious juveniles, showed the same form of aperture. Thus the possibility that a deviating final chamber is built just before reproduction, as in, e.g., *Buliminellita*, is rejected. The occurrence of resorption is unusual, and as far as is known unique within the Buliminacea. Nevertheless, the clearly biserial coiling and the presence of a true toothplate sitting between very bulimine foramina leaves no doubt as to the bolivinitid affinities of this taxon.

The architecture of *Euloxostoma* is puzzling and something of a problem for the basis on which the classification here proposed is based. During most of its ontogeny, *Euloxostoma* appears quite similar to *Brizalina*, not only in overall habitus but also in shape of the toothplate. Only in the very latest stages of its life does the organism arrange its chambers in almost rectilinear series, with the consequent freeing of the attached border of the toothplate. As a result, the taxon is classified along the other biserials with a final rectilinear part and a free, asymmetric toothplate, because the characteristics of the adult are deemed to be the best basis for taxonomic attribution. Nevertheless, the classification of *Euloxostoma* alongside *Parabrizalina* and *Loxostomina* remains tentative and may well change when more and more precise information becomes available. Despite superficial similarities with *Brizalina*, it can be distinguished easily from the latter by the considerable frontal overlap of the chambers, the substantial and interrupted keel and the quite different aperture.

The small *Sagrina* species have been misunderstood from very early on. Although the optical sections published by Hofker of *Sagrina pulchella* are very close to the actual morphology, they nevertheless do not elucidate the full complexity of the internal anatomy. However, despite the small size of the specimens and the technical limitations experienced by Hofker, his study remains the only one to date reporting the inner structure. With the aid of SEM images, Hofker's drawings can now be correctly interpreted. The outer morphology is deceptively simple and the standard bulimine aperture gives no inkling of the complexly folded toothplate occupying a sizeable portion of the lumen of each chamber. As such, it can be seen as the biserial equivalent of the triserial *Fijiella* or *Trimosina*, with the provision that the complexity of the topological deformation in *Sagrina* has no equal. As the most advanced development of the toothplate, it becomes a major hazard for anyone trying to put forward an interpretation of the toothplate as an anatomical structure. The genus *Virgulinopsis* is very closely allied to *Sagrina*, but the very bulimine shape of the aperture allows easy recognition of the genus.

The genera *Eouvigerina* and *Tappanina* have customarily been classified in the vicinity of the bolivinitids *sensu lato*. However, the clearly pronounced tendency of producing the aperture on a neck, well away from the basal suture indicate a more uvigerine affinity. Pending a revision, they are therefore removed from the Bolivinitidae and tentatively reclassified in the Eouvigerinidae.

Despite the great utility of the apertural complex for taxonomic purposes, a few oddities threaten the foundations underlying the proposed classification. The unusual internal structures in *Stainforthia* and *Francesita* show the advisability for caution. Whereas the toothplate-like structure in *Francesita* is very cassiduline in its nature, the analogous structure in *Stainforthia* defies any parallel. With the present state of knowledge, no decision can as yet be taken with any confidence as far as the true nature of *Stainforthia* is concerned. Nevertheless, basing the classification on the shape of the aperture, toothplate and also of the chambers, a fairly consistent scheme has emerged. Compared to the proposal by Loeblich & Tappan (1987), the current scheme advocates a return to the principles underlying the earlier scheme of Loeblich & Tappan (1964), adjusted for some important changes in value of characters used and increase in new taxa. The observations here reported once more echo Haynes (1990) by supporting the view that the 1987 scheme of Loeblich & Tappan recognises too many taxa of familial rank based on tenuous grounds.

The reclassification here proposed may seem at first sight to rely rather heavily on the toothplate as a taxonomic character. However, this choice can be argued for. The toothplate is a purely internal structure and hence less susceptible to environmental factors. It is apposite to note the role played by analogous internal structures in rotaliid taxa, where differences in form of these very structures are used for taxonomic purposes as well. There is also a clear correlation between toothplate shape and coiling mode. As already pointed out, bilaterally symmetric toothplates only occur in taxa with rectilinear chambers (*Siphogenerinoides, Rectobolivina*, and even in a peculiar way in *Tubulogenerina*). Looking beyond bolivinitids, this correlation crops up again in pleurostomellids (peculiar toothplate shape and distinctive coiling), uvigerinids (shape of toothplate supports the usual distinction based on the apertural neck). It is this concordance of toothplate shape with other, more classical features such as coiling, seriality, and shape of the aperture, that support the use of the toothplate in proposing finer subdivisions and help to delineate taxa of lower rank. The rationale underlying the scheme proposed is to combine such features as chamber shape, shape and position of the aperture and shape of the toothplate to delineate various subfamilies, and to use coiling and seriality together with type of aperture at the family level. However, the use of these features is not governed by a restrictive logical arrangement.

SYSTEMATIC DESCRIPTIONS

SUBORDER ROTALIINA LANKESTER, 1885

SUPERFAMILY BULIMINACEA JONES, 1875

1875 Buliminida Jones: 320.
1987 Bolivinacea Glaessner; Loeblich & Tappan: 497.
1975 Bolivinitacea Cushman; Saidova: 299.
1981 Fursenkoinacea Loeblich & Tappan; Saidova: 45.

Description. Test free; chambers arranged in very high trochospiral coils; aperture basically loop-shaped with a periapertural lip, may be modified into a neck with a phialine lip, multiple slits, or partially hidden by a flap; a toothplate made up from inner lining runs from aperture to foramen; wall calcitic, bilamellar, no septal flap present, hyaline, perforate.

FAMILY BOLIVINITIDAE CUSHMAN, 1927

1927 Bolivinitinae Cushman: 61.
1936 Bolivinitidae Cushman; Glaessner: 127.
1937 Bolivininae Glaessner: 420.
1951 Bolivinidae Glaessner; Hofker: 48.
1984 Bolivinoididae Loeblich & Tappan: 42.

Description. Test free, elongated; chambers in biserial coils; aperture commonly loop-shaped and surrounded by a periapertural lip; a toothplate runs from aperture to foramen, fusing with the foraminal lip or the apex of the foraminal toothplate protruding into the foramen; wall calcitic, bilamellar, hyaline, perforate.

Member taxa. Bolivinitinae, Fursenkoininae, Parabrizalininae subfam. nov., and Sagrininae subfam. nov.

SUBFAMILY BOLIVINITINAE CUSHMAN, 1927

Description. Test free, elongated, laterally compressed, biserial; chambers wider than high; aperture loop-shaped, surrounded by a periapertural lip, thickened and somewhat everted, top of the toothplate slightly protruding in the apertural opening; toothplate a simple asymmetric trough, one free border, attachment to the foraminal lip or on the top of the foraminal toothplate; wall calcitic, bilamellar, hyaline, finely perforate.

GENUS *Bolivinita* CUSHMAN, 1927

1927 *Bolivinita* Cushman: 90.

Type species. Textilaria quadrilatera Schwager, 1866, original designation.

Bolivinita quadrilatera (Schwager, 1866)
Pl. 1, Figs. 1-4

1866 *Textilaria quadrilatera* Schwager: 253, pl. 7, fig. 103.
1927 *Bolivinita quadrilatera* (Schwager); Cushman: 90.
1933 *Bolivinita quadrilatera* (Schwager); Galloway: 352, pl. 32, fig. 12.
1966 *Bolivinita quadrilatera* (Schwager); Belford: 18, pl. 4, figs. 4-7.
1980 *Bolivinita quadrilatera* (Schwager); Srinivasan & Sharma: 62, pl. 6, figs. 22-23.
1988 *Bolivinita quadrilatera* (Schwager); Whittaker: 79, pl. 13, figs. 19-23.

Neotype. Section of Micropalaeontology, Department of Geology, Banaras Hindu University, India; designated by Srinivasan & Sharma, 1980.

Type locality. Kar Nicobar, Indian Ocean; Upper Miocene.

Material examined. P48528, P52793, P52804, topotypes; The Natural History Museum, London.

Description. Test elongate, tapering, regularly and slowly increasing in size, quadrangular in end view with concave sides, apertural end broadly rounded, periphery flush to slightly undulate, biserial, may be slightly twisted; 10 to 12 chambers, chambers subcylindrical with straight lateral faces, slightly higher than long, outer edge drawn out, frontal overlap occupying middle third of the test width; sutures distinct, raised, arcuate; aperture in the upper part of the final chamber in an imperforate area, asymmetrically placed, starting somewhat above the basal suture, oval, surrounded on one side by a well defined slightly raised lip, lip curves round the apex of the aperture to merge into the upper edge of the toothplate, thereby delimiting a well defined sulcus; toothplate large, spine straight, attachment long, covering the foraminal toothplate top and running through ending at the lower end of the foraminal lip; wall hyaline, finely perforate, test ornamented by lateral flange-like keels running along the outer edges over the entire test.

Remarks. The specimens here described are different from the majority of Recent specimens usually identified as *B. quadrilatera.* The toothplate anatomy of *B. quadrilatera* as observed in topotypes is quite different from most of the Recent specimens I have seen. In topotypes, the toothplate possesses a straight spine and a well developed highly arched trough with a sinusoid free border and a marked tailing border. Recent specimens show a plate-like non-arched toothplate with a free border remaining apical to the plate, rather than progressing beside it. Also, no tailing border could be observed. It seems that these specimens belong to *B. pliozea* Finlay, 1939a, known to range into the Recent. Therefore, the stratigraphic distribution of *B. quadrilatera* is very likely more restricted than hitherto assumed.

Although the neotype established by Srinivasan & Sharma (1980) is strictly speaking invalid (due to the infringing of ICZN article 75, par. b, litt. ii and par. d, litt. 1), I propose to recognise the designated specimen as valid for the following reasons;

art. 75, b(ii). Exceptional circumstances are in force. The species is the type species of a genus which itself is the type genus of a taxon of familial rank. Furthermore, observations herein reported show that confusion exists as to the correct specific identification of closely related taxa. The observation of the toothplate morphology shows that a great many of the reported identifications are erroneous. This situation can only be remedied by the establishing of a type specimen, stabilising the nomenclature.

art. 75, d(1). The description herein provided includes a differential diagnosis.

GENUS *Bolivina* D'ORBIGNY, 1839

1839b *Bolivina* d'Orbigny: 60.
1911 *Bolivina* d'Orbigny; Cushman: 31.
1959 *Bolivina* d'Orbigny; Reyment: 15.
1966 *Latibolivina* Srinivasan: 240.
1992 *Parabolivina* Resig:30.

Type species. Bolivina plicata d'Orbigny, 1839, subsequent designation by Cushman, 1911.

Bolivina plicata d'Orbigny, 1839
Pl. 1, Figs. 5-8

1839b *Bolivina plicata* d'Orbigny: 62, pl. 8, figs. 4-7.
1911 *Bolivina plicata* d'Orbigny; Cushman: 31.
1933 *Bolivina plicata* d'Orbigny; Galloway: 351, pl. 32, fig. 8.
1937 *Bolivina plicata* d'Orbigny; Cushman: 123, pl. 15, figs. 6-7, *non* 8!
1948 *Bolivina plicata* d'Orbigny; Cushman: 244, pl. 27, fig. 25.
1959 *Bolivina plicata* d'Orbigny; Reyment: 16.
1983 *Bolivina plicata* d'Orbigny; Reyment: 29, pls. 1, 2 (figs. 1-2, 4-5), 3 (figs. 5, 7).
1987 *Bolivina plicata* d'Orbigny; Loeblich & Tappan: 498, pl. 547, figs. 1-4.
non 1964 *Bolivina plicata* d'Orbigny; Loeblich & Tappan: 549, fig. 434/7.
non 1988 *Bolivina plicata* d'Orbigny; Whittaker: 80, pl. 10, figs. 1-3.

Neotype. An exhaustive search in the collections of the Muséum National d'Histoire Naturelle, Paris, has failed to yield any clue as to the possible whereabouts of the original d'Orbigny specimens. All available tubes and labels were repeatedly checked on several occasions, unfortunately in vain. Reyment (1959) selected d'Orbigny's figure 5 and 6 as lectotype. This proposal is in conflict with Galloway's proposal (Galloway, 1933) in which the species was restricted to the specimen figured by d'Orbigny under number 4. Galloway assigned figures 5 and 6 to the new, but unavailable name *distincta*. Galloway's proposal was obviously followed by Cushman (1948), since the latter restricted his figures to coincide with the d'Orbigny figure 4. Cushman thereby revised his earlier illustration of the species. The issue is further complicated by Millett's remark that d'Orbigny reproduced his figure 4 in the Vienna Memoir (d'Orbigny, 1846), but now under the name *costata*, a species created by d'Orbigny in 1839b alongside *plicata* from the same general area (Millett, 1900, p. 545). Cushman (1937) figured a specimen from the Recent off the Panamanian Coast, considering it to be *B. plicata*. Conspecific specimens were subsequently depicted by Cushman (1948), Loeblich & Tappan (1964) and Whittaker (1988). However, these specimens are different from those figured by Reyment (1983) from Valparaiso, the type locality. The illustrations provided by Loeblich & Tappan (1987) are conspecific with Reyment's (1983) but different from the earlier ones (Loeblich & Tappan, 1964). In order to resolve this complex issue, I herewith establish a neotype. In accordance with article 75, paragraph d of the ICZN, the following remarks are called for:

art. 75, par. b(i). This study aims at establishing the true taxonomic relations between the different genera relevant to this study, based on observations of their type species. These species are compared to closely related taxa in order to arrive at an unambiguous description and consequent clarification of the different specific and generic concepts.

art. 75, par b(ii). Exceptional circumstances are in force for the case of *Bolivina plicata*, since there appears to be a persistent confusion in the literature as to the true nature of the species. The lack of a type specimen precludes the resolving of the problem, especially since a number of closely related species are involved. The fact that *Bolivina plicata* is the type species of the genus *Bolivina* increases the urgency for a satisfactory solution.

art. 75, par. b(iii). The designation by Reyment (1959) of a lectotype is herein overruled since no specimens are behind the figures designated, and because the figures in themselves prove insufficient to clarify the situation.

art. 75, par. d(1). See description.

art. 75, par. d(2). The neotype is fully labelled and deposited in the Muséum National d'Histoire Naturelle, Paris, in the d'Orbigny Micropalaeontology Collection, registered as F61753.

art. 75, par. d(3). The d'Orbigny collection has suffered a great many losses over the years. Apart from the hazards involved in the moving of the entire collection from Esnandes to Paris and the initial storage of the collection in the cellars of the Museum, the great flooding by the Seine resulted in the drowning of all the glass tubes containing d'Orbigny's specimens. A great many of the tubes were lost and many others became detached from the thick cardboard identification labels to which they had been glued. Repeated and exhaustive searches have failed to yield any indication of *Bolivina plicata*. All the tubes, including unlabelled ones and all the loose cardboard identification labels have been assembled and repeatedly checked to no avail. I therefore consider potential syntypes as being lost.

art. 75, par. d(4). See description.

art. 75, par. d(5). The neotype was selected from specimens recovered from the original sample used by d'Orbigny himself. The type locality thus remains the same as the original type locality.

art. 75, par. d(6). *Bolivina plicata*, deposited in the Muséum National d'Histoire Naturelle, Paris, herein designated.

Type locality. Off Valparaiso, Chile; Recent.

Material examined. Specimens recovered from d'Orbigny's original sample; Paris. *Galathea* Station 729, 7°22'N 79°33'W, -875 m, Gulf of Panama; Geological Central Institute, Copenhagen. Borbon Basin, Ecuador; Upper Onzole Formation, Pliocene, courtesy J.E. Whittaker.

Description. Test elongate, broadly rounded, slightly tapering, periphery slightly lobulate, broadly oval in end view, biserial; some 20 chambers in the adult test, chambers low, about twice as wide as high, regularly increasing in size, frontal overlap in the later chambers considerable, up to 2/3 of the test width, numerous crenulations present; sutures undulate, in the earlier part of the test obscured in the centre due to the deposition of secondary lamellae on the crenulated chamber edges; aperture loop-shaped, often somewhat twisted, surrounded by a highly raised everted apertural lip, lip asymmetrical, upper part of the toothplate not always apparent in the aperture, a single ridge commonly running from the apex of the aperture towards and somewhat onto the previous chamber; toothplate slim, spine concave and gently arched, no tailing border, free border sigmoid, mingles into the plate halfway down, attachment site along the foraminal toothplate apex; wall hyaline, optically distinctly radial, finely perforate; ornamented by the raising of the crenulations due to the deposition of secondary lamellae, coalescing to form a few sinuous costae, most prominent in the lowest third of the test, the remnants of the crenulations and the intervening arches of the sutures yielding a plicated effect.

Remarks. Differs from *B. costata* in lacking true costae covering the entire test, possessing more crenulations, a completely perforate apertural face and a small ridge running from the top of the aperture downwards opposite the aperture; from *B. sinuata* in having much less regular and less pronounced crenulations and thus intertwining and less regular costae, in possessing a ridge running from the aperture towards the penultimate chamber, and in having much less frontally overlapping chambers; and from *B. streptos* in being broadly rounded, in possessing a prominent everted periapertural lip, in possessing more crenulations in a less regular arrangement, and in having costae in the earlier part of the test.

Specimens referable to *B. plicata* are present in the Pliocene of Ecuador, but the specimen chosen for illustration by Whittaker (1988) belongs to *B. streptos*.

Bolivina costata d'Orbigny, 1839
Pl. 2, Figs. 1-3

1839b *Bolivina costata* d'Orbigny: 62, pl. 8, figs. 8-9.
1846 *Bolivina costata* d'Orbigny; d'Orbigny: 239, pl. 21, figs. 44-45
1937 *Bolivina costata* d'Orbigny; Cushman: pl. 15, fig. 4-5.

non 1884 *Bolivina costata* d'Orbigny; Brady: 426, pl. 53, figs. 26-27.

Syntypes. Muséum National d'Histoire Naturelle, Paris.

Type locality. Cobija Harbour, Chili (given as Bolivia); Recent.

Material examined. Syntypes; Muséum National d'Histoire Naturelle, Paris. Topotypes from d'Orbigny's original samples taken by Heron-Allen; The Natural History Museum, London.

Description. Test elongate, broadly rounded, oral end somewhat truncated, tapering, periphery barely lobulate, broadly oval in end view, biserial; up to 16 chambers, chambers low, frontal overlap restricted to the immediate area of the central axis, 7 to 8 crenulations per chamber, crenulations following each other in regular series, producing the costate outlook; sutures undulate, obscured in the earlier part; aperture running up from the basal suture in the centre of the test to the apex of the chamber, loop-shaped, in the middle of an imperforate area, bordered by a low, thickened and slightly everted lip, more prominent one side, opposite a small ridge indicating the apex of the toothplate; toothplate slim, spine straight, slightly curving towards the foramen, a very small straight tailing border, free border curved, attachment along the foraminal lip, partly onto the top of the foraminal toothplate; wall hyaline, distinctly perforate but for the apertural face; around 12 true costae run along the entire length of the test, surface between the costae relatively flush.

Bolivina sinuata Galloway & Wissler, 1927
Pl. 2, Figs. 4-5

1927 *Bolivina sinuata* Galloway & Wissler: 71, pl. 11, fig. 9 c.
1937 *Bolivina sinuata* Galloway & Wissler; Cushman: 120, pl. 14, figs. 19-20.
1938 *Bolivina sinuata* Galloway & Wissler; Kleinpell: 281.
1988 *Bolivina sinuata* Galloway & Wissler; Whittaker: 89, pl. 10, figs. 4-7.

Holotype. 19781, Paleontology Collection, Columbia University, New York, U.S.A.

Type locality. Lomita Quarry, Lomita, Palos Verdes Hills, California, U.S.A.; Lower San Pedro Formation, Pleistocene.

Material examined. Malaga Cove, California, U.S.A.; Repetto Siltstone, Upper Pliocene; Borbon Basin, Ecuador: Upper Onzole Formation, Pliocene, courtesy J.E. Whittaker.

Description. Test elongate, broadly rounded, gradually and regularly increasing in size, apertural end rounded, periphery barely lobulate, broadly oval in end view but also very lobulate, usually 9 to 10 lobes visible, biserial; up to 26 chambers, chambers inflated, slightly wider than high, very regularly increasing in size, becoming more rounded later in ontogeny, frontal overlap fairly restricted, very little over the central axis; sutures undulate, obscured in the earlier part, 6 to 8 crenulations per chamber, deeply cut out, very regular; aperture in a poreless apertural face, loop-shaped, running up from the basal suture almost to the apex of the chamber, surrounded by a low, distinctly everted lip, lip curving round the apex of the aperture and coalescing into the apex of the slightly protruding toothplate, leaving a distinct sulcus between the toothplate and apertural edge; toothplate slim, curved over at the lower end over the foramen, fusing with the apex of the foraminal toothplate, apparently producing a continuous plate; wall finely perforate but for the apertural face, imperforate sections present between the crenulations of the earlier chambers; crenulations in neat, regular series, forming a distinctly lobulate costate pattern, becoming continuously and truly costate in the lower third of the test.

Bolivina streptos Hasson, 1986
Pl. 2, Figs. 6-9

1937 *Bolivina plicata* d'Orbigny; Cushman: 123, pl. 15, fig. 8 only!
1964 *Bolivina plicata* d'Orbigny; Loeblich & Tappan: 549, fig. 434/7.
1986 *Bolivina imporcata* subsp. *streptos* Hasson, *in* Hasson & Fisher: 40, pl. 1, figs. 1a-c.
1988 *Bolivina plicata* d'Orbigny; Whittaker: 80, pl. 10, figs. 1-3.

Holotype. USNM 256063, Smithsonian Institution, Washington, D.C.

Type locality. Sample 9-19, Wave-cut bench at the ocean front, 6.5 km W of Esmeraldas, Ecuador; Lower Pliocene.

Material examined. Gulf of Panama, *Galathea* Expedition, various Stations; Borbon Basin, Ecuador; Upper Onzole Formation, Pliocene, courtesy J.E. Whittaker.

Description. Test elongate, evenly tapering, may be slightly twisted, apertural end rounded, distinctly compressed laterally with blunt edges, periphery slightly lobulate, biserial; up to 24 chambers, chambers about twice as wide as high, regularly increasing in size, becoming somewhat higher during ontogeny, frontal overlap restricted to the central axis of the test; sutures distinct, somewhat depressed, distinctly arched, only central portion undulate due to the presence of a few crenulations; apertural face perforate, aperture loop-shaped, may be slightly sigmoid, running from the basal suture up to the apex of the chamber, surrounded by a slightly raised, somewhat everted lip, lip curving round the apertural apex and fusing with the top of the toothplate and the apertural rim, which may result in the presence of a narrow sulcus; toothplate thin, inwardly arched, attachment with the top of the foraminal toothplate; wall opaque, distinctly and rather coarsely perforate; maximum 4 crenulations per chamber, very close to the centre of the test axis, yielding a raised band, never merging into a costate pattern, the earliest part of the test may bear a few fine and rather short true costae unrelated to the crenulations.

Bolivina anastomosa Finlay, 1939
Pl. 3, Figs. 1-4

1939a *Bolivina anastomosa* Finlay: 320, pl. 27, figs. 75-77, 103, 111.
1966 *Latibolivina anastomosa* (Finlay); Srinivasan: 240.

Holotype. TF 1122/1, New Zealand Geological Survey.

Type locality. Loc. 5273, Kakanui Beach, 10 km SW of Oamaru, South Island, New Zealand; All Day Bay Mudstone, Altonian, Lower Miocene.

Material examined. P52794 & 95, North Bank of Mangaoporo River, Ruatoria, East Cape, New Zealand; Tutamoe Formation, Middle Miocene, Dorreen slide XI, square 15a, donated by Dorreen to the The Natural History Museum, London.

Description. Test elliptical, broadly rounded, laterally compressed, periphery flush, biserial; 15 chambers, chambers low, about three times as long as high, regularly increasing in size, becoming relatively lower later in ontogeny, frontal overlap minimal; sutures ill-defined, depressed, gently arcuate, in the centre of the test obscured by superficial ornamentation; aperture running up from the basal suture, reaching the apex of the test, almost terminal, oval, rather small, surrounded by a much thickened but ill-defined lip, toothplate commonly protruding in the aperture; toothplate small, spine sigmoid, free border originating very close to the aperture, pronounced concave arch, with a small tailing border, attachment along the entire length of the foraminal lip; wall coarsely perforate; ornamented in the centre of the test by reticulate low and flattened costae.

Remarks. This species was designated by Srinivasan as the type species of *Latibolivina* Srinivasan, 1966. The differences between *B. anastomosa* and other *Bolivina* species does not stretch beyond superficial ornamentation. This is deemed insufficient to warrant generic separation.

GENUS *Afrobolivina* REYMENT, 1959

1959 *Afrobolivina* Reyment: 19.

Type species. *Afrobolivina afra* Reyment, 1959, original designation.

Afrobolivina afra Reyment, 1959
Pl. 3, Figs. 5-8

1959 *Afrobolivina afra* Reyment: 21, pl. 1, figs. 1-4, pl. 2, figs. 1-5, pl. 3, figs. 1-5, pl. 4, fig. 1, pl. 5, figs. 1-3.
1983 *Afrobolivina afra* Reyment; Reyment: pl. 2, fig. 3, pl. 3, figs. 1-4, 6, 8, pl.4, figs. 1-6, pl. 5, figs. 1-8.

Holotype. G I F 21/*WB*, Geologiska Institutet, Stockholm University.

Type locality. Gbekebo Borehole, 960-1005 m, Western Nigeria; Upper Maastrichtian.

Material examined. Topotypes, courtesy R. A. Reyment.

Description. Test elongate, well rounded, broadly elliptical in end view, slowly and regularly increasing in width, apertural end broadly rounded, periphery slightly lobulate, biserial; up to 16 chambers, chambers fairly equidimensional, subelliptical, regularly increasing in size, becoming higher during ontogeny, frontal overlap occupying the central third of the test width, chambers with numerous lobes, often marked through reticulations due to secondary lamination; sutures largely obscured by the lobes and ornamentation, apparently fairly straight, flush with the surface; aperture loop-shaped, often sigmoid, especially in microspheric generation with raised lip, toothplate not protruding in the apertural opening; toothplate slim, clinging, spine concavely arched, no tailing border, free border fairly straight, fusing with the foraminal lip at the top-peripheral part, over a fairly short distance; wall densely perforate; ornament consisting in a reticulate set of thin costae, produced through secondary lamination deposited in the sutures and between the chamber lobes.

Remarks. Dimorphism is very pronounced in this species.

GENUS *Bolivinoides* CUSHMAN, 1927

1927 *Bolivinoides* Cushman: 89.

Type species. *Bolivina draco* Marsson, 1878, original designation.

Bolivinoides draco (Marsson, 1878)
Pl. 4, Figs. 1-4

1878 *Bolivina draco* Marsson: 157, pl. 3, figs. 25a-d.
1927 *Bolivinoides draco* (Marsson); Cushman: 89.

Type. No information is available.

Type locality. Isle of Rügen, Germany; Maastrichtian.

Material examined. Stevns Klint, Denmark; late Maastrichtian. Valhall Field, Block 2/8, Central North Sea; Tor Formation, late Maastrichtian. Courtesy H.W. Bailey.

Description. Test elongate, subrhombohedral, laterally compressed, elliptical in end view, commonly slightly twisted, rapidly increasing in width, upper third of the test often abruptly wider, apertural end broadly rounded, periphery flush, carinate, biserial; up to 16 chambers, chambers low and drawn out, very regularly increasing in size, becoming progressively lower during ontogeny, frontal overlap limited to the central axis of the test, with true retral processes; sutures completely obscured by the superficial ornamentation; aperture an elongated opening in the area between the basal suture and the apex of the chamber, surrounded by a barely raised lip, lip recognisable by the small thickening of the imperforate chamber wall, top of the toothplate protruding in the aperture, partially delimiting a small narrow sulcus; toothplate small, spine gently arched, free border sigmoid, no tailing border, attachment site extensive, along the top of the foraminal toothplate, stopping short of the lowermost end of the foraminal lip; wall finely perforate, in well preserved specimens distinctly perforate; ornamented with small, broadly rounded ponticuli harbouring the retral processes, running perpendicular to the cameral sutures, arranged in neat rows, earlier ponticuli coalescing, eventually forming solid costae, in the intial part of the test producing 2 parallel costae.

Remarks. Specimens are usually recovered from Chalk facies, which explains why almost all specimens are infilled with calcite and commonly recrystallised to various extents. The number of ponticuli in the later chambers seems to be a useful character for stratigraphic purposes.

GENUS *Brizalina* COSTA, 1856

1856 *Brizalina* Costa: 296.
1964 *Brizalina* Costa; Loeblich & Tappan: 552.
1973 *Bolivina (Brizalina)* Costa; Haynes: 128.
1987 *Brizalina* Costa; Loeblich & Tappan: 498.

Type species. *Brizalina aenariensis* Costa, 1856, original designation.

Brizalina aenariensis Costa, 1856
Pl. 4, Figs. 5-8

1856 *Brizalina aenariensis* Costa: 297, pl. 15, fig. 1.
1911 *Bolivina aenariensis* (Costa); Cushman: 44, fig. 71.
1937 *Bolivina aenariensis* (Costa); Cushman: 105, pl. 12, figs. 21-26.
1964 *Brizalina aenariensis* Costa; Loeblich & Tappan: 552, figs. 434/5 – 6, 436/1 – 2.
1992 *Bolivina aenariensis* (Costa); Sgarella: 322, pl. 1, figs. 1-13, pl. 2, figs. 1-11.

Lectotype. 15377-A, Museo Geologico di Napoli, Italy, designated by Sgarella, 1992.

Type locality. Casamicciola, Isola d'Ischia, Campania, Italy; Pleistocene.

Material examined. Topotypes, Piani di S. Paolo, Isola d'Ischia, Italy; Pleistocene. Courtesy M. del Re.

Description. Test elongate, regularly tapering, test may be arcuate, apertural end rounded, strongly compressed laterally, thin, periphery lobulate, edges sharp, biserial; 20 to 22 chambers, chambers narrow, almost thrice as long as high, arcuate, drawn out towards the periphery, regularly increasing in size, becoming proportionally higher during ontogeny; sutures distinct, depressed, seemingly limbate, arcuate, through contact with the previous suture yielding a zigzag pattern along the central axis of the test; aperture terminal, at the apex of the chamber, a narrow slit originating through the parting of the marginal keel, resulting in a narrow slit bordered by two barely everted lips, starting slightly above the basal suture, toothplate protruding in the aperture; toothplate elongated and very thin, spine straight to gently concave, no tailing border, free border almost straight and diminishing towards the end but butting into the foramen before disappearing altogether, attachment on the foraminal toothplate but continuing unto the foraminal lip about halfway down the foramen, thereby creating a division of the foramen; wall hyaline, finely and distinctly perforate; ornamented by a few faint striae, test often bearing a short initial spine.

GENUS *Coryphostoma* LOEBLICH & TAPPAN, 1962

1962 *Coryphostoma* Loeblich & Tappan: 111.

Type species. Bolivina plaita Carsey, 1926, original designation.

Coryphostoma plaitum (Carsey, 1926)
Pl. 5, Figs. 1-4

1926 *Bolivina plaita* Carsey: 26, pl. 4, fig. 2.
1932 *Loxostoma plaitum* (Carsey); Plummer: 182, pl. 10, figs. 5-7.
1962 *Coryphostoma plaitum* (Carsey); Loeblich & Tappan: 111.

Neotype. designated by Plummer, 1932. Invalid (ICZN article 75, paragraphs b and c). As the nature of the species does not pose any systematic problems, the designation of a neotype is unnecessary.

Type locality. Jones' Crossing of Onion Creek, East of Austin-Bastrop Highway, 9 Miles Southeast of State Capitol Building in Austin, Travis County, Texas, U.S.A.; Corsicana Marl, Lower Navarro, Maastrichtian.

Material examined. Topotypes, courtesy A.R. Loeblich. Specimens from Crosswick Creek, Navesink, New Jersey; Monmouth Formation.

Description. Test elongate, gradually and slowly increasing in size, laterally compressed, compressed elliptically in end view, periphery lobulate, biserial; up to 12 chambers, chambers about twice as long as high, slightly inflated, laterally compressed, frontal overlap occupying the central third of the test; sutures at first depressed, quickly becoming raised due to the deposition of secondary lamellae, a distinct boss being formed on the earlier chambers at the joining of two successive chambers; aperture terminal, an elliptical opening positioned well clear from the basal suture, lip low and rather thick, mainly at the peripheral side, curving round the aperture at the top, continuing onto the toothplate protruding in the aperture, delimiting a well defined rather long sulcus; toothplate large, with a slightly concave spine, free border sigmoidally curved, turning away from about halfway down the lumen, usually with a small tailing border, attachment site long, along the entire top of the foraminal toothplate; wall perforate.

Remarks. The gender of *Coryphostoma* is neuter.

GENUS *Loxostomoides* REISS, 1957

1957 *Loxostomoides* Reiss: 241.
1959 *Bolivina (Loxostomoides)* Reiss; Reyment: 16.

Type species. Bolivina applinae Plummer, 1926, original designation.

Loxostomoides applinae (Plummer, 1926)
Pl. 5, Figs. 5-8

1926 *Bolivina applini* Plummer: 69, pl. 4, fig. 1.
1929 *Bolivina applinae* Plummer; Galloway & Morrey: 35, pl. 5, fig. 9.
1930 *Loxostomum applinae* (Plummer); Nuttall: 285, pl. 24, figs. 4-5.
1937 *Loxostoma applinae* (Plummer); Cushman: 173, pl. 20, fig. 20.
1957 *Loxostomoides applinae* (Plummer); Reiss: 241.

Cotypes. 33006, Walker Museum, University of Chicago, Chicago.

Lectotype. Walker Museum, University of Chicago, Chicago, herein designated. (Leftmost specimen in slide 33006.)

Type locality. Claypit of the Mexia Brickworks, Mexia, Limestone County, Texas, U.S.A.; Wills Point Formation, Midway Group, Palaeocene.

Material examined. Type series, 33006 and 36440, Chicago, courtesy M.M. Nitecki. Topotypes, courtesy A.R. Loeblich.

Description. Test elongate, slowly but regularly increasing in size, broadly oval in end view, periphery almost flush, not compressed, biserial but later in ontogeny a tendency towards rectilinear arrangement of the chambers; up to 16 chambers, chambers semispherical, well rounded, inflated, frontal overlap considerable, very regularly increasing in size; sutures straight to slightly curved, at first depressed but later in ontogeny becoming flush with the surface due to deposition of secondary lamellae, at regular intervals punctured by small depressions which become more accentuated during ontogeny due to secondary lamination rising alongside them; aperture terminal, a narrow elongated opening, bordered on one side by a thickened, broad but very low lip, lip curves round the top of the aperture to touch the end of the slightly cristate, much thinner toothplate protruding in the aperture; toothplate narrow and thin, spine arched, no tailing border, free border sigmoidally arched, arch starting only 2/3 down into the lumen, attachment along the entire foraminal lip; wall distinctly perforate; the earliest part of the test may develop a low costate outlook.

GENUS *Lugdunum* SAIDOVA, 1975

1975 *Lugdunum* Saidova: 308.

Type species. Bolivina hantkeniana Brady, 1881, original designation.

Lugdunum hantkenianum (Brady, 1881)
Pl. 6, Figs. 1-4

1881 *Bolivina hantkeniana* Brady: 58.
1884 *Bolivina hantkeniana* Brady; Brady: 424, pl. 53, figs. 16-18.
1911 *Bolivina hantkeniana* Brady; Cushman: 42, fig. 68.
1937 *Bolivina hantkeniana* Brady; Cushman: 127, pl. 16, figs. 18-20.
1975 *Lugdunum hantkenianum* (Brady); Saidova: 308.

Lectotype. ZF4962, The Natural History Museum, London, herein designated.

Type locality. Off Papeete, Tahiti, 420 faths., H.M.S. *Challenger* Station 279A.

Material examined. The type series: ZF1178, ZF1179 and ZF1180, resp. *Challenger* Stations 279a, 279b and 279c; ZF4962, lectotype, and ZF4963, illustrated paralectotype; The Natural History Museum, London.

Description. Test elongated, tapering, laterally compressed, periphery distinctly lobulate, keeled, biserial; up to 15 chambers, chambers large, about twice as long as high, obliquely arranged, frontal overlap almost the central third of the test, regularly increasing in size, earliest chambers slightly higher than long, gradually becoming more elongate during ontogeny; sutures distinct, depressed, gently arched with a nick halfway across the chambers; aperture large, running up from the basal suture to the apex of the chamber, broadly elliptical, bordered by a very prominent thickened lip, toothplate very prominent in the aperture; toothplate large, concave, spine distinctly arched, with a small straight tailing border, free border sigmoidally arched, ornamented with small denticulae in the upper part, attachment along the top of the foraminal toothplate, continuing to cross the foraminal lip in its lowermost part; wall hyaline, finely perforate; ornamented by numerous thin costae, each restricted to a single chamber face, outer edges keeled, with the successive keels coalescing into a single irregular keel.

Remarks. The lectotype is a microspheric specimen. Dimorphism is pronounced in this species. The megalospheric generation is characterised by being only half as large as the microspheric one, with less oblique chambers and a more regular outline.

GENUS *Sagrinella* SAIDOVA, 1975

1975 *Sagrinella* Saidova: 309.

Type species. *Sagrinella guinae* Saidova, 1975, original designation.

Sagrinella jugosa (Brady, 1884)
Pl. 6, Figs. 5-8

1884 *Textularia jugosa* Brady: 358, pl. 42, figs. 7a-b.
1975 *Sagrinella guinae* Saidova: 309.

Lectotype. ZF4964, The Natural History Museum, London.

Type locality. *Challenger* Station 185, Raine Island; Recent. *S. guinae* Saidova, Off New Guinea, - 25 m, Pacific Ocean; Recent.

Material examined. ZF2454, syntypes, Raine Island; *Challenger* Type Slide TS C14:10; ZF4964, lectotype and ZF4965, illustrated paralectotype; The Natural History Museum. 11°06'N 80°05'E, - 148 m, off Tranquebar, *Galathea* Station 288; 5°25'S 117°03'E, -570 m, Bali Sea, *Galathea* Station 490; 26°33'S 153°31'E, - 86 m, *Galathea* Station 539; courtesy H. J. Hansen.

Description. Test small, tapering, laterally compressed, periphery saw-edged, apertural end obliquely truncate, initial end broadly rounded, quite rapidly increasing in width, biserial; 10 chambers, chambers subrectangular, becoming proportionally lower during ontogeny, adult chambers 2.5 times as wide as high, flush with the surface, regularly increasing in size, half of the circumference accentuated by an extending keel; sutures distinct, partially obscured by the keels, almost straight, raised; aperture in the centre of an almost poreless apertural face, apertural face slightly concave, subterminal, broadly loop-shaped, on one side with a slightly raised lip, barely differentiated from the apertural face, lip curves into the aperture to cover the top of the toothplate; toothplate rather large, extending straight down into the chamber, spine straight, free border curled up a little, no tailing border, fusing on the septal face adjacent to the aperture, probably in part with the foraminal lip; wall perforate; ornamented by a dense cover of small, low tubercles between the projecting intercameral keels.

Remarks. The description and figures available for *S. guinae*, together with the geographic occurrence of this species, fail to provide any evidence for the separation of *S. guinae* from *S. jugosa*. Therefore, *S. guinae* is here considered synonymous with the senior *S. jugosa*.

GENUS *Saidovina* HAMAN, 1984

1975 *Loxostomina* Saidova: 311.
non 1969 *Loxostomina* Sellier de Civrieux: 159.
1984 *Saidovina* Haman: 419.

Type species. *Bolivina karreriana* Brady, 1881, original designation.

Saidovina karreriana (Brady, 1881)
Pl. 7, Figs. 1-4

1881 *Bolivina karreriana* Brady; 58.
1884 *Bolivina karreriana* Brady: Brady: 424, pl. 53, figs. 19-21.
1911 *Bolivina karreriana* Brady: Cushman : 40, fig. 65.
1937 *Loxostoma karreriana* (Brady); Cushman: 184, pl. 21, fig. 17.
1975 *Loxostomina karreriana* (Brady); Saidova: 311.
1984 *Saidovina karreriana* (Brady); Haman: 419.
1989 *Loxostomum karrerianum* (Brady); Hornibrook, Brazier & Strong: 95, fig. 23/25.

Lectotype. ZF4966, The Natural History Museum, London, herein designated.

Type locality. 35°11'N 139°28'E, South of Japan, - 345 faths., *Challenger* Station 232.

Material examined. ZF1181, *Challenger* Station 232, Type series; ZF4966, lectotype and ZF4967, illustrated paralectotype; The Natural History Museum, London.

Description. Test elongate fusiform, laterally compressed, elliptical in end view, periphery somewhat lobulate, apertural end slightly truncate, biserial; up to 10 chambers, chambers subovoid, laterally compressed, about 1.5 times as high as wide, frontal overlap about 2/3 of the test width, slightly inflated; sutures indistinct, largely obscured by superficial ornamentation, arcuate; aperture terminal, occupying the entire apex, surrounded by a well developed thickened lip which splits off at one point to cover the top of the protruding toothplate; toothplate large, spine sigmoid, free border sigmoid, reducing towards the bottom and mingling into the tailing border, attachment site along the top of the foraminal toothplate and continuing until touching the bottom part of the foraminal lip, dividing the foramen into two; wall semi-hyaline, distinctly perforate; ornamented by numerous fairly short and low costae, costae may coalesce with each other, the test often bears an initial spine.

GENUS *Sigmavirgulina* LOEBLICH & TAPPAN, 1957

1957 *Sigmavirgulina* Loeblich & Tappan: 227.

Type species. *Bolivina tortuosa* Brady, 1881, original designation.

Sigmavirgulina tortuosa (Brady, 1881)
Pl. 7, Figs. 5-8

1881 *Bolivina tortuosa* Brady: 57.
1884 *Bolivina tortuosa* Brady; Brady: 420, pl. 52, figs. 31-34.
1937 *Bolivina tortuosa* Brady; Cushman: 133, pl. 17, figs. 11-19.
1957 *Sigmavirgulina tortuosa* (Brady); Loeblich & Tappan: 227.

Lectotype. ZF4968, The Natural History Museum, London, herein designated.

Type locality. Nares Harbour, Admiralty Islands, - 17 faths., *Challenger* Station 219A.

Material examined. ZF1201, *Challenger* Station 219A only!, type series, ZF4968, lectotype and ZF4969, illustrated paralectotype; The Natural History Museum, London.

Description. Test small, tapering, compressed in end view, distinctly and regularly twisted, periphery barely lobulate, slightly carinate, biserial; up to 12 chambers, chambers much compressed, at first almost as long as high, but during ontogeny gradually becoming about twice as long as high, flush with the surface, frontal overlap minimal; sutures indistinct, gently arched, depressed; aperture terminal, narrowly elliptical, surrounded by a slightly raised thickened periapertural lip, denticulate apex of the toothplate protruding at the uppermost centre of the aperture; toothplate small, spine a concave arch, free border originating from fairly low down, almost straight, a small straight tailing border, attachment along the peripheral foraminal lip; wall distinctly perforate, pores in two different size groups.

Remarks. The specimens of slide ZF1202, *Challenger* Station 352, part of the original syntype series, are the syntypes of *Sigmavirgulina atlantica* (Cushman, 1936).

SUBFAMILY FURSENKOININAE LOEBLICH & TAPPAN, 1961

1961 Fursenkoininae Loeblich & Tappan: 314.
1964 Fursenkoininae Loeblich & Tappan: 731.

Description. Test free, elongated, commonly laterally compressed, biserial, coiling often irregular or twisted; chambers higher than wide; aperture loop-shaped, with a well defined lip, running up the apertural face, top of the toothplate usually visible in the aperture; toothplate narrow, closely clinging to the chamber wall, attachment with the foraminal lip, may continue over the foraminal toothplate top; wall calcareous, perforate.

GENUS *Fursenkoina* LOEBLICH & TAPPAN, 1961

1826 *Virgulina* d'Orbigny: 267.
non 1823 *Virgulina* Bory de St. Vincent.
1961 *Fursenkoina* Loeblich & Tappan: 314.
1951 *Cassidella* Hofker: 264, *nomen nudum*.
1953 *Cassidella* Hofker: 26.
1964 *Cassidella* Loeblich & Tappan: 732.

Type species. *Virgulina squammosa* d'Orbigny, 1826, type by monotypy.

Remarks. ICZN case 2809 (Revets, 1994) pending for the conservation of the name *Fursenkoina*.

Fursenkoina squammosa (d'Orbigny, 1826)
Pl. 8, Figs. 1-4

1826 *Virgulina squammosa* d'Orbigny: 267.
1865 *Virgulina squamosa* d'Orbigny; Parker, Jones & Brady: 29, pl. 2, fig. 66, *err. cit.*
1961 *Fursenkoina squammosa* (d'Orbigny); Loeblich & Tappan: 314.

Neotype. An exhaustive search in the collections of the Muséum National d'Histoire Naturelle, Paris, has failed to yield any information as to the whereabouts of possible syntypes of *Virgulina squammosa*. As was the case for *Bolivina plicata*, one has to presume that if syntypes ever existed, they have been lost. Unfortunately, the sediment collection of d'Orbigny, held in the same institution, does not contain a trace of material from Siena, Italy. Cushman established Coroncina, near Siena, as one of the most likely localities for the Siena species described by d'Orbigny (Cushman, 1930).

An application has been filed with the ICZN (Revets, 1994, 1995), asking to conserve *Fursenkoina* in preference over *Cassidella*. Systematic stability would be further enhanced by the availability of a type specimen.

In accordance with article 75, paragraph d of the ICZN, the following remarks are called for:

art. 75, par. b(i). This study aims at establishing the taxonomic relations between the different genera relevant to this study, based on observations of their type species. These species are compared to closely allied species in order to arrive at an unambiguous description and consequent clarification of the respective specific and generic concepts.

art. 75, par. b(ii). Exceptional circumstances are in force for the case of *Fursenkoina squammosa*. It is the type species of a genus currently the subject of a plea for conservation lodged with the ICZN. The particulars of the case make the availability of a type specimens highly desirable. The necessity for such a type is increased by the recurrent confusion in the literature between *F. squammosa* and *F. schreibersiana*.

art. 75, par. d(1). see description.

art. 75, par. d(2). The neotype is fully labelled and deposited in the collections of the The Natural History Museum, London, in the Micropalaeontology collection, under no P52796.

art. 75, par. d(3). The d'Orbigny collection has suffered a great many losses over the years. Apart from the disruption caused by moving the entire collection from Esnandes to Paris and the initial storage of the collection in the cellars of the Museum, the flooding by the Seine resulted in the drowning of all the glass tubes containing d'Orbigny's specimens. A great many of the tubes were lost and many others became detached from the thick cardboard identification labels to which they had been glued. Repeated and exhaustive searches have failed to yield any indication of *Virgulina squammosa*. All the tubes, including unlabelled ones and all the loose cardboard identification labels have been assembled and repeatedly checked to no avail. I therefore consider potential syntypes as being lost.

art. 75, par. d(4). see description.

art. 75, par. d(5). No information could be found in the d'Orbigny collection to pinpoint the exact locality from which *V. squammosa* was described. Ever since Cushman (1930), the most likely locality is deemed to have been some of the clay-pits, Coroncina, at the outskirts of Siena.

art. 75, par. d(6). The neotype is deposited in the collections of the The Natural History Museum, London.

Type locality. Cava Semplice, Coroncina, near Siena, Italy; Pliocene.

Material examined. Topotypes from sample By103, Cava Semplice, Siena, The Natural History Museum. Meltemi, South of Rafina, Attica, Greece; Upper Pliocene.

Description. Test elongate, subcylindrical, slightly wider in the middle of the test, broadly rouded, somewhat compressed, regularly twisted, periphery lobulate, subovate in end view, twisted biserial; 9 chambers, chambers ovate, circular in end view, elongated, about thrice as high as wide, slightly inflated, frontal overlap very restricted; sutures distinct, depressed, gently curved but broken into different portions due to the different intercameral contacts; aperture loop-shaped, narrow, running from or slightly above the basal suture up to the apex of the chamber, this apex slightly pinched in, bordered peripherally by a low, somewhat thickened lip, lip curving round the apex of the aperture and leaving a narrow, ill-defined sulcus while fusing with the top of the protruding toothplate; toothplate slim and elongate, spine almost straight to gently arched, free border curved, attachment along the foraminal toothplate and with the upper part of the foraminal peripheral lip; wall semi-opaque, finely perforate.

Remarks. Differs from *F. schreibersiana* in possessing much higher chambers and much less twisted initial coils. The aperture of *F. schreibersiana* is much more bulimine than that of *F. squammosa*.

Fursenkoina schreibersiana (Cžjžek, 1848)
Pl. 8, Figs. 5-8

1848 *Virgulina schreibersiana* Cžjžek: 147, pl. 13, figs. 18-21.
non 1942 *Virgulina schreibersiana* Cžjžek; ten Dam & Reinhold: 82, pl. 5, fig. 14.

Type. Syntypes should have been deposited in the collections of the Geologische Bundesanstalt, Vienna, but specimens cannot be traced due to the vagaries caused by the second World War (comm. from Drs. F. Stojaspal and F. Rögl).

Type locality. Baden, near Vienna, Austria; Badenian, Miocene.

Material examined. Topotypes, courtesy F. Rögl and H. J. Hansen.

Description. Test elongate, subcylindrical, broadly elliptical in end view, periphery lobulate, somewhat compressed laterally, biserial, coiling clearly twisted initially, later in ontogeny more strictly biserial; up to 11 chambers, chambers ovate, inflated, 1.5 to 2 times as high as wide, little frontal overlap; sutures distinct, gently arcuate, depressed; aperture loop-shaped, running from slightly above the basal suture up the chamber onto its apex, bordered by a well defined apertural lip, top of the toothplate clearly visible in the aperture, mingling into the peripheral lip at the apex of the aperture, a well defined sulcus present between toothplate and axial border; toothplate fairly narrow, elongate, spine straight, free border gently curved, attachment to the foramen at the apex of the foramen, along the foraminal lip and top of the foraminal toothplate; wall hyaline, perforate.

Fursenkoina oligocenica (Hofker, 1951)
Pl. 9, Figs. 1-4

1942 *Virgulina schreibersiana* Cžjžek; ten Dam & Reinhold: 82, pl. 5, fig. 14.

1951 *Cassidella oligocenica* Hofker: 265, figs. 176a-c.

Lectotype. MK91001, ex F 248, Rijksgeologische Dienst, Haarlem, The Netherlands (specimen figured by ten Dam & Reinhold, 1942), herein designated.

Type locality. Drilling Db 14 Belfeld, 280.6 m, The Netherlands; Oligocene.

Material examined. F248, Belfeld Drilling, ten Dam & Reinhold Specimens; F2056, Db12 Bessel Drilling, 347.5 m, and F2057, Beeringen Drilling, 285 m, Hofker specimens; all Oligocene, Rijksgeologische Dienst, courtesy L. Witte and R. J. Van Leeuwen.

Description. Test elongate, extremities broadly rounded, laterally compressed, elliptical in end view, periphery lobulate, twisted biserial; up to 12 chambers, chambers elongated, about twice as high as wide, inflated, frontal overlap minimal; sutures depressed, gently arched, broken into different portions; aperture subterminal, a long narrow elliptical opening, running up the ill defined apertural face from the basal suture to the very top, at the peripheral side with a slightly everted and raised lip, a well defined sulcus present between the top of the toothplate and the thickened axial side of the aperture, the lip curving round to cover the top of the slightly protruding toothplate; toothplate a narrow concave arch, clinging rather closely to the lateral chamber wall, fusing with the top of the foraminal toothplate over almost its entire length; wall finely perforate.

Remarks. Differs from *F. squammosa* in possessing less elongated chambers and a more everted apertural lip. It is however clearly closely related to *F. squammosa*. Differs from *F. schreibersiana* in possessing a much more elongated aperture, and higher chambers. Also, the coiling is less twisted than in *F. schreibersiana*.

Virgulina tegulata Reuss, 1846
Pl. 9, Figs. 5-10

1846 *Virgulina tegulata* Reuss: 40, pl. 13, fig. 81.

non 1937 *Virgulina tegulata* Reuss; Cushman: 4, pl. 1, figs. 8-12.

non 1951 *Cassidella tegulata* (Reuss); Hofker: 264, fig. 174a, figs. 175a-f.

Type. Originally in the Fürstlich Lobkowitz Mineralien Kabinet, Bilin. This collection was subsequently moved to Budapest, where it was destroyed during the Soviet invasion of 1956 (H. Kollman, written comm.).

Type locality. Rannay and Kystra, Bohemia, Czech Republic; Turonian.

Material examined. Locality 32, 18th European Micropalaeontological Colloquium, Kystra, Ohre Region, Czech Republic; Jizera Formation, Middle Turonian; courtesy H. J. Hansen.

Description. Test elongate, gently tapering, laterally very strongly compressed, thinly elliptical in end view, periphery slightly lobulate, biserial, usually with a single twist; 15 chambers, chambers very much compressed, about as wide as high, barely inflated, regularly increasing in size, growth almost isometric, degree of lateral compression increases during ontogeny, frontal overlap minimal; sutures depressed, gently arched, broken in three pieces due to the chamber arrangement; aperture subterminal, details of aperture and eventual internal morphological features unrecognisable due to the preservational state.

Remarks. A proposal has been submitted to the International Commission for Zoological Nomenclature (Revets, 1994, 1995) to ask for a ruling concerning the status of *Cassidella*, since the genus is based on a misidentified type species (ICZN article 70b). The specimens studied and described by Hofker (1951) as *Virgulina tegulata* Reuss from the Maastrichtian deposits of the Jeker Valley in Belgium are not conspecific with the specimens originally described by Reuss from the Turonian deposits of Bohemia, as demonstrated through the study of topotypes of Bohemian deposits. However, the preservational state of these specimens precludes any form of critical study.

The confusion caused by the original designation of *Cassidella oligocenica*, as well as *V. tegulata* at type species was apparently resolved by the subsequent designation of *V. tegulata* by Hofker (1953). But the description given by Hofker of *Cassidella*, and well illustrated by *C. oligocenica* shows its concept to be identical to *Fursenkoina*. For the sake of stability, the ICZN has received an application to use its plenary powers to suppress the name *Cassidella* in favour of *Fursenkoina*.

The species *Virgulina tegulata* Reuss is unrecognisable, since it proves impossible to recover specimens from the type deposits sufficiently well preserved to allow critical observations, and should be considered *incertae sedis*.

GENUS *Galliherina* KLEINPELL & TIPTON, 1980

1980 *Galliherina* Kleinpell & Tipton: 75.

Type species. Bulimina uvigerinaformis Cushman & Kleinpell, 1934, original designation.

Galliherina uvigerinaformis (Cushman & Kleinpell, 1934)
Pl. 10, Figs. 1-4

1934 *Bulimina uvigerinaformis* Cushman & Kleinpell: 5, pl. 1, fig. 14.

1980 *Galliherina uvigerinaformis* (Cushman & Kleinpell); Kleinpell & Tipton: 76, pl. 11, figs. 8-10.

1988 *Bulimina uvigerinaformis* Cushman & Kleinpell; Whittaker: 58, pl. 7, figs. 1-4.

Holotype. CC20124, Smithsonian Institution, Washington, D.C.

Type locality. Base of Ocean Bluffs, East of the mouth of Dos Pueblos Creek, West of Naples, California, U.S.A.; Miocene.

Material examined. Newport Beach, Orange County, California; Mohnian, Miocene. Progresso Basin, Ecuador; Progresso Formation, Middle Miocene, courtesy J.E. Whittaker.

Description. Test elongated, tapering, broadly rounded in end view, inflated, periphery lobulate, at first rapidly increasing in width, then fairly constant in size, biserial but twisting; up to 10 chambers, chambers spheroid, strongly inflated, embracing, frontal overlap fairly restricted, upper end asymmetrically sagged-in; sutures distinct, depressed, straight; aperture terminal, where the chamber is slightly pinched in, running up from the basal suture or slightly above it, narrow, loop-shaped, bordered by a barely thickened lip, distinctly cristate apex of the toothplate protruding in the aperture; toothplate thin, a strongly concave trough, spine arched, no tailing border, free border arched and very low, just above and parallel to the foramen, attachment at the apex of the foraminal lip, running along the top of the foraminal toothplate; wall finely perforate; ornamented with a number of regular, fine costae which cross the sutures but are nicked in the process of doing so.

GENUS *Hopkinsinella* BERMÚDEZ & FUENMAYOR, 1966

1966 *Hopkinsinella* Bermúdez & Fuenmayor: 508.

Type species. Uvigerina auberiana var. *glabra* Millett, 1903, original designation.

Hopkinsinella glabra (Millett, 1903)
Pl. 10, Figs. 5-8

1903 *Uvigerina auberiana* var. *glabra* Millett: 268, pl. 5, figs. 8-9.
1966 *Hopkinsinella glabra* (Millett); Bermúdez & Fuenmayor: 508.
non 1987 *Hopkinsinella glabra* (Millett); Loeblich & Tappan: 516, pl. 566, figs. 16-18.

Lectotype. 1955:11:1:5006, The Natural History Museum, London, herein designated.

Type locality. Station 12, Malay Archipelago.

Material examined. 1955:11:1:5006-5055, type series.

Description. Test elongate, gradually increasing in size, somewhat compressed laterally, periphery lobulate, broadly elliptical in end view, biserial, earliest whorls may be triserial in the microspheric generation; 11 chambers, chambers subellipsoid, inflated, 1.5 to 2 times as high as wide, becoming proportionally higher during ontogeny, frontal overlap occupying the middle third of the test; sutures distinct, depressed, gently arched and broken into two parts; aperture running up from the basal suture to the apex of the chamber, lower end of the aperture open, surrounded in the final chamber by a twisted, distinctly everted and raised periapertural lip, top of the toothplate protruding in the aperture; toothplate slim and elongated, clinging closely to the chamber wall, spine gently arched to slightly sigmoid, free border quickly coalescing with the chamber floor close to the aperture, attachment to the top of the foraminal lip, foraminal lip with a prominent triangular upwardly projecting platelet at the peripheral side; wall finely but distinctly perforate, optically distinctly radial.

Remarks. The description and figures given by Loeblich & Tappan (1987) do not conform to the morphology of the specimens making up the type series.

SUBFAMILY PARABRIZALININAE SUBFAM. NOV.

Description. Test free, elongated, laterally compressed, biserial, with a tendency towards rectilinearity; chambers usually compressed, roughly as wide as high; aperture subterminal to terminal; toothplate asymmetrical, at least in later chambers with both borders free, fusing with the top of the foraminal toothplate; wall calcareous, perforate.

GENUS *Parabrizalina* ZWEIG-STRYKOWSKI & REISS, 1975

1975 *Parabrizalina* Zweig-Strykowski & Reiss: 100.

Type species. Bolivina porrecta Brady, 1881, original designation.

Parabrizalina porrecta (Brady, 1881)
Pl. 11, Figs. 1-4

1881 *Bolivina porrecta* Brady: 57.
1884 *Bolivina porrecta* Brady; Brady: 418, pl. 52, figs. 22a-c.
1911 *Bolivina (Bifarina) porrecta* Brady: Cushman: 48, fig. 79.
1937 *Loxostoma porrecta* (Brady); Cushman: 190, pl. 22, figs. 7-10.
1975 *Parabrizalina porrecta* (Brady); Zweig-Strykowski & Reiss: 100.

Lectotype. ZF4970, The Natural History Museum, London, herein designated.

Type locality. Off Culebra Island, North of St. Thomas's, West Indies, 390 faths., *Challenger* Station 24.

Material examined. ZF1190, the type series; ZF4970, lectotype and ZF4971 illustrated paralectotype, The Natural History Museum, London.

Description. Test elongated, slightly tapering, somewhat compressed laterally, elliptical in end view, periphery slightly lobulate, apertural end somewhat truncate but well rounded, biserial, with a tendency towards rectilinearity later in ontogeny; 14 chambers, chambers subovate, somewhat inflated, about twice to thrice as high as wide, frontal overlap almost complete; sutures distinct, depressed, slightly curved, becoming an imperforate band in the earlier part of the test; aperture terminal, elliptical, occupying almost the entire apex, surrounded by a much thickened, slightly everted, almost periapertural lip, part of the lip runs down the apertural face, often reaching the sutural junction with the penultimate chamber, denticulate top of the toothplate protruding in the aperture; toothplate large, asymmetrical, to a large extent with two free borders, trough-like with curled-up borders, in the lowermost part plate slightly nicked due to a change in direction, attachment along the foraminal toothplate top, along the entire length of the foramen; wall hyaline, distinctly perforate; the sides of the test bear a keel-like ornamentation, due to the coalescing of the peripheral extensions of the apertural lips.

GENUS *Euloxostoma* MCCULLOCH, 1977

1977 *Euloxostomum* McCulloch: 262.
1987 *Euloxostomum* McCulloch; Loeblich & Tappan: 515.

Type species. Loxostoma instabile Cushman & McCulloch, 1942, original designation.

Remarks. The genus name is herein emended to *Euloxostoma.* This emendation also supports the emendation by Howe (1930) of *Loxostomum* to *Loxostoma.* The error stems from the misguided belief that the latinisation of the neuter term -*στομα* should become -stomum in latin to reflect the gender: the term -stomum does not exist in Latin (see ICZN art. 32, par. d).

Euloxostoma instabile (Cushman & McCulloch, 1942)
Pl. 11, Figs. 5-8

1942 *Loxostoma instabile* Cushman & McCulloch: 221, pl. 27, figs. 15-17, pl. 28, figs. 1-7.
1977 *Euloxostomum instabile* (Cushman & McCulloch); McCulloch: 262.

Holotype. AHF47, now at the Smithsonian Institution, Washington, D.C. as CC48733.

Type locality. Station 2070, 29°8'N 115°10'W, 250 faths., off Guadeloupe Island, Gulf of Mexico, Mexico; Recent.

Material examined. 7°20'N 79°38'W, - 520 m, Gulf of Panama, *Galathea* Station 734, courtesy H. J. Hansen.

Description. Test elongate, tapering, at first rapidly increasing in width, later half of the test almost constant in size, laterally compressed, narrow elliptical in end view, periphery lobulate, biserial, later in ontogeny with a tendency towards rectilinear arrangement of the chambers; 14 chambers, chambers ovate, strongly compressed laterally, somewhat inflated in the middle, early in ontogeny almost four to three times as wide as high, becoming proportionally lower during ontogeny, last few chambers somewhat wider than high, frontal overlap occupying the central third of the test width; sutures distinct, depressed, slightly arcuate, in later chambers almost straight with a nick due to the frontal overlap; aperture almost terminal, slit-like, surrounded on one side by the thickened edge of the aperture, at the other side by a lip which curves back into the aperture to cover the top of the toothplate, lip continuous with a band-like keel running to the basal suture, the thickened apertural rim continuing over the apex to the suture with the prepenultimate chamber; toothplate thin and elongated, spine slightly arcuate, free border straight, close to the foramen the attached border becoming free as well, attachment on top of the foraminal toothplate; wall finely and densely perforate; ornamented by a marginal keel formed by the coalescing of the prolongations of apertural borders and lips, keel saw-edged due to the undercutting at the cameral boundaries.

GENUS *Loxostomina* SELLIER DE CIVRIEUX, 1969

1969 *Loxostomina* Sellier de Civrieux: 159.
1975 *Loxostomella* Saidova: 311, objective synonym.

Type species. Bolivina mayori Cushman, 1922, original designation.

Loxostomina mayori (Cushman, 1922)
Pl. 12, Figs. 1-4

1884 *Bolivina nobilis* Hantken; Brady: 424, pl. 53, figs. 14-15.
1922 *Bolivina mayori* Cushman: 27, pl. 3, figs. 5-6.
1935 *Loxostomum mayori* (Cushman); Bermúdez: 197.
1937 *Loxostoma mayori* (Cushman); Cushman: 195, pl. 22, figs. 16-21.
1969 *Loxostomina mayori* (Cushman); Sellier de Civrieux: 159.
1975 *Loxostomella mayori* (Cushman); Saidova: 311.

Holotype. Probably at the Smithsonian Institution, Washington, D.C., at present untraceable.

Type locality. The Dry Tortugas, Florida, U.S.A.; Recent.

Material examined. Topotypes, The Dry Tortugas, courtesy P. Hallock Muller. ZF 1188, Nares Harbour, Admiralty Islands, *Challenger* Station 219A, labelled *Bolivina nobilis* Hantken, The Natural History Museum, London.

Description. Test elongate, parallel sides, apertural end often slightly reduced, laterally compressed, elliptical in end view, periphery lobulate, biserial, upper part with a clear tendency towards rectilinearity, coiling axis often slightly arcuate; chambers compressed ovate, about as high as wide, becoming proportionally higher later in ontogeny, drawn-out towards earlier part, frontal overlap small but fairly drawn-out vertically; sutures depressed, irregularly arcuate; aperture terminal, elliptical, very slightly produced, almost symmetrical, on one side a thickened extension of the chamber wall, on the other side an apertural lip which curves round into the aperture to form the cristate top of the toothplate; toothplate large, almost symmetrical, two free borders, almost straight, a concavo-convex trough, usually with one free border more inwardly curved than the other, attachment at the convex side of the toothplate with the foraminal toothplate top; wall distinctly perforate, pores arranged in large part along longitudinal lines; ornamented by narrow sinuous costae usually restricted to their respective chamber faces, density of costae increases during ontogeny.

SUBFAMILY SAGRININAE SUBFAM. NOV.

Description. Test free, elongated, laterally compressed, biserial; chambers about as wide as high; aperture loop-shaped, surrounded by a periapertural lip, lip usually thickened, top of the toothplate protruding in the aperture; toothplate large and complex, commonly a highly curved plate encasing the foramen with a funnel at the back of the main part of the toothplate, may unroll to form a large plate almost bisecting the chamber lumen; wall calcareous, perforate.

GENUS *Sagrina* D'ORBIGNY, 1839

1839a *Sagrina* d'Orbigny: 144.

Type species. Sagrina pulchella d'Orbigny, 1839, type by monotypy.

Sagrina pulchella d'Orbigny, 1839
Pl. 12, Figs. 5-8

1839a *Sagrina pulchella* d'Orbigny: 150, pl. 1, figs. 23-24.
1922 *Bolivina pulchella* (d'Orbigny); Cushman: 41, pl. 7, fig. 4.
1937 *Sagrina pulchella* d'Orbigny: Cushman: 151, pl. 15, figs. 9-11.
1956 *Bitubulogenerina pulchella* (d'Orbigny); Hofker: 49, pl. 4, figs 21-36.
1977 *Sagrina pulchella* d'Orbigny; Le Calvez: 120, figs. 1-3.

Lectotype. FO316, Muséum National d'Histoire Naturelle, Paris, designated by Le Calvez (1977).

Type locality. Cuba; Recent.

Material examined. The type series; specimens from Jamaica, original d'Orbigny sample; Muséum National d'Histoire Naturelle, Paris. The Dry Tortugas, Florida, U.S.A.; courtesy P. Hallock Muller.

Description. Test elongate, tapering, regularly increasing in width, laterally compressed, elliptically elongate in end view, periphery lobulate with a tendency to undercutting, biserial; 9 chambers, chambers subovate, laterally compressed, about 1.5 times as wide as high, moderately inflated, regularly increasing in size, becoming more elliptical during ontogeny, frontal overlap less than the middle third of the test; sutures distinct, somewhat depressed, virtually straight; aperture terminal, large, extending from just above the basal suture over the apex of the chamber, ovate, surrounded by a slightly raised and everted periapertural lip, apertural face may bear a number of fine, short, upwardly projecting spines, top of the toothplate protruding into the aperture, upper edge of the toothplate denticulate; toothplate very prominent and large, multiple attachment points between the attached border and the chamber wall, spine strongly sigmoid, curved in three dimensions, free border sigmoid, also curved in three dimensions, bottommost part of the free border parallel to the septum and swinging round itself to encircle the foramen, apparently encasing the foramen like a collar, upper side of the toothplate bearing numerous thin, usually curved, fairly high spines; wall hyaline, sparsely perforate; ornamented by slightly raised costae which remain restricted to their respective chamber face.

GENUS *Alectinella* GEN. NOV.

Description. A slender, elongated sagrinid genus, characterised by the overspilling of the periapertural lip onto earlier chambers, and by the simpler toothplate, for a sagrinid, which partially straddles the foramen.

Type species. Bifarina elongata Millett, 1900, herein designated.

Etymology. After Alecto, one of the three Eumenides.

Alectinella elongata (Millett, 1900)
Pl. 13, Figs. 5-9

1900 *Bifarina elongata* Millett: 539, pl. 4, figs. 1-2.
1937 *Bifarina elongata* Millett; Cushman: 200, pl. 22, fig. 35.
1964 *Valvobifarina elongata* (Millett); Loeblich & Tappan: 654.

Lectotype. 1955:11:1:59, The Natural History Museum, London, herein designated.

Type locality. Station 14, Malay Archipelago; Recent.

Material examined. 1955:11:1:59-120, the type series.

Description. Test elongate, elegant fusiform, slender, laterally compressed, periphery irregular due to the presence of small spines, biserial; chambers semicircular to subtriangular, gradually increasing in size, somewhat inflated, low borders slightly denticulate; sutures distinct, depressed, undercutting the chambers; aperture terminal, a very elongated slit, running over 3/4 of the apex, bordered by a well defined, slightly everted lip, lip crossing the suture at the axial side, covering the upper third of the previous chamber; toothplate large and curved, attached to the foramen along the foraminal lip on one hand, but also to the opposite lip over a short distance, forming a small bridge over the upper part of the foramen; wall hyaline, distinctly perforate; ornamented by low ridges in the lower half of each chamber, continuing into small outwardly projecting spines.

Remarks. The revision of *Valvobifarina* showed that this genus lacks a toothplate (Revets, 1991b), thereby refuting the assignment of *B. elongata* to *Valvobifarina* as proposed by Loeblich & Tappan (1964).

Because of the peculiar anatomy of the apertural complex with no counterpart in other toothplate-bearing taxa, and the highly characteristic overspilling apertural lip, a new genus was created to accomodate *B. elongata.*

GENUS *Pseudobrizalina* ZWEIG-STRYKOWSKI & REISS, 1975

1975 *Pseudobrizalina* Zweig-Strykowski & Reiss: 109.
1987 *Sagrinella* Saidova; Loeblich & Tappan: 517, *partim.*

Type species. Bolivina lobata Brady, 1881, original designation.

Pseudobrizalina lobata (Brady, 1881)
Pl. 14, Figs. 1-4

1881 ***Bolivina lobata*** Brady: 58.
1884 ***Bolivina lobata*** Brady; Brady: 425, pl. 53, figs. 22-23.
1937 ***Loxostoma lobata*** (Brady); Cushman: 188, pl. 22, figs. 2-4.
1975 ***Pseudobrizalina lobata*** (Brady); Zweig-Strykowski & Reiss: 110.
1987 *Sagrinella lobata* (Brady); Loeblich & Tappan: 517.

Lectotype. ZF4972, The Natural History Museum, London, herein designated.

Type locality. Nares Harbour, Admiralty Islands, 16-25 faths., *Challenger* Station 219A.

Material examined. ZF1185, the type series, ZF4972, lectotype and ZF4973, illustrated paralectotype; The Natural History Museum, London.

Description. Test elongated, periphery very much lobulate, slowly increasing in width, somewhat compressed laterally, broadly elliptical in end view, biserial; up to 13 chambers, chambers distinctly inflated, ellipsoid, somewhat longer than high later in ontogeny, frontal overlap covering middle third of the test; sutures distinct, depressed, straight; aperture running from slightly above the basal suture up to the apex of the chamber, broadly elliptical, surrounded by a low thickened apertural lip, top of the toothplate very prominent in the aperture; toothplate large, spine straight, and almost vertical, free border slightly arched, attached border running into the sutural jointure and becoming detached over a short distance just before the foramen, attachment along the peripheral foraminal lip over its entire lenght; wall coarsely perforate; ornamented by low costae, remaining restricted to their respective chamber face, becoming reticulate in the earliest parts of the test.

Remarks. The genus *Pseudobrizalina* is here recognised as distinct from *Sagrinella* on the basis of the important differences in apertural and toothplate morphology. The differences between *S. jugosa* (= *S. guinae*) and *P. lobata* are deemed sufficient to classify them in different subfamilies.

GENUS *Virgulinopsis* HOFKER, 1956

1956 *Virgulinopsis* Hofker: 47.

Type species. Bolivina cubana Bermúdez, 1935, original designation.

Virgulinopsis cubana (Bermúdez, 1935)
Pl. 13, Figs. 1-4

1935 ***Bolivina cubana*** Bermúdez: 196, figs. 2-3.
1937 ***Bolivina cubana*** Bermúdez; Cushman: 152, pl. 18, figs. 4-6.
1956 *Virgulinopsis cubana* (Bermúdez); Hofker: 47, pl. 4, figs. 8-15.

Holotype. No. 11, in the private collection of Bermúdez.

Type locality. Bahia de Matanzas, Rio Bueyvaca, 200 m out to Sea, - 45 m, Cuba; Recent.

Material examined. The Dry Tortugas, Florida, U.S.A.; courtesy P. Hallock Muller.

Description. Test small, elongated, tapering, may be slightly arcuate, gradually and regularly increasing in width, periphery slightly saw-edged, ovate in end view, biserial, usually somewhat twisted; 10 to 12 chambers, chambers ovate, slightly compressed laterally, about as wide as high, frontal overlap considerable, but the height quickly reducing; sutures distinct, depressed, distinctly sigmoid, slightly angular; aperture terminal, loop-shaped, running from the basal suture over the apex of the chamber, bordered by a slightly everted lip, lip curving round the apex of the aperture to turn back and cover the top of the toothplate protruding in the aperture, a narrow sulcus present between the toothplate and apertural border; toothplate an extensive structure, attached border fixed to the chamber wall well away from the foramen, free border distinctly arched, tailing border very large, at first curving downward towards the septum but then rising again to form the back end of a funnel-like collar encasing the foramen, at the apertural side ornamented by numerous slender and high spines; wall hyaline, distinctly perforate; ornamented by a few low costae restricted to their respective chamber face.

GENUS *Virgulopsis* FINLAY, 1939

1939a *Virgulopsis* Finlay: 321.

Type species. Virgulopsis pustulata Finlay, 1939, original designation.

Virgulopsis pustulata Finlay, 1939
Pl. 14, Figs. 5-8

1939a *Virgulopsis pustulata* Finlay: 321, pl. 27, figs. 72-74, 104-106.
1961 ***Bitubulogenerina pustulata*** (Finlay); Hornibrook: 78, pl. 9, figs. 165-166.
1989 *Virgulopsis pustulata* Finlay; Hornibrook, Brazier & Strong: 103, fig. 21/27.

Holotype. TF1127/1, New Zealand Geological Survey.

Type locality. Locality F5273, Kakanui Beach, 10 km SW of Oamaru, South Island, New Zealand; All Day Bay Mudstone, Altonian Stage, Lower Miocene.

Material examined. P47365, P52797 & 98, topotypes donated by N. Hornibrook to The Natural History Museum, London.

Description. Test elongated, sides almost parallel, slightly compressed laterally, periphery flush apart for the ornamentation, broadly elliptical in end view, twisted biserial; around 10 chambers, chambers subspherical, about as wide as high, inflated, frontal overlap almost complete; sutures largely obscured by the ornamentation, depressed, gently arched; aperture running up from the basal suture to the apex of the chamber, lower end of the aperture remaining open, surrounded by a slightly thickened lip, toothplate not apparent in the aperture; toothplate extensive and large, spine gently arched, free border curved into a concave arch, attachment along the foraminal lip, continuous with the attached border which runs along the chamber wall into the sutural jointure; wall coarsely perforate; ornamented by a multitude of low tubercles.

GENERA REMOVED FROM THE BOLIVINITIDAE

FAMILY EOUVIGERINIDAE CUSHMAN, 1927

GENUS *Eouvigerina* CUSHMAN, 1926

1926 *Eouvigerina* Cushman: 4.

Type species. Eouvigerina americana Cushman, 1926, original designation.

Eouvigerina americana Cushman, 1926
Pl. 15, Figs. 1-3

1926 *Eouvigerina americana* Cushman: 4, pl. 1, figs. 1a-c.

Holotype. CC 4986, Smithsonian Institution, Washington, D.C.

Type locality. Clay Pitt, Dallas Brick Co., 1/2 miles West of Mesquite, Texas, U.S.A.; Taylor Marl, Upper Cretaceous.

Material examined. P 39734, P 52799 & 800, Ditch South of McKinney-Formerville Road, 7.2 miles East of Railroad tracks, McKinney, Texas; Lower Taylor, Upper Cretaceous. Donated by J. A. Cushman to the The Natural History Museum, London.

Description. Test elongated, gradually tapering, periphery a zigzag pattern, subrectangular in end view, biserial, later chambers tending towards rectilinearity; 12 chambers, chambers subcubical, about as wide as high, regularly increasing in size, with concave sides and distinct peripheral curved ridges, almost angular; sutures distinct, depressed, gently arched; aperture terminal, produced on a small neck, with a slightly thickened, barely everted lip, toothplate not apparent in the aperture; toothplate elongated, thin, almost symmetrical, spine straight, a straight concavoconvex trough, attachment to the top of the foraminal lip and only slightly protruding into the foraminal opening; wall finely perforate.

GENUS *Tappanina* GALLITELLI, 1956

1955 *Tappanina* Gallitelli: 190, *nomen nudum.*
1956 *Tappanina* Gallitelli: 36.

Type species. Bolivinita selmensis Cushman, 1933, subsequent designation by Gallitelli, 1956.

Tappanina selmensis (Cushman, 1933)
Pl. 15, Figs. 4-7

1933 *Bolivinita selmensis* Cushman: 58, pl. 7, figs. 3-4.
1956 *Tappanina selmensis* (Cushman); Gallitelli: 37, pl. 7, figs. 3-4.

Holotype. CC19043, Smithsonian Institution, Washington, D.C.

Type locality. New Corinth Highway, 13.5 miles South of Selmer, McNairy County, Tennessee, U.S.A; Selma Chalk, Upper Cretaceous.

Material examined. Vincentown, U.S.A.; Palaeocene. Klagsham, Sweden; Danian.

Description. Test elongate, tapering, subquadrangular in end view, periphery distinctly lobulate, apertural end rounded, gradually increasing in size, very regular, biserial; 12 chambers, chambers hemispherical, lateral sides straight, chamber edges somewhat angular and protruding, chambers slightly overhanging each other, central portion of the test concave; sutures distinct, raised, formed by the protruding chamber edges, resulting in a zigzag pattern; aperture narrowly oval, apparently slightly sunken in the apertural face, running up from the basal suture but not reaching the chamber apex, bordered on one side by a low thickened lip, toothplate not apparent in the aperture; toothplate thin, spine straight, free border remaining low, somewhat arched and virtually parallel to the foramen, no tailing border, attachment very short, to the top of the foraminal lip; wall finely perforate.

SUPERFAMILY PAVONINACEA EIMER & FICKERT, 1899

FAMILY LOXOSTOMATIDAE LOEBLICH & TAPPAN, 1962

GENUS *Grimsdaleinella* BOLLI, 1959

1959 *Grimsdaleinella* Bolli: 1.

Type species. Grimsdaleinella spinosa Bolli, 1959, original designation.

Grimsdaleinella spinosa Bolli, 1959
Pl. 16, Figs. 6-9

1959 *Grimsdaleinella spinosa* Bolli: 1, pl. 1, figs. 1-11.
1987 *Grimsdaleinella spinosa* Bolli; Loeblich & Tappan: 499, pl. 549, figs. 6-10.

Holotype. C2519, Natural History Museum, Basel, Switzerland.

Type locality. HGK3725, TLL5719, A loose boulder, Stollmeyer Quarry, Trinidad; Turonian-Coniacian.

Material examined. Paratypes, courtesy H. Bolli.

Description. Test elongated, very much compressed laterally, biserial; 8 chambers, chambers low and elongated, about four to five times as wide as high, the lateral sides projecting backwards, becoming pointed in the process, gradually increasing in size, projections usually arranged on top of each other; sutures distinct, depressed, very much arched; apertural complex not observable due to the preservational state of the available specimens. Toothplate absent, as ascertained by light microscopy in transmitted and polarised light (360 X).

GENUS *Zeauvigerina* FINLAY, 1939

1939b *Zeauvigerina* Finlay: 541.

Type species. Zeauvigerina zelandica Finlay, 1939b, original designation.

Zeauvigerina zelandica Finlay, 1939
Pl. 15, Figs. 8-10

1939b *Zeauvigerina zelandica* Finlay: 541, pl. 69, fig. 4.
1971 *Eouvigerina zelandica* (Finlay); Jenkins: 163, pl. 1, figs. 27-29.
1989 *Zeauvigerina zelandica* Finlay; Hornibrook, Brazier & Strong: 137, figs. 24/16 and 25/11.

Holotype. TF1033/1, New Zealand Geological Survey.

Type locality. Locality 5300, 60 km NE of Dunedin, Moeraki Survey District, New Zealand; Hampden Marl, Upper Bortonian (Upper Middle Eocene).

Material examined. P52801 & 802, topotypes, donated to the The Natural History Museum, London.

Description. Test small, elongate, almost fusiform, gradually increasing in width, irregularly elliptical in end view, periphery barely lobulate, twisted biserial; 10 chambers, chambers subspherical, almost as wide as high, moderately inflated, becoming proportionally higher during ontogeny; sutures indistinct, largely obscured by superficial ornamentation; aperture terminal, produced on a neck with a thickened phialine lip; no toothplate; wall finely perforate; ornamented by a dense layer of very low, almost hispid tubercles.

Remarks. The proposed inclusion of *Zeauvigerina* into the Globigerinacea, as proposed by Hornibrook, Brazier & Strong (1989) is herein rejected. The authors present no evidence for the drastic reclassification of this genus. The morphological features characterising the test of species of *Zeauvigerina* are well known in other benthic taxa and not at all in Recent planktonic forms.

Incertae Sedis

GENUS *Stainforthia* HOFKER, 1956

1956 *Stainforthia* Hofker: 908.

Type species. Virgulina concava Höglund, 1947, original designation.

Stainforthia concava (Höglund, 1947)
Pl. 17, Figs. 1-5

1947 *Virgulina concava* Höglund: 257, pl. 23, figs. 3-4, pl. 32, figs. 4-7, textfigs. 273-275.
1956 *Stainforthia concava* (Höglund); Hofker: 908, pl. 4, figs. 6-7.

Holotype. 2094, Naturhistoriska Riksmuseet, Stockholm, Sweden.

Type locality. 58°16.05'N 11°27.85'E, -47 m, Gullmar Fjord, Sweden; Recent.

Material examined. Læsø, Kattegat, Denmark; courtesy H. J. Hansen.

Description. Test elongate, slightly tapering, irregularly elliptical and well rounded in end view, periphery distinctly lobulate, twisted biserial; 9 chambers, chambers ovate, about twice as high as wide, distinctly inflated, overlap between the chambers usually considerable but variable; sutures distinct, slightly depressed, gently curved; aperture loop-shaped, a very high arch on the axial side of the chamber, bordered at the peripheral side by a clearly raised lip, lip turns at the apex of the aperture and forms the denticulate top of the pseudo-toothplate, leaving a narrow sulcus between itself and the apertural rim; pseudo-toothplate very large, widening rapidly under the aperture, at first with one free border, just above the septum both borders becoming free, gently curved, fusing with the apex of the previous chamber, staying well clear from the foramen, pseudo-toothplate bilamellar throughout; wall hyaline, finely and densely perforate, optically distinctly radial; proloculus may bear a few short small spines.

Remarks. The bilamellar nature of the toothplate-like structure, as revealed by etched sections, prove the term toothplate to be inappropriate. This is further reinforced by the peculiar mode of attachment of the structure to the septum.

GENUS *Francesita* LOEBLICH & TAPPAN, 1963

1963 *Francesita* Loeblich & Tappan: 215.

Type species. Virgulina ? advena Cushman, 1922, original designation.

Francesita advena (Cushman, 1922)
Pl. 17, Figs. 6-10

1922 *Virgulina ? advena* Cushman: 120, pl. 25, figs. 1-3.
1932 *Virgulina advena* Cushman; Cushman: 14, pl. 2, figs. 11a-b.
1937 *Virgulina advena* Cushman; Cushman: 29, pl. 4, fig. 29.
1963 *Francesita advena* (Cushman); Loeblich & Tappan: 215.
1987 *Francesita advena* (Cushman); Loeblich & Tappan: 534, pl. 581, figs. 1-7.

Holotype. USNM16280a, Smithsonian Institution, Washington, D.C.

Type locality. 38°20'00"N 70°08'30"W, 1859 faths., North Atlantic, *Albatross* Station D2713.

Material examined. The holotype, also paratypes USNM16279 and USNM16280.

Description. Test subcylindrical, moderately compressed laterally, at first very rapidly increasing in size, most of the test of equal diameter, well rounded, initial end broadly rounded, periphery lobulate, broadly ovate in end view, twisted biserial; around 8 chambers, chambers ovoid, clearly inflated, about 1.5 to 2 times as high as wide, becoming higher during ontogeny, frontal overlap less than 1/3 of the test width, a marked tendency towards rectilinear arrangment of the chambers in later ontogeny; sutures depressed, not clearly marked, gently arched to sigmoid; aperture terminal, a narrow slit running up from the basal suture over the apex of the chamber down to almost the basal suture again, veering away and curling up into a small incipient spiral, apertural edges rounded, lip not defined, edges of the aperture thickened but well rounded; inside the chamber a slim structure is observed running down along the inside of the outer edge of the aperture, continuing along the lateral chamber wall without expanding into the lumen, reaching the septum and fusing with the top of the previous chamber over a short distance in a rather plump bulge, staying well clear from the foraminal opening; wall shiny, optically granular, smooth, perforate.

Remarks. The incipient toothplate-like structure sets this genus apart from the Caucasininae in which it was classified by Loeblich & Tappan (1987). Although described by these authors as lacking a toothplate, the anatomical details of the aperture point towards a relation with *Stainforthia.* In both genera, the structure is bilamellar throughout, and the structure fuses with the top of the previous chamber, well away from the foramen.

Perhaps other genera also show this remarkable arrangement, which may prompt the creation of a separate supergeneric taxon to accommodate them.

SUBORDER TEXTULARIINA LANKESTER, 1885

Incertae Sedis

GENUS *Tortoplectella* LOEBLICH & TAPPAN, 1985

1985 *Tortoplectella* Loeblich & Tappan: 113.

Type species. Textularia crispata Brady, 1884, original designation.

Tortoplectella crispata (Brady, 1884)
Pl. 16, Figs. 1-5

1884 *Textularia crispata* Brady: 359, pl. 113, fig. 2.
1985 *Tortoplectella crispata* (Brady); Loeblich & Tappan: 113, pl. 1, figs. 1-9.

Lectotype. ZF4974, herein designated, The Natural History Museum, London.

Type locality. Off Raine Island, Torres Strait, *Challenger* Station 185.

Material examined. The type series, The Natural History Museum, London; also specimens from the Andaman Sea, Phuket, Thailand, collections of the Geological Institute, University of Copenhagen.

Description. Test elongated, regularly increasing in width, periphery regularly indented, oral end somewhat truncate, rounded, rhomboidal in end view, biserial, usually slightly twisted; up to 20 chambers, chambers rhomboidal, about twice as long as high, frontal overlap minimal, regularly increasing in size, outer edges slightly thickened, resembling low keels; sutures raised, formed by the slightly thickened chamber edges, slightly arcuate; aperture elliptical, set askew, close to a side edge of the rectangular apertural face, aperture surrounded by a highly raised, periapertural lip; a small plate clinging closely to the lateral wall, running from the aperture to the foraminal lip, constructed of non-mineralised organic material; wall agglutinated, with large agglutinated particles of various origins embedded in a calcitic matrix, non-lamellar, surface irregular, perforate.

ACKNOWLEDGEMENTS

I gratefully acknowledge donations and loans of specimens by J. E. Whittaker, The Natural History Museum, London; A. R. Loeblich, University of California; H. W. Bailey, Palaeo Services, Watford, UK; P. Hallock Muller, University of South Florida; M. A. Buzas, Smithsonian Institution, Washington, D.C.; M. M. Nitecki, Walker Museum, University of Chicago, Chicago; M. del Re, Napoli; M.-T. Vénec-Peyré, Muséum National d'Histoire Naturelle, Paris; P. Strong, New Zealand Geological Survey; H. Bolli, Paläontologisches Institut und Museum, Zürich; L. Witte and R. J. van Leeuwen, Rijksgeologische Dienst, Haarlem; H. J. Hansen, Geologisk Centralinstitut, Copenhagen; R. A. Reyment, Geologiska Institutet, Stockholm; F. Rögl, Naturhistorisches Museum, Wien, and F. Stojaspal, Geologische Bundesanstalt, Wien. I especially thank J. E. Whittaker for many discussions and constructive comments which were a substantial aid during the gestation of this paper.

REFERENCES

Belford, D. J., 1966, Miocene and Pliocene smaller foraminifera from Papua and New Guinea: Bulletin Bureau of Mineral Resources, Geology and Geophysics, v. 79, p. 1-306.

Bermúdez, P. J., 1935, Foraminíferos de la Costa Norte de Cuba: Memorias de la Sociedad Cubana de Historia Natural 'Felipe Poey', v. 9, p. 129-224.

Bermúdez, P. J. and Fuenmayor, A. N., 1966, Consideraciones sobre los sedimentos del Mioceno medio al Reciente de las costas central y oriental de Venezuela. Segunda parte. Los Foraminíferos bentónicos: Boletín de Geología, Venezuela, v. 7, p. 413-611.

Bolli, H. M., 1959, *Grimsdaleinella*, a new genus of the foraminiferal Heterohelicidae: Eclogae Geologicae Helvetiae, v. 52, p. 1-4.

Brady, H. B., 1881, Notes on some of the reticularian Rhizopoda of the *Challenger* Expedition, Part III: Quarterly Journal of Microscopical Sciences, New Series, v. 21, p. 31-71.

—, 1884, Report on the Foraminifera dredged by H.M.S. *Challenger*, during the years 1873-1876: Reports on the Scientific Results of the Voyage of the H.M.S.*Challenger* during the years 1873-1876, Zoology, v. 9, p. 1-814.

Carsey, D. O., 1926, Foraminifera of the Cretaceous of Central Texas: University of Texas Bureau of Economic Geology and Technology Bulletin, v. 2612, p. 1-56.

Costa, O. G., 1856, Paleontologia del regno di Napoli, Parte II: Atti dell' Accademia Pontaniana Napoli, v. 7, p. 113-378.

Cushman, J. A., 1911, A monograph of the Foraminifera of the North Pacific Ocean; Part II - Textulariidae: Bulletin U.S. National Museum, v. 71, p. 1-108.

—, 1922, Shallow-water Foraminifera of the Tortugas region: Publications Carnegie Institution of Washington, v. 17, p. 1-85.

—, 1926, *Eouvigerina*, a new genus from the Cretaceous: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 2, p. 3-6.

—, 1927, An outline of a re-classification of the Foraminifera: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 3, p. 1-105.

—, 1930, On *Uvigerina pigmea* d'Orbigny: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 6, p. 62-63.

—, 1932, Notes on the genus *Virgulina*: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 8, p. 7-23.

—, 1933, New American Cretaceous Foraminifera: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 9, p. 49-64.

—, 1936, New genera and species of the families Verneuillinidae and Valvulinidae and of the subfamily Virgulininae: Cushman Laboratory for Foraminiferal Research, Special Publication, v. 6, p. 1-71.

—, 1937, A monograph of the subfamily Virgulininae of the foraminiferal family Buliminidae: Cushman Laboratory for Foraminiferal Research, Special Publication, v. 9, p. xv + 228.

—, 1948, Foraminifera, their classification and economic use: Harvard University Press, Cambridge, Massachusetts, ix + 535 p.

Cushman, J. A. and Kleinpell, R. M., 1934, New and unrecorded Foraminifera from the California Miocene: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 10, p. 1-23.

Cushman, J. A. and McCulloch, I., 1942, Some Virgulininae in the collections of the Allan Hancock Foundation: Allan Hancock Pacific Expeditions, v. 6, p. 21-28.

Cžjžek, J., 1848, Beitrag zur Kenntniss der fossilen Foraminiferen des wiener Beckens: Naturwissenschaftlige Abhandlungen Wien, v. 2, p. 137-150.

d'Orbigny, A., 1826, Tableau méthodique de la classe des Céphalopodes: Annales des Sciences Naturelles, v. 7, p. 245-314.

—, 1839a, Foraminifères *in* Ramon de la Sagra. Histoire physique, politique et naturelle de l'ile de Cuba. Bertrand, Paris, p. xlviii + 224 p.

—, 1839b, Voyage dans l'Amérique méridionale-Foraminifères: Bertrand, Paris, 86 p.

—, 1846, Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche): Gide et Comp., Paris, 312 p.

Eimer, G. H. and Fickert, C., 1899, Die Artbildung und Verwandtschaft bei den Foraminiferen. Entwurf einer natürlichen Eintheilung derselben: Zeitschrift für Wissenschaftliche Zoologie, v. 65, p. 527-636.

Finlay, H. J., 1939a, New Zealand Foraminifera: Key species in stratigraphy-No. 3: Transactions Royal Society of New Zealand, Geology, v. 69, p. 309-329.

—, 1939b, New Zealand Foraminifera: The occurrence of *Rzehakina, Rotaliatina*, and *Zeauvigerina*: Transactions Royal Society of New Zealand, Geology, v. 68, p. 504-543.

Gallitelli, M. E., 1955, Foraminiferi Cretacei delle marna a fucoidi di Serramazzoni (Appennino Modenese): Atti e Memorie Accademia di Scienze, Lettere e d Arti, Modena, v. 13, p. 175-204.

—, 1956, *Bronnimannella, Tappanina* and *Trachelinella*, three foraminiferal genera from the Upper Cretaceous: Contributions from the Cushman Foundation for Foraminiferal Research, v. 7, p. 35-39.

Galloway, J. J., 1933, A manual of Foraminifera: Principia Press, Bloomington, Indiana, xii + 483 p.

Galloway, J. J. and Morrey, M., 1929, A lower Tertiary foraminiferal fauna from Manta, Ecuador: Bulletin American Paleontology, v. 15, p. 1-56.

Galloway, J. J. and Wissler, S. G., 1927, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journal of Paleontology, v. 1, p. 35-87.

Glaessner, M. F., 1936, Die Foraminiferengattungen *Pseudotextularia* und *Amphimorphina*: Problemy Paleontologii, Paleontologicheskaya Laboratoriya Moskovskogo Gosudartvennogo Universiteta, v. 1, p. 95-134.

—, 1937, Die Entfaltung der Foraminiferenfamilie Buliminidae: Problemy Paleontologii, Paleontologicheskaya Laboratoriya Moskovskogo Gosudartvennogo Universiteta, v. 2-3, p. 411-422.

Haman, D., 1984, *Saidovina*, new name for *Loxostomina* Saidova, 1975 (non Sellier de Civrieux, 1968) and the status of *Loxostomella* Saidova, 1975 (Foraminiferida): Proceedings of the Biological Society of Washington, v. 97, p. 419.

Hansen, H. J. and Lykke Andersen, A., 1976, Wall structure and classification of fossil and recent elphidiid and nonionid foraminifera: Fossils and Strata, v. 10, p. 1-37.

Hasson, P. F. and Fischer, A. G., 1986, Observations on the Neogene of northwestern Ecuador: Micropaleontology, v. 32, p. 32-42.

Haynes, J. R., 1973, Cardigan Bay Recent Foraminifera (Cruises of the R.V. *Antur*, 1962-1964): Bulletin The Natural History Museum, Zoology Series, v. 4, p. 1-245.

—, 1981, Foraminifera: MacMillan Publishers, London, xii + 433 p.

—, 1990, The classification of the Foraminifera-A review of historical and philosophical perspectives: Palaeontology, v. 33, p. 503-528.

Höglund, H., 1947, Foraminifera in the Gullmar Fjord and the Skagerak: Zoologiska Bidrag från Uppsala, v. 26, p. 1-328.

Hofker, J., 1951, The Foraminifera of the Siboga Expedition. Part III. Ordo Dentata, subordines Protoforaminata, Biforaminata, Deuteroforaminata: Brill, Leiden, 513 p.

—, 1953, Types of genera described in part III of the "Siboga Foraminifera": Micropaleontologist, v. 7, p. 26-28.

—, 1956, Foraminifera Dentata: Foraminifera of Santa Cruz and Thatch Island, Virginia Archipelago, West Indies: Spolia Zoologica Musei Hauniensis, v. 15, p. 1-237.

Hornibrook, N. de B., 1961, Tertiary Foraminifera from the Oamaru district (N.Z.), Part 1-Systematics and distribution: Paleontological Bulletin, Wellington, v. 34, p. 1-192.

Hornibrook, N. de B., Brazier, R. C. and Strong, C. P., 1989, Manual of New Zealand Permian to Pleistocene foraminiferal biostratigraphy: New Zealand Geological Survey Paleontological Bulletin, v. 56, p. 1-175.

Howe, H. V., 1930, Distinctive new species of Foraminifera from the Oligocene of Mississippi: Journal of Paleontology, v. 4, p. 327-331.

Jenkins, D. G., 1971, New Zealand Cenozoic planktonic Foraminifera: Paleontological Bulletin, Wellington, v. 42, p. 1-278.

Jones, T. R., 1875, *in* Griffith, J. W. and Henfrey, A. The micrographic dictionary. Van Voorst, London, p. 316-320.

Kleinpell, R. M., 1938, Miocene stratigraphy of California: American Association of Petroleum Geologists, Tulsa, 450 p.

Kleinpell, R. M. and Tipton, A., 1980, Taxonomy *in* Kleinpell, R. M. and others. The Miocene stratigraphy of California revisited. Studies in Geology, American Association Petroleum Geologists, Tulsa, p. 70-80

Lankester, E. R., 1885, Protozoa *in* Encyclopedia Britannica. p. 830-866

Le Calvez, Y., 1977, Foraminifères de l'ile de Cuba - Tome 2: Cahiers de Micropaléontologie, v. 2, p. 1-131.

Loeblich, A. R. and Tappan, H., 1957, Eleven new genera of Foraminifera: Bulletin U.S. National Museum, v. 215, p. 223-232.

—, 1961, Suprageneric classification of the Rhizopodea: Journal of Paleontology, v. 35, p. 245-330.

—, 1962, Six new generic names in the Mycetozoida (Trichiidae) and Foraminiferida (Fischerinidae, Buliminidae, Caucasinidae and Pleurostomellidae), and a redescription of *Loxostomum* (Loxostomidae, new family): Proceedings of the Biological Society of Washington, v. 75, p. 107-113.

—, 1963, Four new Recent genera of Foraminiferida: Journal of Protozoology, v. 10, p. 212-215.

—, 1964, Sarcodina, chiefly "Thecamoebians" and Foraminiferida, *in* Moore, R. C. (ed.), Treatise on invertebrate paleontology: University of Kansas Press, Kansas, 900 p.

—, 1984, Suprageneric classification of the Foraminiferida (Protozoa): Micropaleontology, v. 30, p. 1-70.

—, 1985, *Tortoplectella*, a new calcareous biserial foraminiferal genus: Journal of Foraminiferal Research, v. 15, p. 111-113.

—, 1987, Foraminiferal Genera and their Classification: Van Nostrand Reinhold, New York, x + 970, viii + 1059 p.

—, 1994, Foraminifera of the Sahul Shelf and Timor Sea: Cushman Foundation for Foraminiferal Research, Special Publication, v. 31, 661 p.

Marsson, T., 1878, Die Foraminiferen der weissen Schreibkreide der Inseln Rügen: Mitteilungen des naturwissenschaftlichen Vereins Neu-Vorpommeren und Rügen in Greifswald, v. 10, p. 115-196.

McCulloch, I., 1977, Qualitative observations on Recent foraminiferal tests with emphasis on the Eastern Pacific: University of Southern California, Los Angeles, vi + 1079 p.

Millett, F. W., 1900, Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S. - Part IX: Journal of the Royal Microscopical Society, p. 539-549.

—, 1903, Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S. - Part XIV: Journal of the Royal Microscopical Society, p. 253-275.

Nuttall, W. L. F., 1930, Eocene Foraminifera from Mexico: Journal of Paleontology, v. 4, p. 271-293.

Parker, W. K., Jones, T. R. and Brady, H. B., 1865, On the nomenclature of the Foraminifera. Part XII. The species enumerated by d'Orbigny in the "Annales des Sciences Naturelles" vol. vii. 1826: Annals and Magazine of Natural History, v. 16, p. 15-41.

Plummer, H. J., 1926, Foraminifera of the Midway Formation in Texas: University of Texas Bureau of Economic Geology and Technology Bulletin, v. 2644, p. 1-206.

—, 1932, Some Cretaceous Foraminifera in Texas: University of Texas Bulletin, v. 3103, p. 109-203.

Reiss, Z., 1957, Notes on Foraminifera from Israel: Bulletin of the Geological Survey of Israel, v. 9, p. 1-7.

Resig, J. M., 1992, *Parabolivina peruensis*, a new oxygen minimum foraminifer from the Peru Margin: Journal of Foraminiferal Research, v. 22, p. 30-33.

Reuss, A. E., 1846, Die Versteinerungen der böhmischen Kreideformation: E. Schweizerbart, Stuttgart, iv + 148 p.

Revets, S. A., 1989, Structure and comparative anatomy of the toothplate in the Buliminacea (Foraminiferida): Journal of Micropalaeontology, v. 8, p. 23-36.

—, 1991a, The generic revision of the Reussellids (Foraminiferida): Journal of Micropalaeontology, v. 9, p. 71-84.

—, 1991b, The nature of *Virgulinella* Cushman, 1932 and the implications for its classification: Journal of Foraminiferal Research, v. 21, p. 293-298.

—, 1991c, Revision of the genus *Valvobifarina* Hofker, 1951 (Foraminiferida): Journal of Micropalaeontology, v. 10, p. 115-119.

—, 1994, *Fursenkoina* Loeblich & Tappan, 1961 (Protoctista; Foraminiferida): proposed conservation: Bulletin of Zoological Nomenclature, v. 51, p. 98-101.

—, 1995, Comments on the proposed conservation of *Fursenkoina* Loeblich & Tappan, 1961 (Foraminiferida): Bulletin of Zoological Nomenclature, v. 52, p. 175-176.

REYMENT, R. A., 1959, The foraminiferal genera *Afrobolivina* gen. nov. and *Bolivina* in the Upper Cretaceous and lower Tertiary of West Africa: Stockholm Contributions in Geology, v. 3, p. 1-57.

—, 1983, Internal structure of *Bolivina* and *Afrobolivina*: Micropaleontology, v. 29, p. 50-59.

SAIDOVA, K. M., 1975, Bentosnye Foraminifery Tikhogo Okeana: Institut Okeanologii Moskva, Akademiya Nauk SSSR, Moskva, 875 p.

—, 1981, O sovromennom sostoyanii sistemy nadvidovyk taksonov Kaynozoyskikh bentosnykh foraminifer: Institut Okeanologii Moskva, Akademiya Nauk SSSR, Moskva, 73 p.

SCHWAGER, C., 1866, Fossile Foraminiferen von Kar Nikobar, Reise der österreichischen Fregatte *Novara* um Erde in den Jahren 1857-1859: Paläontologische Mitteilungen, v. 2, p. 187-268.

SCOTT, G. H., 1977, Toothplate cavity in *Bolivinita*: Revista Española de Micropaleontologia, v. 9, p. 337-341.

—, 1978, Shell design in *Bolivinita quadrilatera, B. pohana*, and *B. compressa* (Foraminiferida): New Zealand Journal of Geology and Geophysics, v. 21, p. 85-95.

SELLIER DE CIVRIEUX, J. M., 1969, Cuatro generos nuevos de Foraminíferos del Mare Caribe: Boletin del Instituto Oceanografico, Universidad de Oriente, v. 7, p. 149-193.

SGARELLA, F., 1992, Revision of *Brizalina aenariensis* Costa, 1856: Bollettino della Societa Paleontologica Italiana, v. 31, p. 317-323.

SRINIVASAN, M. S., 1966, Descriptions of new species and notes on taxonomy of foraminifera from the Upper Eocene and lower Oligocene of New Zealand: Transactions Royal Society of New Zealand, Geology, v. 3, p. 231-256.

SRINIVASAN, M. S. and SHARMA, V., 1980, Schwager's Car Nicobar Foraminifera in the Reports of the *Novara* Expedition-A revision: Today & Tomorrow's Printers and Publishers, New Dehli, 83 p.

TEN DAM, A. and REINHOLD, T., 1942, Die stratigraphische Gliederung des niederländischen Oligo-Miozäns nach Foraminiferen [mit Ausnahme von S. Limburg]: Mededeelingen van de Geologische Stichting, v. C-V-2, p. 1-106.

WHITTAKER, J. E., 1988, Benthic Cenozoic Foraminifera from Ecuador: The Natural History Museum, London, xi + 194 p.

ZWEIG-STRYKOWSKI, M. and REISS, Z., 1975, Bolivinitidae from the Gulf of Elat: Israel Journal of Earth Sciences, v. 24, p. 97-111.

PLATE 1

Bolivinita quadrilatera (Schwager, 1866). BMNH P52793 and P52804, topotypes. Kar Nicobar, Indian Ocean; Upper Miocene.
1 Habitus (250 μm).
2 Close-up of the aperture (25 μm).
3 Stereopair of an opened specimen (250 μm).
4 Close-up of successive toothplates (50 μm).

Bolivina plicata d'Orbigny, 1839. MNHN Neotype (F61753) and topotype (F61754). Off Valparaiso, Chile; Recent.
5 Habitus neotype (250 μm).
6 Aperture neotype, partially broken but showing remnants of the toothplate (50 μm).
7 Stereopair of an opened topotype (250 μm).
8 Close-up of the relation between toothplate, foramen and foraminal toothplate (25 μm).

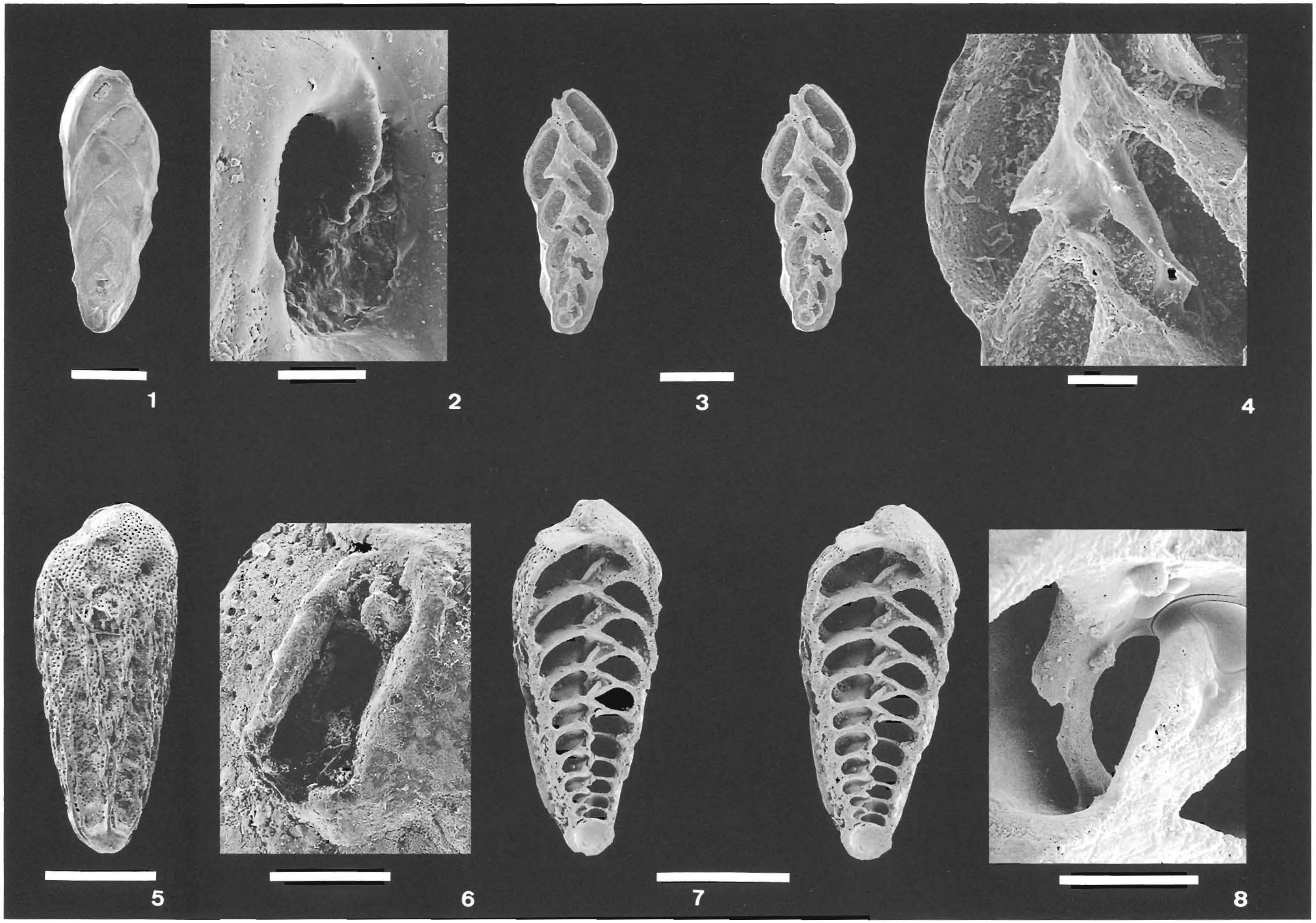
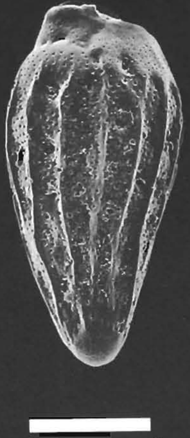

1
2
3
4
5
6
7
8

PLATE 2

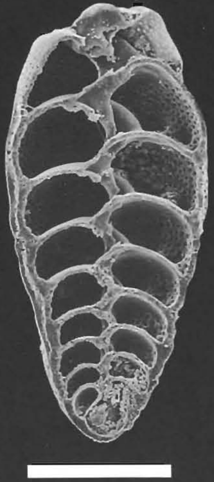
Bolivina costata d'Orbigny, 1839. BMNH ZF5057 and ZF5058, topotypes. Paita, Peru; Recent. Heron-Allen & Earland collection, ex d'Orbigny.
1 Habitus (100 μm).
2 Opened specimen, showing the toothplates and the relation to the foramina (100 μm).
3 Close-up of the aperture (25 μm).

Bolivina sinuata Galloway & Wissler, 1927. BMNH PF53038. Malaga Cove, California; Upper Pliocene.
4 Habitus (250 μm).
5 Close-up of the aperture (25 μm).

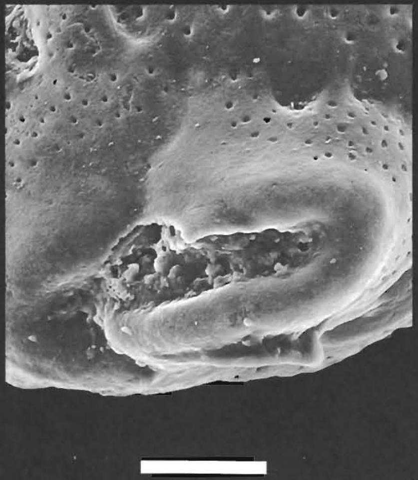
Bolivina streptos Hasson, 1986. BMNH ZF5045-5047. Gulf of Panama; Recent.
6 Habitus of microspheric specimen (250 μm).
7 Close-up of the aperture (25 μm).
8 Habitus of megalospheric specimen (250 μm).
9 Stereopair of an opened specimen (250 μm).



1



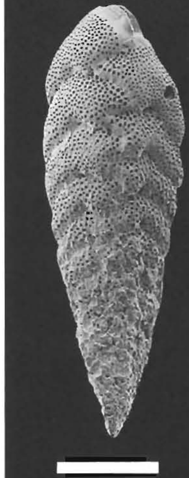
2



3

4

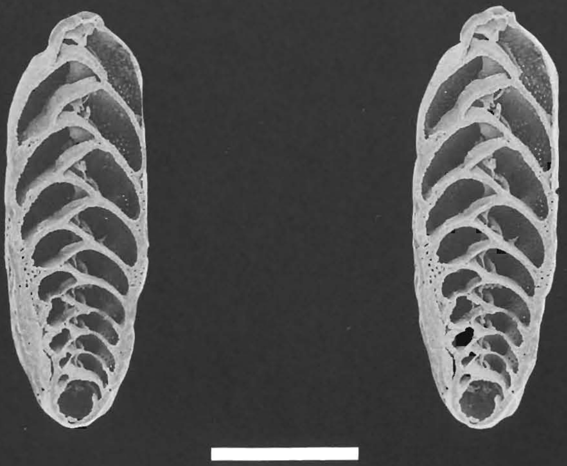
5



6

7

8



9

PLATE 3

Bolivina anastomosa Finlay, 1939. BMNH P52794 and P52795. Ruatoria, New Zealand; Miocene.
1 Habitus (250 μm).
2 Close-up of the aperture (50 μm).
3 Stereopair of an opened specimen (250 μm).
4 Close-up of a toothplate and the attachment to the foramen (25 μm).

Afrobolivina afra Reyment, 1959. BMNH PF53039-41, topotypes. Gbekebo Borehole, Nigeria; Upper Maastrichtian.
5 Habitus microspheric specimen (500 μm).
6 Habitus megalospheric specimen (250 μm).
7 Stereopair of an opened specimen (200 μm).
8 Close-up of foramina with toothplates. Note also the "keels" (50 μm).

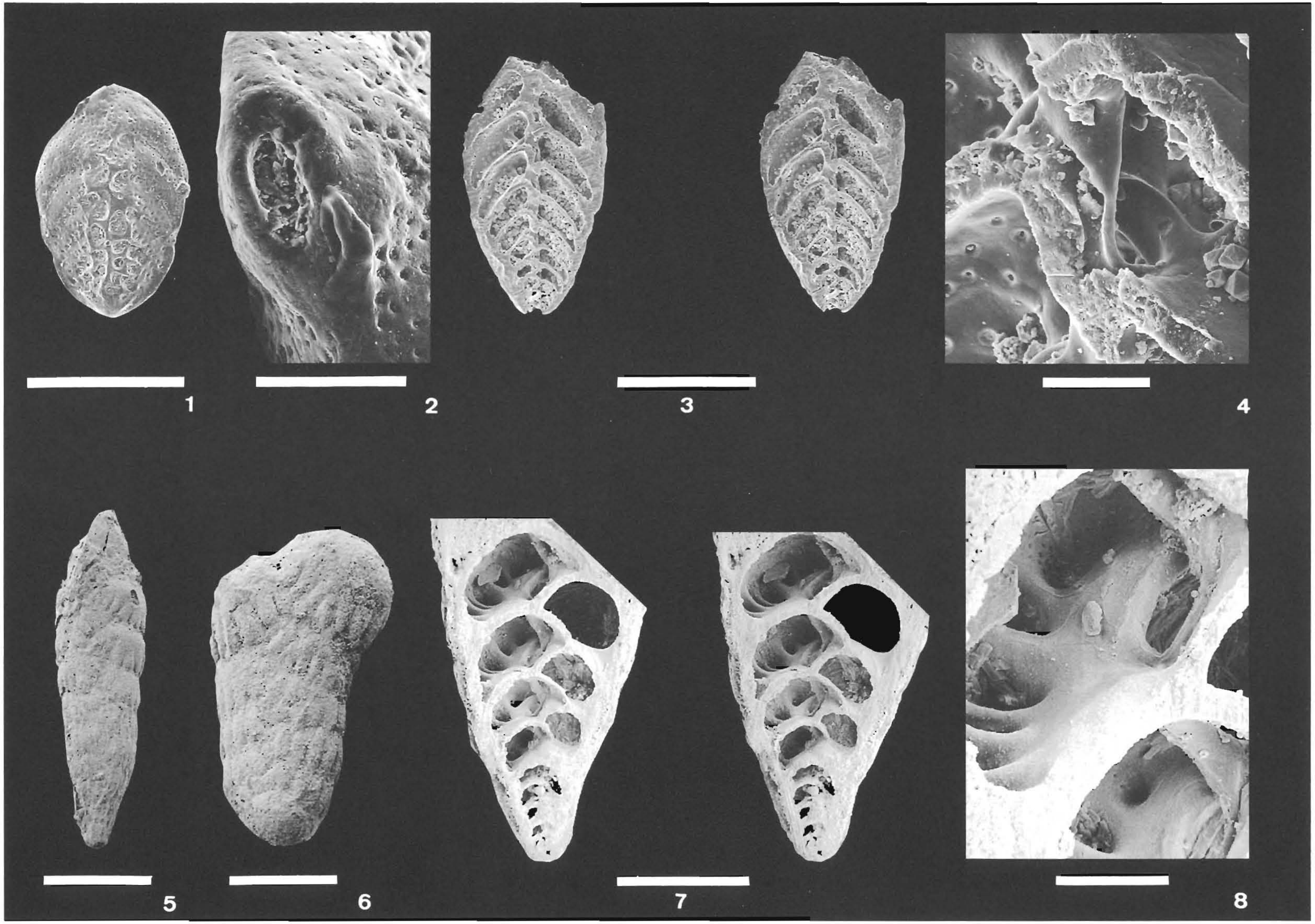

1
2
3
4
5
6
7
8

PLATE 4

Bolivinoides draco (Marsson, 1878). BMNH PF53042-43. Valhall Field, Block 2/8, North Sea; Upper Maastrichtian.
1 Habitus (250 μm).
2 Close-up of the aperture (25 μm).
3- 4 Stereopair of an opened specimen (250 μm).

Brizalina aenariensis Costa, 1856. BMNH PF53044-45. Piani di S. Paolo, Isola d'Ischia; Pleistocene.
5 Habitus (250 μm).
6 Close-up of the aperture, with the distinctly serrated upper edge of the toothplate protruding (25 μm).
7 Stereopair of an opened specimen (250 μm).
8 Close-up of the toothplate from the back, with the attachment laterally to the foramen (25 μm).

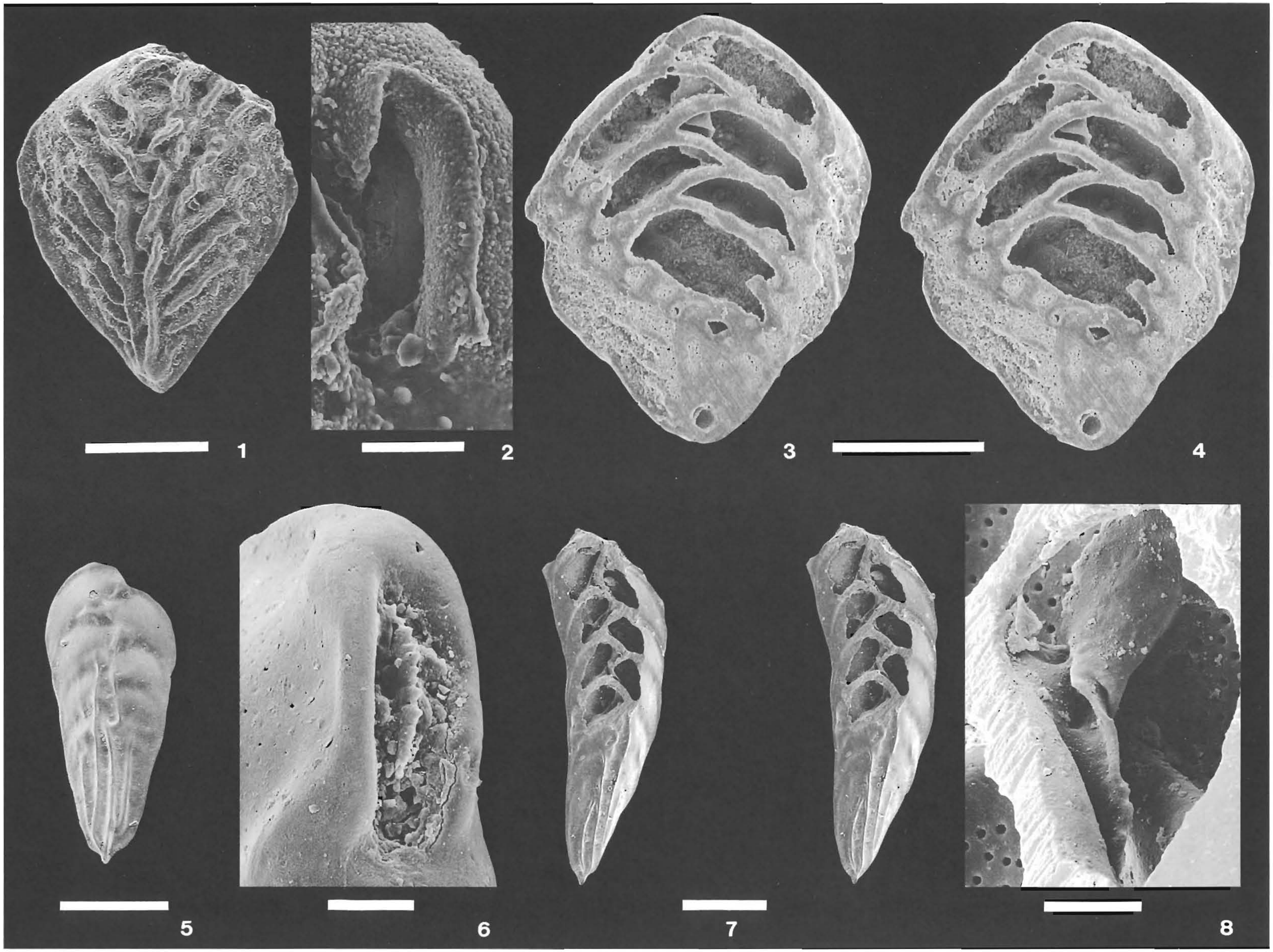

1
2
3
4
5
6
7
8

PLATE 5

Coryphostoma plaitum (Carsey,1926). BMNH PF53046-47, topotypes. Jones' Crossing, Onion Creek, Texas; Maastrichtian.
1 Habitus (250 μm).
2 Close-up of the aperture (25 μm).
3 Stereo-pair of an opened specimen (250 μm).
4 Close-up of two successive toothplates (25 μm).

Loxostomoides applinae (Plummer, 1926). BMNH PF53048-49, topotypes. Mexia Brickworks, Mexia, Texas; Palaeocene.
5 Habitus (250 μm).
6 Close-up of the aperture (25 μm).
7 Stereopair of an opened specimen (250 μm).
8 Close-up of the attachment of the toothplate to the foramen (25 μm).

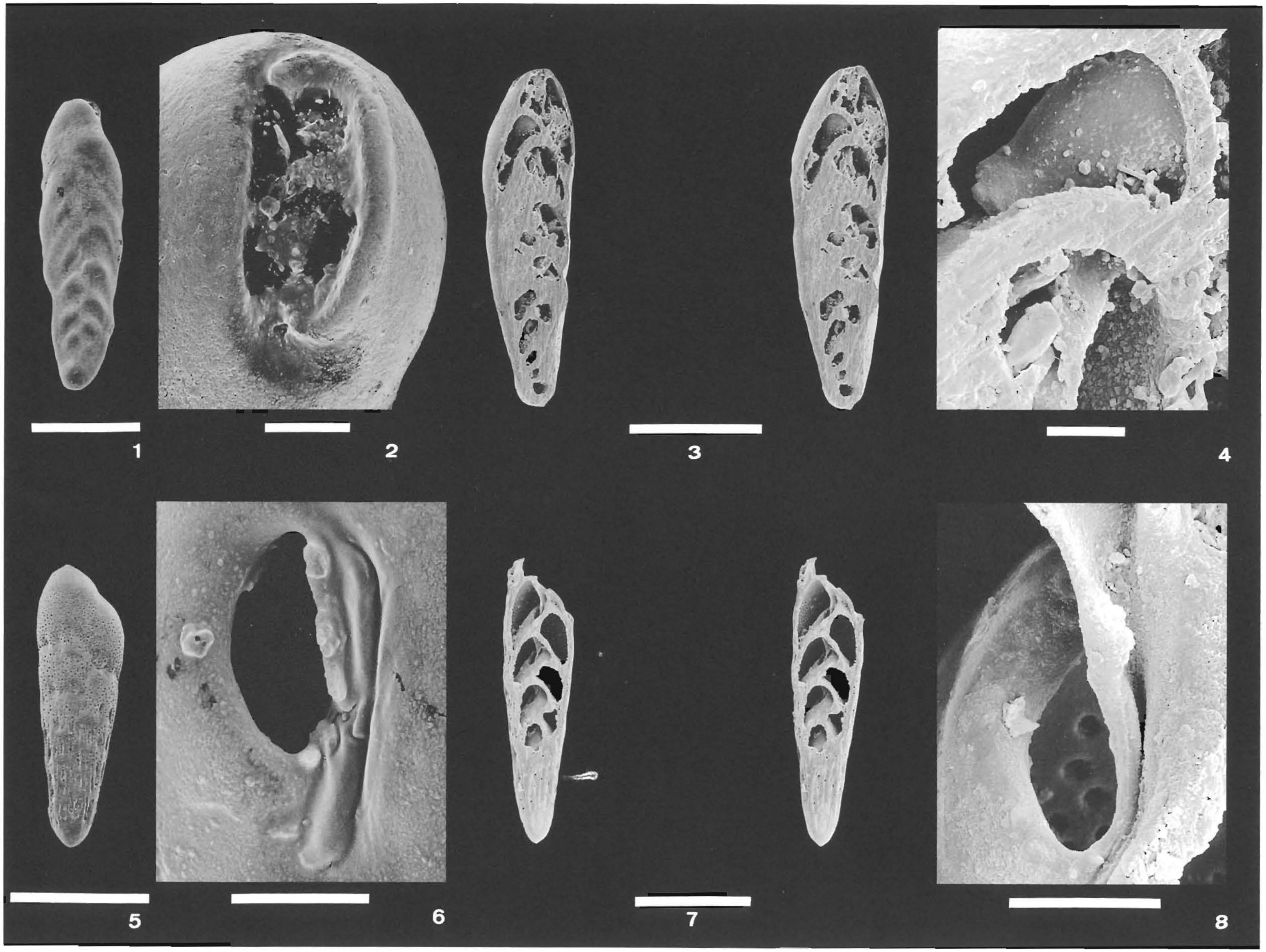

1
2
3
4
5
6
7
8

PLATE 6

Lugdunum hantkenianum (Brady, 1881). BMNH ZF4962, lectotype & ZF4963, paralectotype. Off Papeete, Tahiti; Recent.
1 Habitus lectotype (250 μm).
2 Aperture lectotype (100 μm).
3 Stereopair of an opened paralectotype (250 μm).
4 Oblique close-up of a toothplate fusing in the foramen (25 μm).

Sagrinella jugosa (Brady, 1884). BMNH ZF2454, lectotype & ZF4965, paralectotype. Off Raine Island; Recent.
5 Habitus lectotype (100 μm).
6 Frontal view with the aperture (100 μm).
7 Stereopair of an opened paralectotype (100 μm).
8 Close-up of the 2 final toothplates (25 μm).

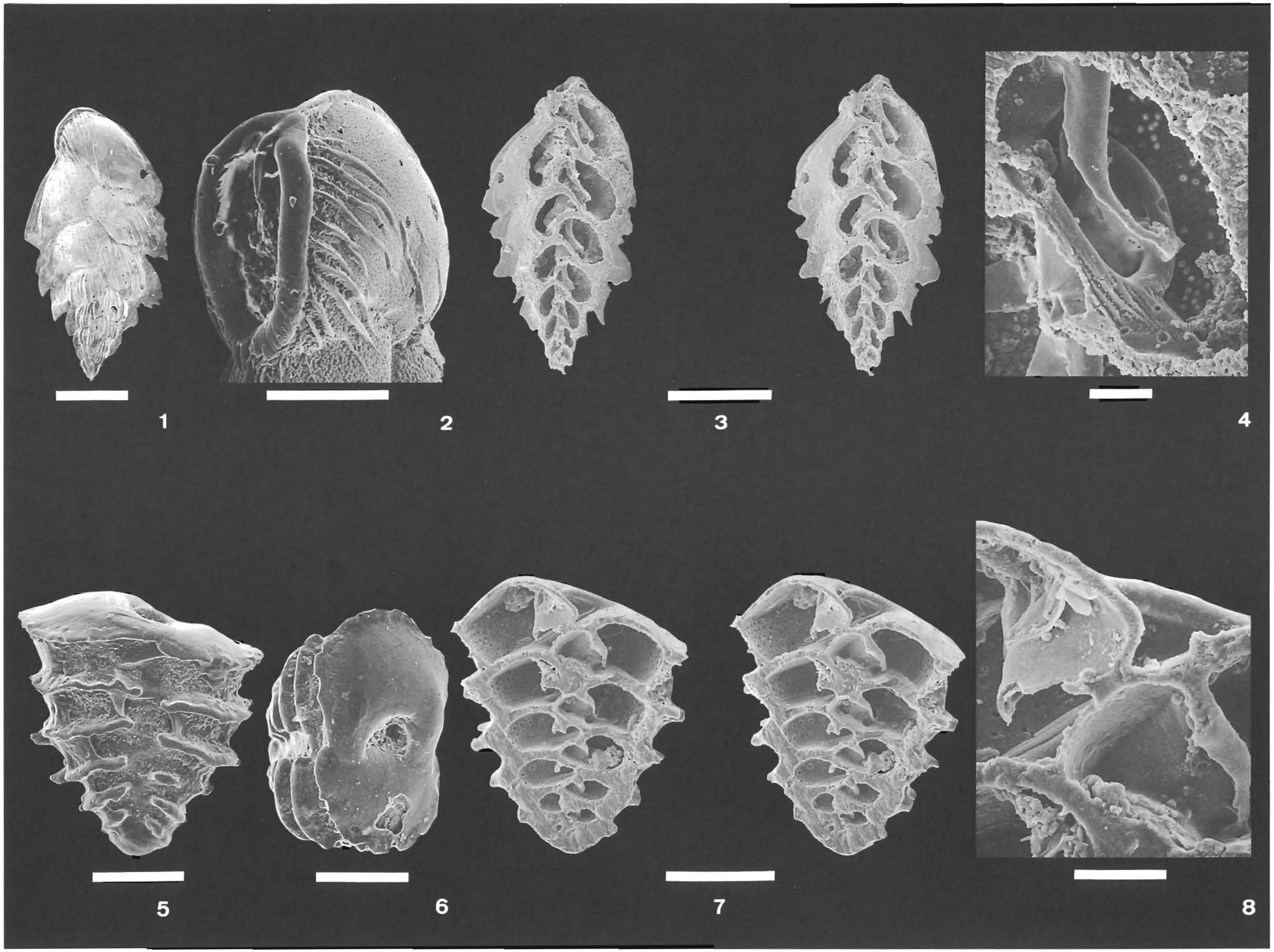

1
2
3
4
5
6
7
8

PLATE 7

Saidovina karreriana (Brady, 1881). BMNH ZF4966, lectotype & ZF4967, paralectotype. Pacific Ocean, South of Japan; Recent.
1 Habitus lectotype (250 μm).
2 Aperture lectotype (50 μm).
3 Stereopair of an opened paralectotype (250 μm).
4 Oblique close-up from below of a toothplate, showing the relation to the aperture and foramen (25 μm).

Sigmavirgulina tortuosa (Brady, 1881). BMNH ZF4968, lectotype & ZF4969, paralectotype. Nares Harbour, Admirality Islands; Recent.
5 Habitus lectotype (100 μm).
6 Aperture lectotype (25 μm).
7 Stereopair of an opened paralectotype (100 μm).
8 Close-up of two successive toothplates and their relation to the foramen (25 μm).

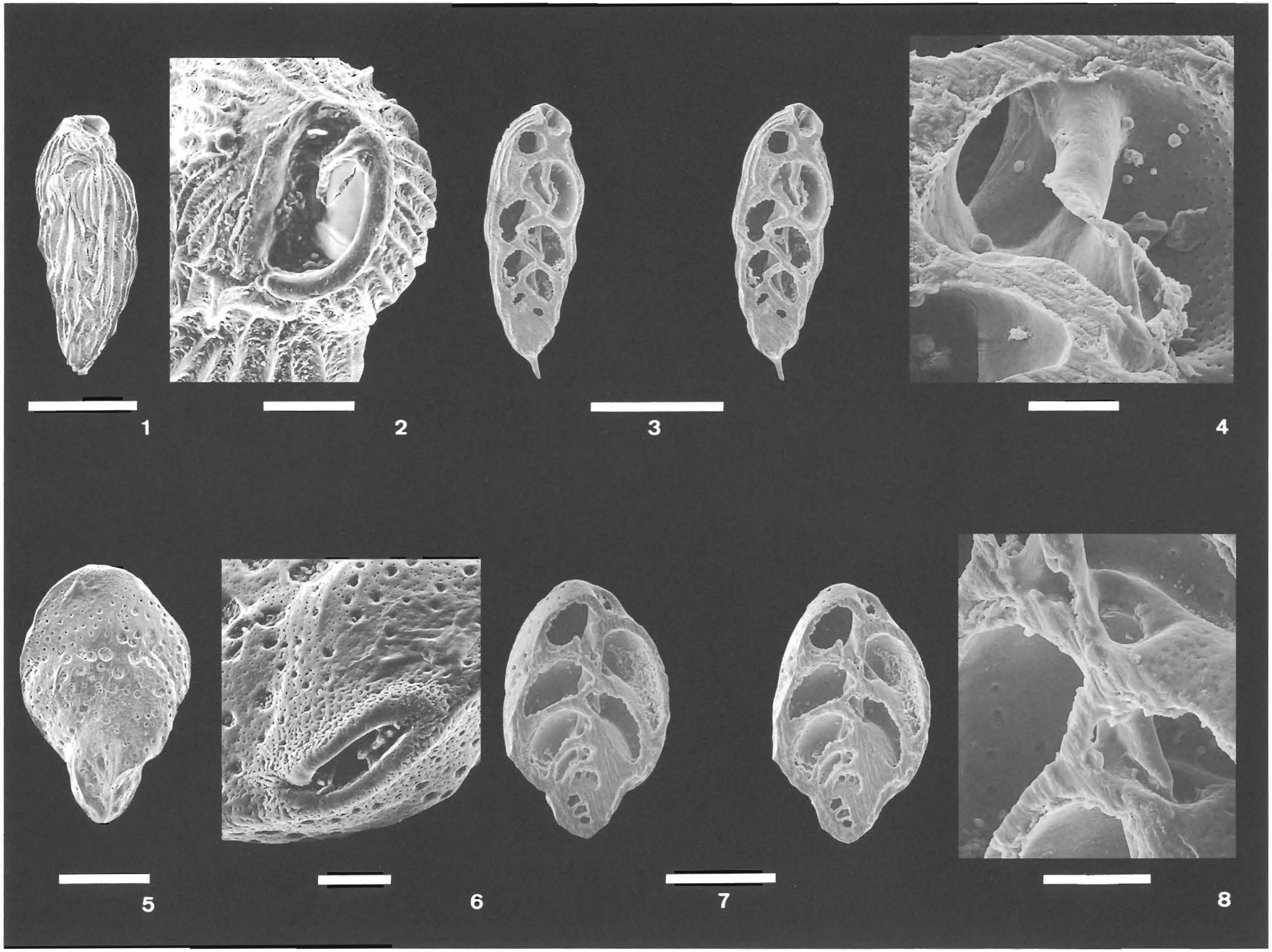

1
2
3
4
5
6
7
8

PLATE 8

Fursenkoina squammosa (d'Orbigny, 1826). BMNH P52796, neotype & topotype. Cava Semplice, Siena; Upper Pliocene.
1 Habitus neotype (250 μm).
2 Aperture neotype (50 μm).
3 Stereopair of an opened topotype (250 μm).
4 Close-up of a toothplate and the attachment site along the foramen (25 μm).

Fursenkoina schreibersiana (Cžjžek, 1848). BMNH PF53051-52, topotypes. Baden, near Vienna; Miocene.
5 Habitus (250 μm).
6 Close-up of the aperture (50 μm).
7 Stereopair of an opened specimen (250 μm).
8 Close-up of a toothplate and the corresponding foramen (25 μm).

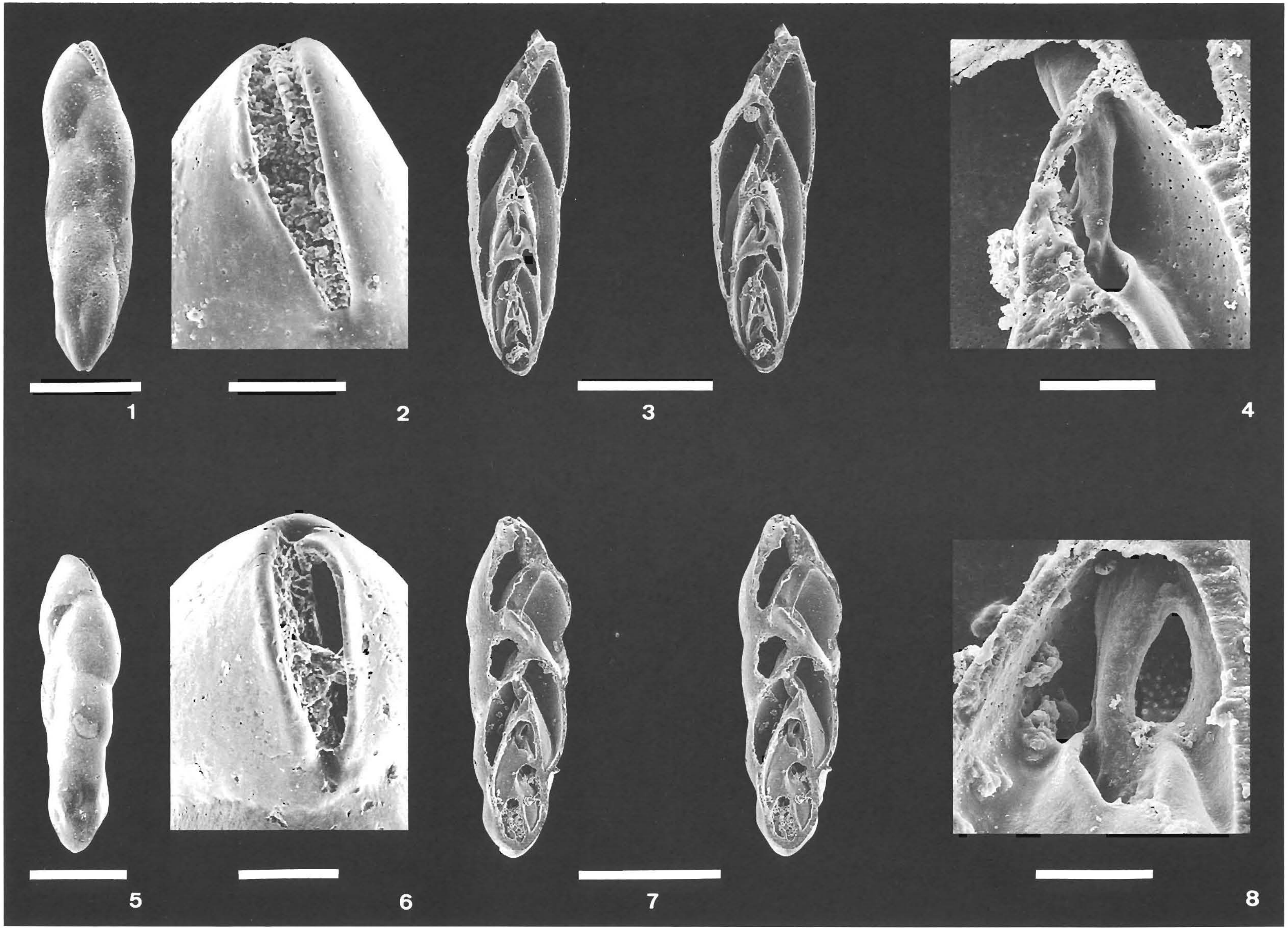

1
2
3
4
5
6
7
8

PLATE 9

Fursenkoina oligocenica (Hofker, 1951). RGDH MK91001, lectotype & paralectotype. Belfield Drilling Db14; Oligocene.
1 Habitus lectotype (250 μm).
2 Aperture lectotype (25 μm).
3 Habitus broken paralectotype (250 μm).
4 Close-up of a foramen with the attachment of a toothplate (25 μm).

Virgulina tegulata Reuss, 1846. BMNH PF53053-57, topotypes. Kystra, Bohemia, Czech Republic; Turonian.
5-7 Habitus, showing the intially twisted nature of the test (250 μm).
8 Close-up of the foraminal region (25 μm).
9 Habitus (250 μm).
10 Habitus (100 μm)

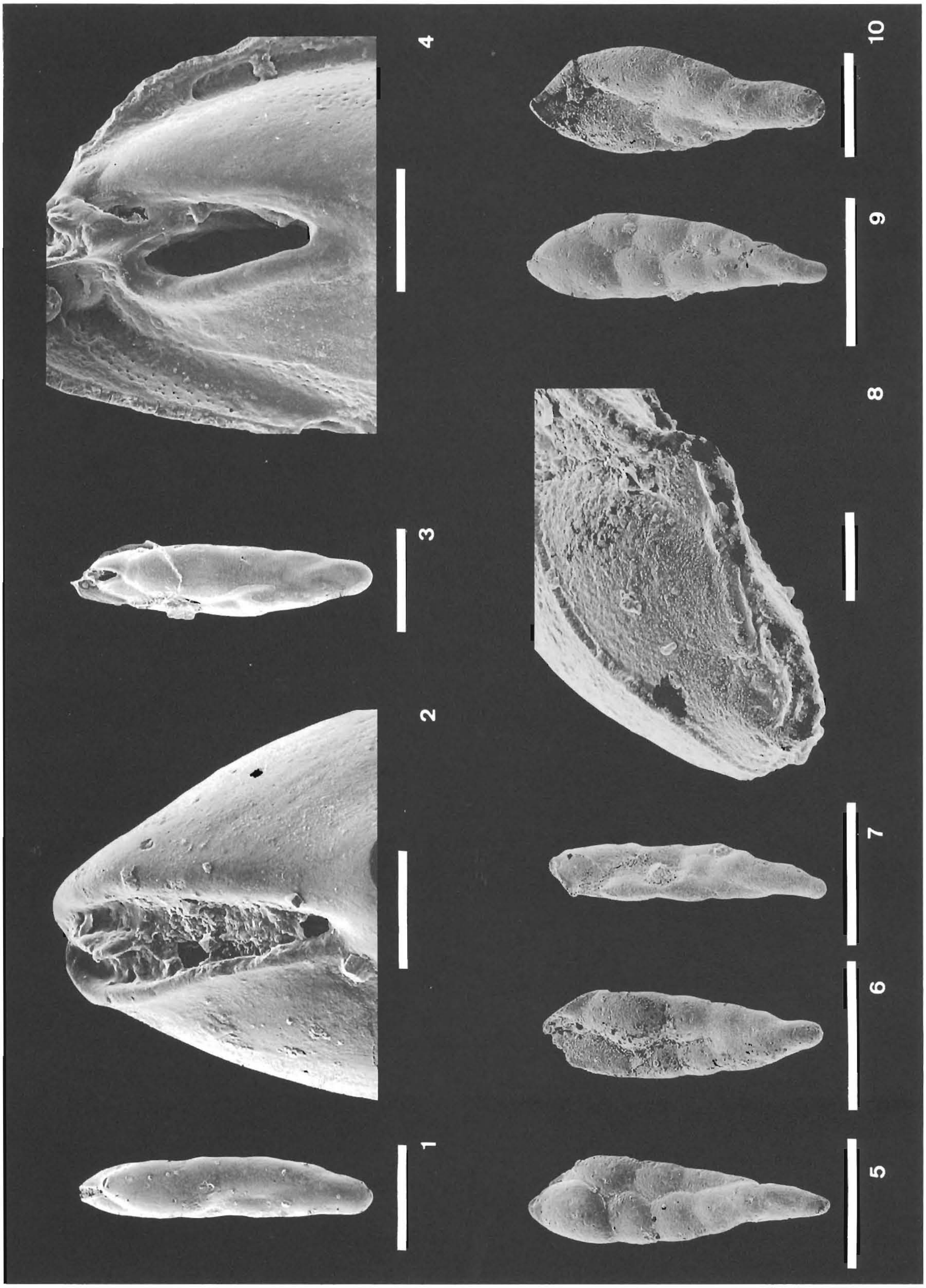
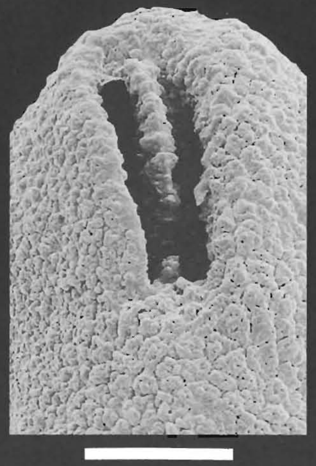

1
2
3
4
5
6
7
8
9
10

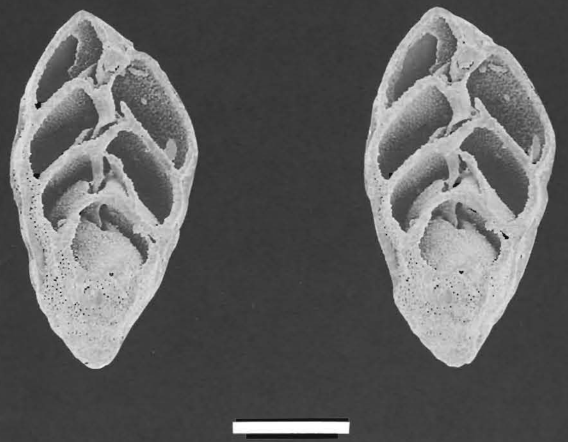
PLATE 10

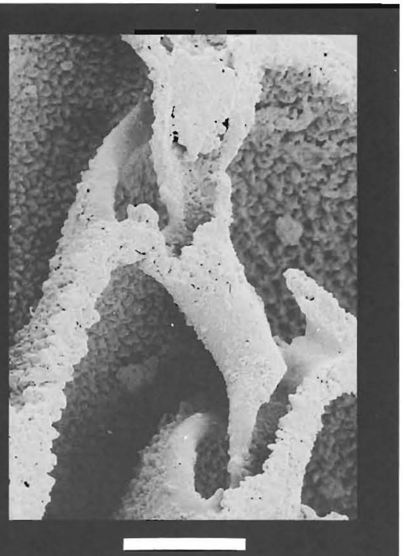
Galliherina uvigerinaformis (Cushman & Kleinpell, 1934). BMNH PF53058-59. Newport Beach, California; Miocene.
1 Habitus (100 μm).
2 Close-upof the aperture, with the top of the toothplate prominent (25 μm).
3 Stereopair of an opened specimen (100 μm).
4 Close-up of two successive toothplates, slightly oblique from above (25 μm).

Hopkinsinella glabra (Millett, 1903). BMNH 1955:11:1:5006, lectotype & 5007 paralectotype. Station 12, Malay Archipelago; Recent.
5 Habitus lectotype (100 μm).
6 Aperture lectotype (25 μm).
7 Stereopair of an opened paralectotype (100 μm).
8 Close-up of a toothplate from behind. Note also the triangular upwards projecting piece (25 μm).


1

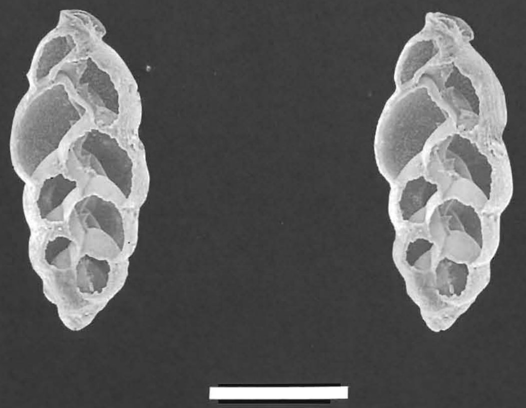

2


3


4


5


6


7

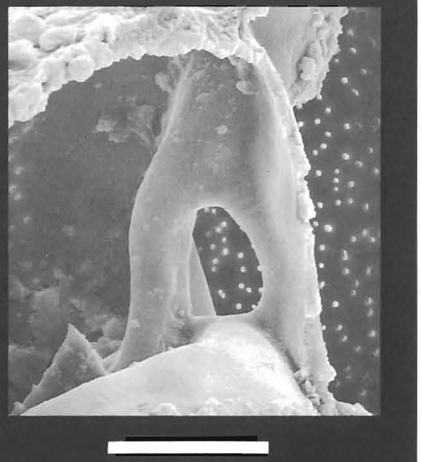

8

PLATE 11

Parabrizalina porrecta (Brady, 1881). BMNH ZF4970, lectotype & ZF4971, paralectotype. Off Culebra Island, West Indies; Recent.
1 Habitus lectotype (250 μm).
2 Aperture lectotype (100 μm).
3 Stereopair of an opened paralectotype (250 μm).
4 Close-up of an early toothplate, distinctly asymmetric (25 μm).

Euloxostoma instabile (Cushman & McCulloch, 1942). BMNH ZF5048-49. Gulf of Panama; Recent.
5 Habitus (250 μm).
6 Close-up of the aperture, with the smooth upper edge of the toothplate protruding (50 μm).
7 Stereopair of an opened specimen (250 μm).
8 Close-up of a toothplate and foramen. Note the two free borders on the toothplate (25 μm).

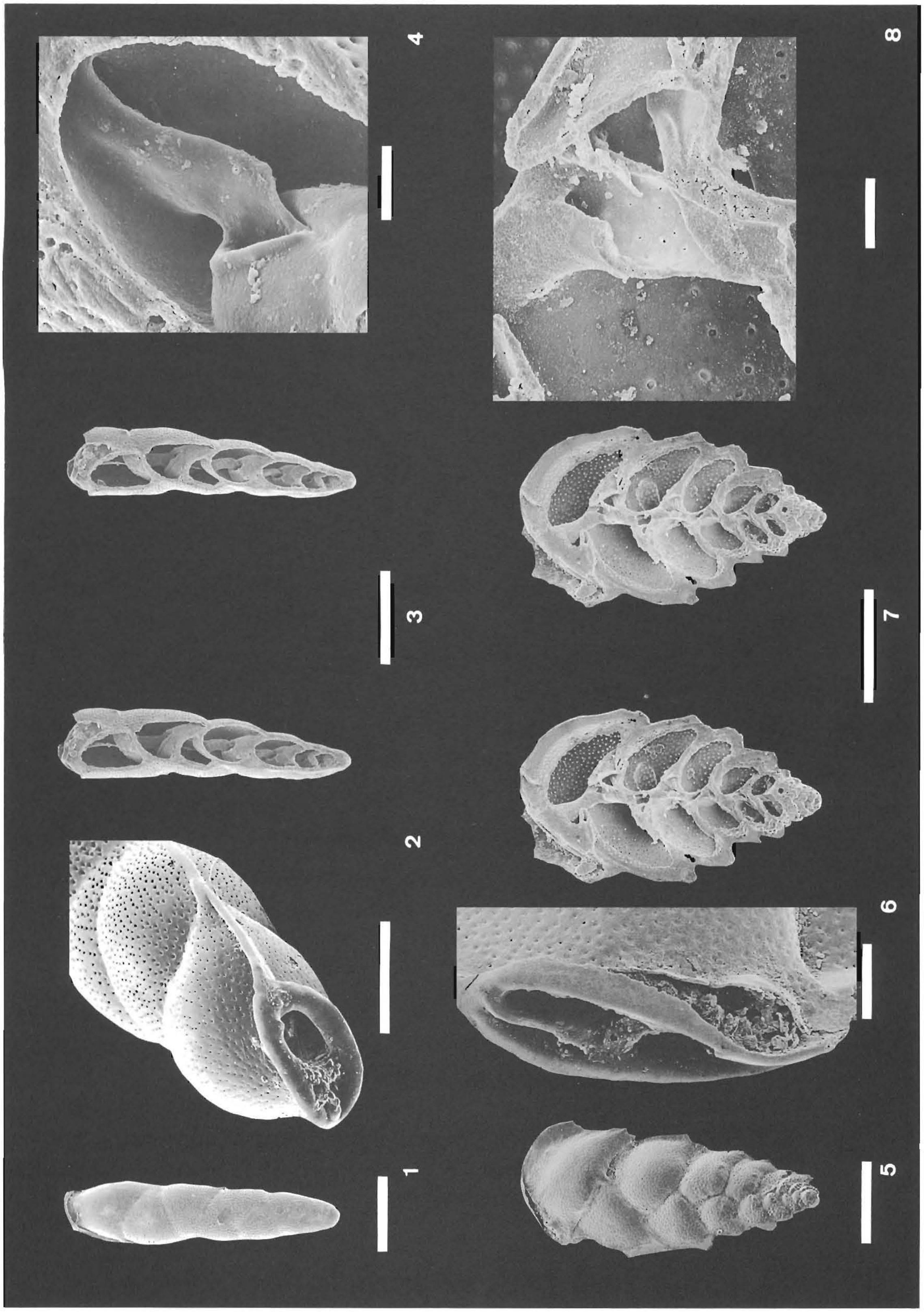
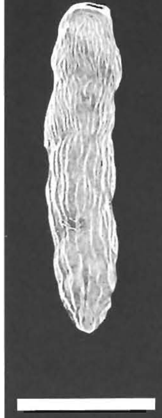

1
2
3
4
5
6
7
8

PLATE 12

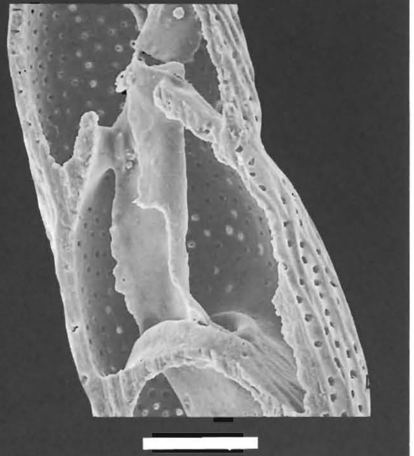
Loxostomina mayori (Cushman, 1922). 1,2,4, BMNH ZF1188, Nares harbour, Admirality Islands; Recent (as *Bolivina nobilis sensu* Brady, 1884). 3 Topotype, BMNH ZF5050. the Dry Tortugas, Florida; Recent.
1 Habitus (250 μm).
2 Close-up of the aperture (25 μm).
3 Stereopair of a broken, opened topotype (250 μm).
4 Close-up of an opened specimen, with the prominent, asymmetric toothplates (50 μm).

Sagrina pulchella d'Orbigny, 1839. MNHN F61755 & F61756, Jamaica; Recent (from d'Orbigny's sample)
5 Habitus (100 μm)..
6 Close-up of a broken foramen (50 μm).
7 Stereopair of an opened specimen (100 μm).
8 Close-up of the complex folded toothplate, seen obliquely from below (2.5 μm).

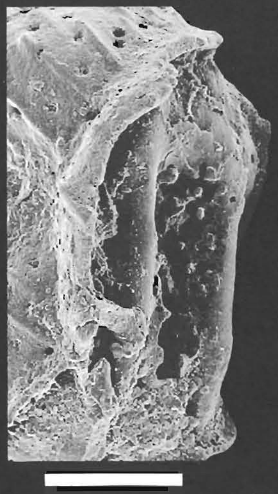

1

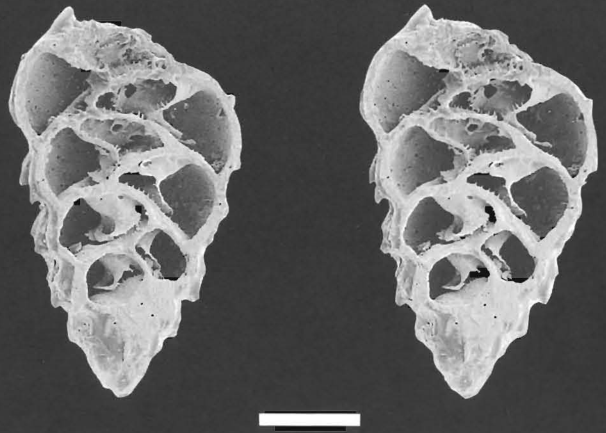

2


3


4


5


6


7


8

PLATE 13

Virgulinopsis cubana (Bermúdez, 1935). BMNH ZF5051-52. The Dry Tortugas; Recent.
1 Habitus of a megalospheric specimen (200 μm).
2 Close-up of the almost bulimine aperture (50 μm).
3 Stereopair of an opened specimen (100 μm).
4 Close-up of the very contorted toothplate (25 μm).

Alectinella elongata (Millett, 1900). BMNH 1955:11:1:59, lectotype & 60, paralectotype. Station 14, Malay Archipelago; Recent.
5 Habitus lectotype (200 μm).
6 Oblique view of lectotype, showing the elongated aperture with the lip spilling over onto earlier chambers (100 μm).
7 Habitus of a damaged paralectotype (200 μm).
8 Close-up of some toothplates, seen slightly from below (50 μm).
9 Toothplates seen from aside (50 μm).

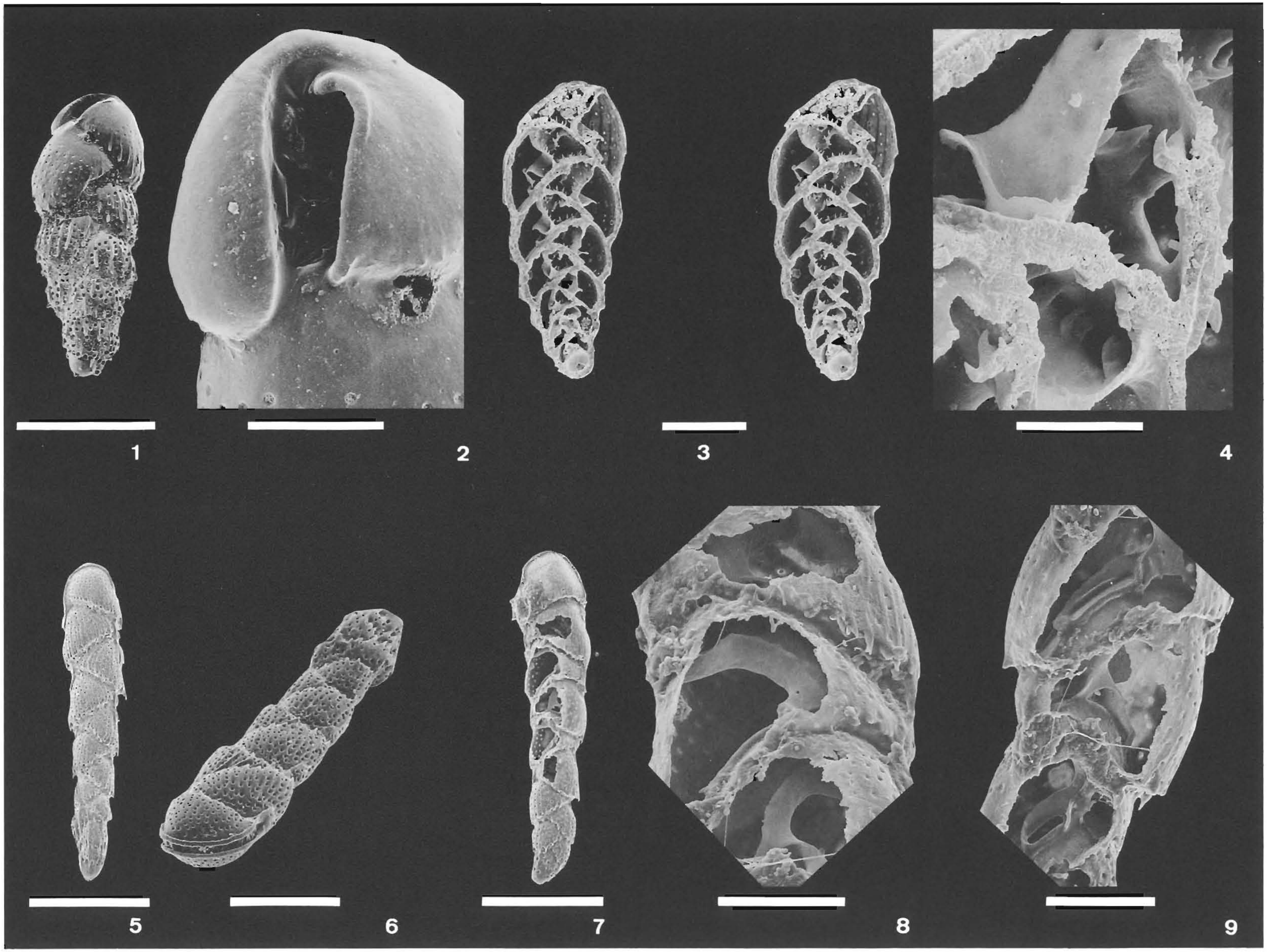

1
2
3
4
5
6
7
8
9

PLATE 14

Pseudobrizalina lobata (Brady, 1881). BMNH ZF4972, lectotype & ZF4973, paralectotype. Nares Harbour, Admirality Islands; Recent.
1 Habitus lectotype (200 μm).
2 Close-up of apertural end, here broken (50 μm).
3 Stereopair of an opened paralectotype (100 μm).
4 Close-up of a toothplate. Note the long projection of the plate along the chamber roof (25 μm).

Virgulopsis pustulata Finlay, 1939. BMNH P52797 & P52798, topotypes. Kakanui Beach, South Island, New Zealand; Lower Miocene.
5 Habitus (200 μm).
6 Close-up of the aperture (25 μm).
7 Stereopair of an opened specimen (100 μm).
8 Close-up of a toothplate (25 μm).

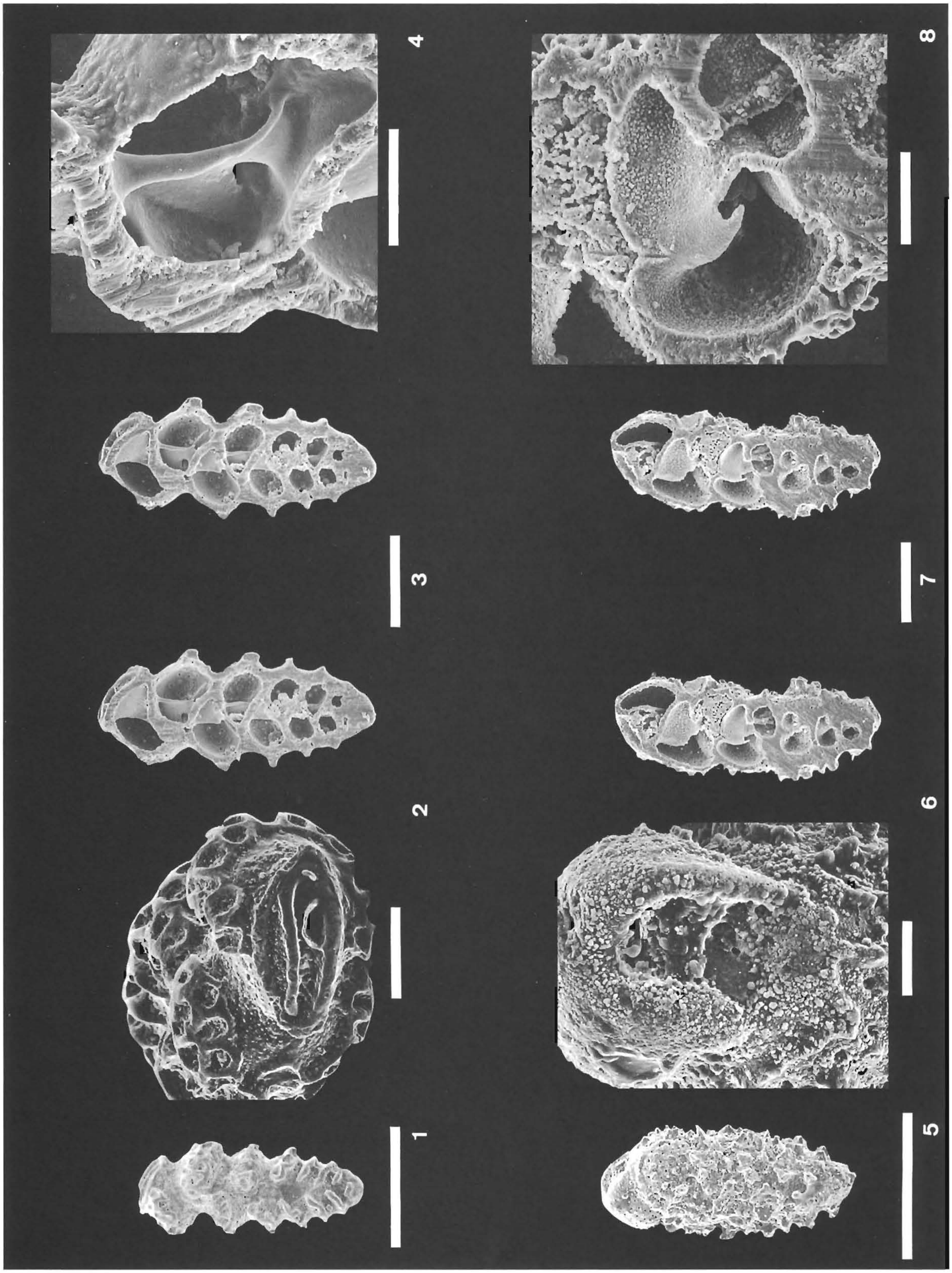

1
2
3
4
5
6
7
8

PLATE 15

Eouvigerina americana Cushman, 1926. BMNH P52799 & P52800. McKinney, Texas; Upper Cretaceous.
1 Habitus (100 μm).
2 Close-up of the aperture (25 μm).
3 Close-up of the final toothplate (10 μm).

Tappanina selmensis (Cushman, 1933). 4, 5 BMNH PF53060, Vincentown; Palaeocene. 6, 7 BMNH PF53061, Klagsham; Palaeocene.
4 Habitus (100 μm).
5 Close-up of the aperture (10 μm).
6 Stereopair of an opened specimen (100 μm).
7 Lateral view of two successive toothplates (25 μm).

Zeauvigerina zelandica Finlay, 1939. BMNH P52801 & P52802, topotypes. Near Dunedin, South Island, New Zealand; Middle Eocene.
8 Habitus (100 μm).
9 Close-up of the aperture (25 μm).
10 Stereopair of an opened specimen (100 μm).

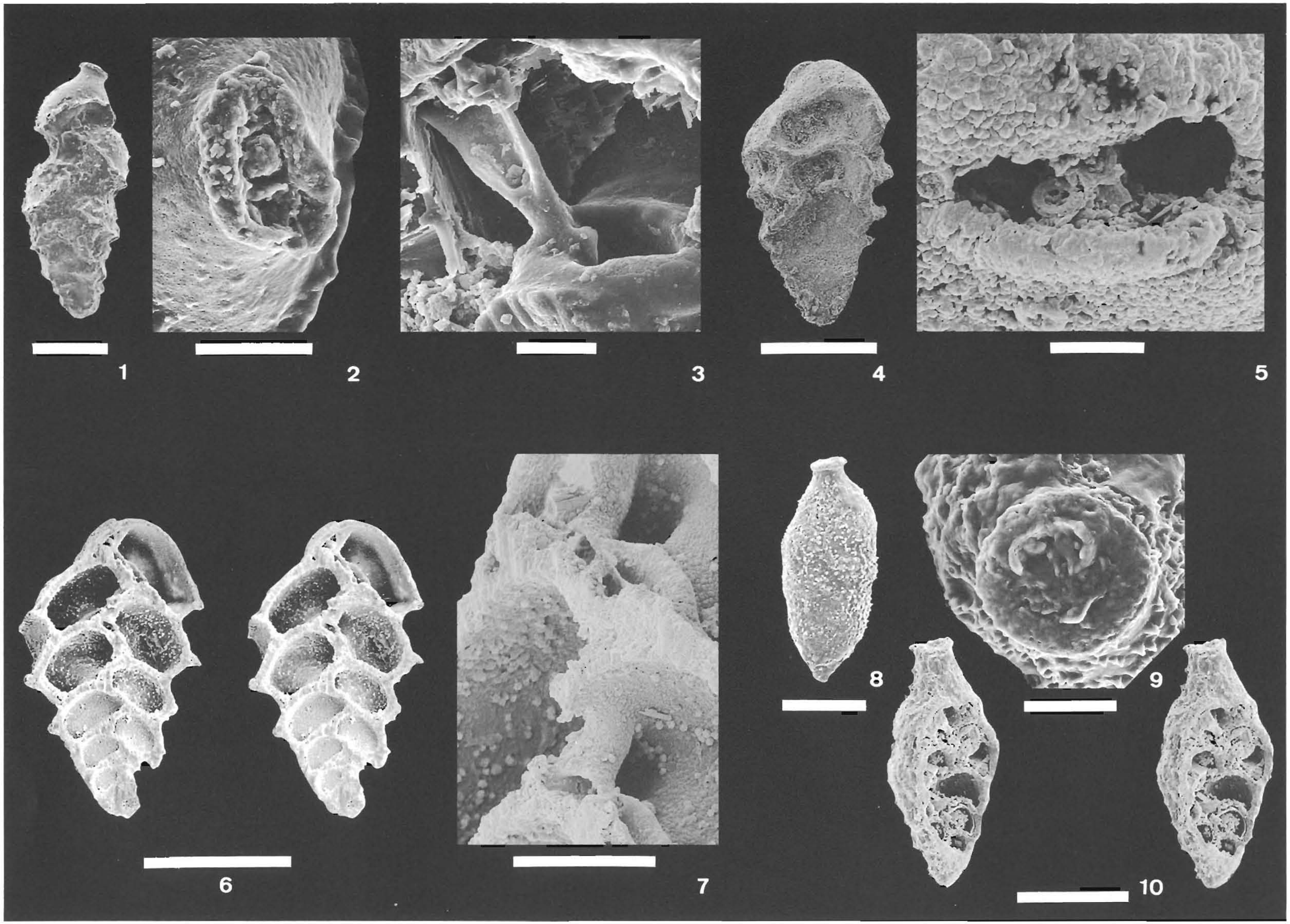

1
2
3
4
5
6
7
8
9
10

PLATE 16

Tortoplectella crispata (Brady, 1884). BMNH ZF4974, lectotype. Off Raine Island, Torres Strait; Recent.
1 Habitus (250 μm).
2 Oblique frontal view (250 μm).
3 Close-up of the agglutinated chamber wall (10 μm).
4 Overview of an opened specimen (250 μm).
5 Close-up of the foraminal region with toothplate-like structure (25 μm).

Grimsdaleinella spinosa Bolli, 1959. Paratype, H. Bolli Coll. Stollmeyer Quarry, Trinidad; Turonian-Coniacian.
6 Habitus (100 μm).
7 Oblique frontal view (100 μm).
8 Light microscopical view, ordinary light (100 μm).
9 as 6 but with polarised light (100 μm).

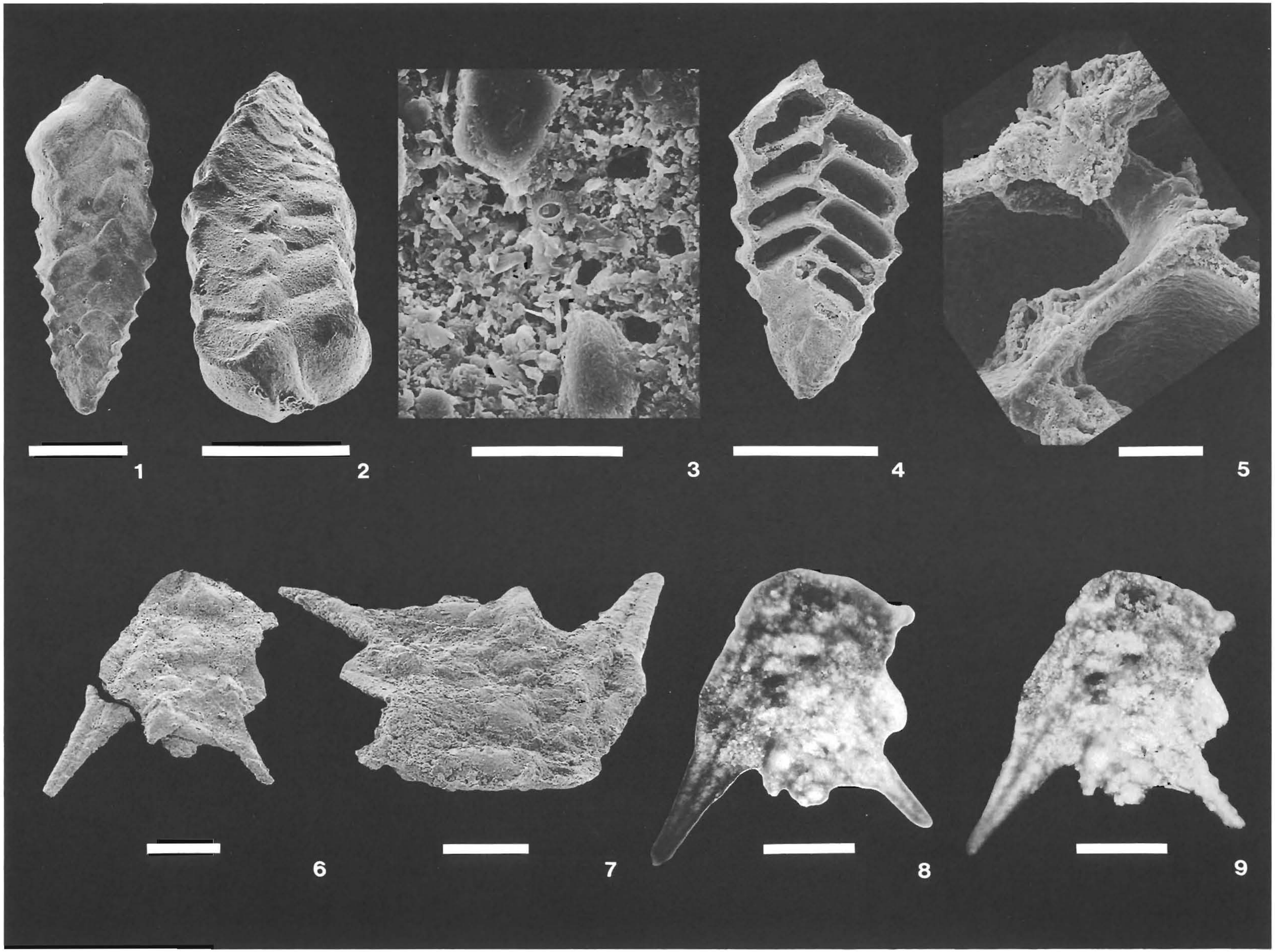
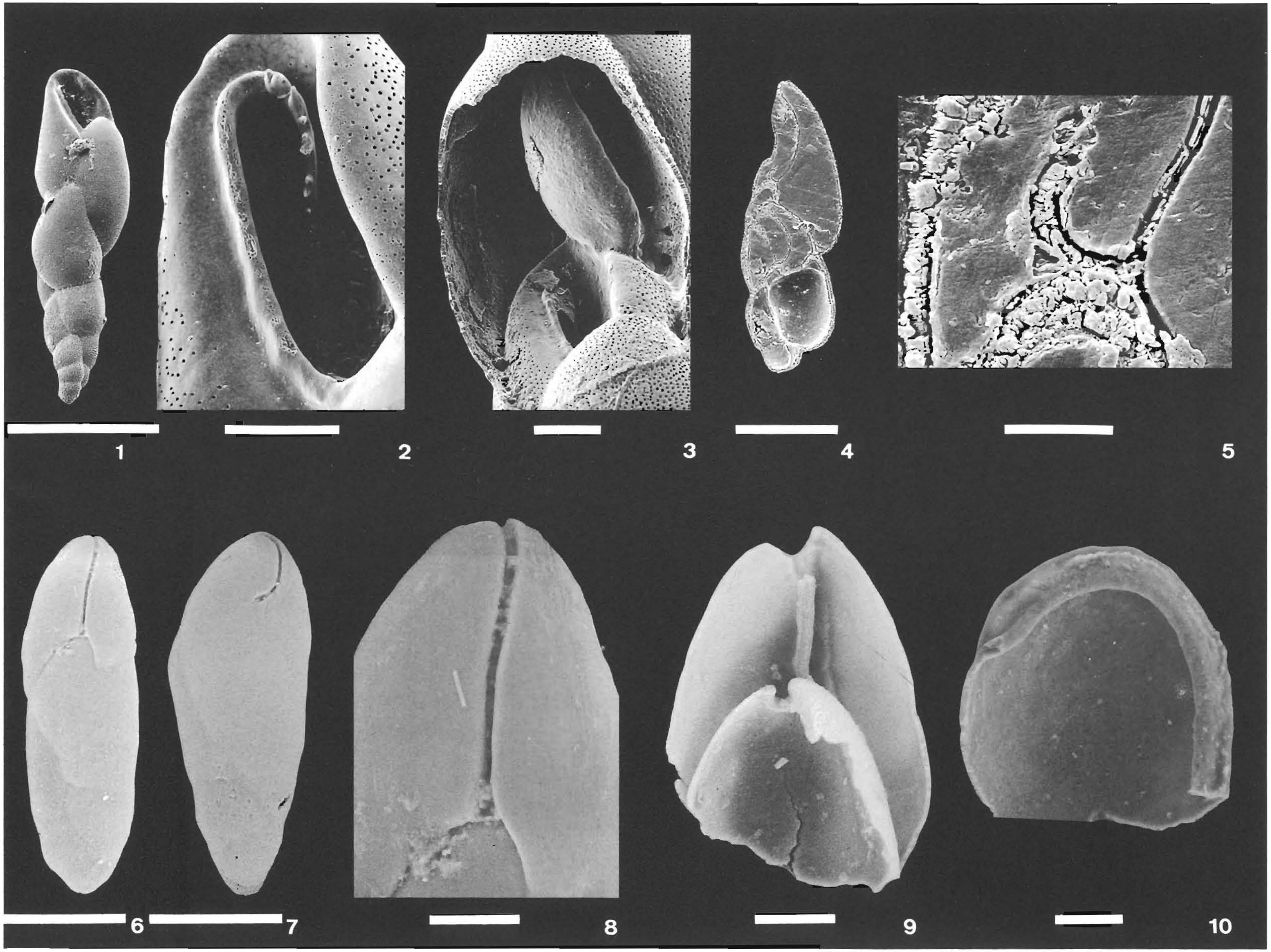

1
2
3
4
5
6
7
8
9

PLATE 17

Stainforthia concava (Höglund, 1947). BMNH ZF5053-55. Læsø, Denmark; Recent.
1 Habitus (250 μm).
2 Close-up of the aperture, with the denticulate upper edge of the toothplate-like structure (25 μm).
3 Internal view showing the toothplate-like structure and its relation to the foramen (25 μm).
4 Overview of an etched section (100 μm).
5 Close-up of the attachment site of the toothplate-like structure. Note especially the bilamellar nature of this structure (10 μm).

Francesita advena (Cushman, 1922). USNM16280a, Holotype & USNM16280, paratypes. North Atlantic; Recent.
6 Habitus of the holotype (250 μm).
7 Close-up of the slit-like aperture (50 μm).
8 Back view of the aperture (50 μm).
9 Fragmented paratype, with the toothplate-like structure (50 μm).
10 Overview of the toothplate-like structure and its relation to the aperture and foramen (100 μm).


1
2
3
4
5
6
7
8
9
10

CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

SPECIAL PUBLICATION NO. 34

THE GENERIC REVISION OF FIVE FAMILIES OF ROTALIINE FORAMINIFERA

PART II
THE ANOMALINIDAE, ALABAMINIDAE, CANCRISIDAE & GAVELINELLIDAE

by

STEFAN A. REVETS
DEPARTMENT OF GEOLOGY & GEOPHYSICS
UNIVERSITY OF WESTERN AUSTRALIA
NEDLANDS, WA6907
AUSTRALIA

TABLE OF CONTENTS

Cushman Foundation Special Publication No. 34 p. 57-113, 1996

THE GENERIC REVISION OF THE ANOMALINIDAE, ALABAMINIDAE, CANCRISIDAE & GAVELINELLIDAE

STEFAN A. REVETS
Department of Geology, University of Western Australia
Nedlands, WA6907 Australia

ABSTRACT

The type species of various 'anomalinid' genera have been restudied, where possible on the basis of the original types. The concepts of these taxa are discussed in the light of the new observations herein reported.

The Anomalinidae comprise the genera *Anomalina, Anomalinoides, Cibicidoides* with *Rhodanopeza* as a subjective synonym, *Hanzawaia, Heterolepa, Loisthostomata, Orithostella, Parrelloides* and *Riminopsis.*

The Alabamininidae are restricted to *Alabamina*, with *Eponidoides* as a subjective synonym, *Charltonina, Cribroparrella, Conorotalites, Goupillaudina, Oridorsalis* and *Osangularia.* The Gavelinellidae include *Gavelinella*, with *Pseudovalvulineria* as a subjective synonym, *Angulogavelinella, Berthelina, Boldia, Cocoarota, Hansenisca, Lingulogavelinella, Notoplanulina*, and *Pseudogavelinella.*

The Cancrisidae include *Cancris, Brotzenella, Cibicorbis, Gyroidinoides*, with *Valvalabamina* as a subjective synonym, *Scheibnerova, Stensioeina* and *Valvulineria.*

Gyroidina*, with *Serovaina* as a subjective synonym, as well as *Globorotalites*, possess features typical of eponidid taxa, posing difficulties for its classification. The genera *Nummodiscorbis, Hollandina* and *Holmanella* are considered *incertae sedis*, while *Gavelinonion* remains a *nomen inquaerendum.

INTRODUCTION

As is the case for so many other important genera, *Anomalina* was originally proposed by d'Orbigny in 1826. Although he included only 5 species at the time, adding a few more in his Vienna memoir in 1846, over the years the genus grew in importance to contain eventually some 300 species names. Surprisingly, there is a clear gap in this growth: not before the inclusion of *Anomalina* by Cushman in his classification schemes did the number of newly described species take off. It was ignored by most workers, with the notable exceptions of Brady and Heron-Allen & Earland.

In actual practice, the concept of *Anomalina* proved to be rather vague, leading to the subsequent creation and proliferation of other genera. Quite a substantial number of *Anomalina* species were reclassified into various other genera, again as the result of the vagueness with which *Anomalina* is circumscribed.

The Anomalinidae were proposed by Cushman (1927) to accommodate a variety of genera (Anomalininae for *Anomalina, Palmerinella, Ruttenia, Planulina, Laticarinina* and *Anomalinella*; Cibicidinae for *Cibicides, Stichocibicides, Dyocibicides, Annulocibicides, Rectocibicides, Cyclocibicides, Cibicidella* and *Webbina*), while genera such as *Gyroidina, Stensioeina* and *Valvulineria* were classified in the Discorbinae, Rotaliidae. Interestingly, in the discussion of the Anomalinidae, Cushman described them as deriving from the Rotaliidae through forms like *Discorbis*. Cushman observed that the group was a very close-knit one, emphasising that although derived from the Rotaliidae, they were very distinct from that family. *Cancris* was included in the Bagginininae, Rotaliidae.

Galloway (1933) held a very different opinion, witness his inclusion of *Anomalina* in the Discorbinae, alongside *Discorbis, Epistomaria, Cymbalopora, Tretomphalus, Cycloloculina, Cyclocibicides* and *Sherbornina.* He also pointed out that the phylogeny within this group was very difficult to determine because the genera were very similar, only differing in shape of the test and character of the aperture. *Cancris*, together with *Baggina, Gyroidina* and *Valvulineria* amongst others was reclassified in the Rotaliinae.

Glaessner's classification (Glaessner, 1945) mirrored to a considerable extent Cushman's proposal except that he put *Cibicides, Cibicidoides, Planulina, Anomalina, Laticarinina* and *Anomalinella* together, arguing that the various irregularly spreading cibicidids should be retained in *Cibicides*. For Glaessner, the Discorbidae were composed of the Discorbinae, Siphonininae and Anomalininae. The Discorbinae included *Discorbis, Valvulineria, Gyroidina, Stensioeina, Eponides, Alabamina, Pulvinulinella, Parrella, Coleites, Baggina* and *Cancris*.

Reclassifications, very often drastic, continued to be put forward at short intervals until Loeblich & Tappan (1964) proposed their critically documented and highly influencial classification. Many of the current ideas, concepts and general understanding of what is loosely understood to be the anomalinids can be traced back to this publication. In this authorative publication, Loeblich & Tappan used the optical nature of the test (radial or granular appearance under polarised light) as a fundamental characteristic to differentiate rotaliine taxa on the superfamily level. This resulted in the separation of the cibicidids from the anomalinids, while *Gavelinella* and allied genera were included in the Anomalininae.

When Haynes (1981) put forward his proposal, lamellarity patterns had been put on a more secure footing by Hansen and co-workers while the optical nature of the test had been discredited as a character of supraspecific value. The inconsistencies in the optical nature of the test invalidated some of the overall separations proposed by Loeblich & Tappan in 1964, but the changes proposed by Haynes went beyond an attempt to salvage the 'Treatise' classification. Because two of the previously fundamental characteristics fell by the side (lamellarity and optical nature of the test), classifications were in urgent need of redefinition, resulting in this case in a classification harking back to some extent to the views expressed by Cushman. Haynes not only refrained from using optical nature and lamellarity as previously perceived, he also moved away from a strict hierarchical use of characters towards a more relational one. Haynes brought *Gavelinella* together with *Cancris, Gyroidina, Gyroidinoides* and *Valvulineria* in the Cancrisidae as part of the Discorbacea while the Anomalinidae were composed of *Anomalina, Anomalinoides, Anomalinella, Cibicides, Cibicidoides, Cibicidina, Hanzawaia, Planulina, Hyalinea, Heterolepa* and *Stensioeina*. Interestingly, the reclassification of the Anomalinidae in the Orbitoidacea went together with the inclusion of the cibicidids in this family.

Loeblich & Tappan (1987) proposed a major overhaul of their previous classifications, incorporating a very large amount of new taxa which had been proposed in the intervening years. A marked feature of this imposing edifice is the very fragmented and strongly split nature of the taxa: the number of genera recognised rose from 1192 in 1964 to 2446, while taxa of familial rank grew from 241 to 661. The rather low number of genera in some of the families does indicate a tendency towards splitting and underlines the often inadequate amount of information available on which to found a classification more securely (see also Haynes, 1990). This view had been expressed before by Whittaker (1988) when dealing with the abundant and diverse anomalinid fauna found in the Ecuadorian Tertiary. And, as Haynes (1990) pointed out, the authors continued to rely on wall structure at the subordinal level, including behaviour under polarised light. Because they incorporated the suppression of *Anomalina* in favour of *Epistomaroides* in anticipation of a ruling by the ICZN, most of the anomalinid genera were reclassified in the Gavelinellidae. This decision created serious problems since the application by Hansen and Rögl to suppress *Anomalina*, and hence the Anomalinidae, had been withdrawn (see Revets, 1994; Rögl, pers. comm).

The recent instability surrounding the type of *Anomalina* and all the ramifications this entailed prompted a study of this genus in an attempt to stabilise not only the central concept but also the classification on a higher level. The difficulties experienced with *Anomalina* will hopefully come to an end, pending the use of plenary powers requested from the ICZN to redesignate the type species of *Anomalina*. While the elective species, *A. ariminensis*, is rather close to the well supported concept of *Anomalinoides*, enough differences are present to differentiate both genera at this point in time (Revets, 1994). If the proposal is accepted by the ICZN, the concept of *Anomalina* will be clearly defined, resulting in a more precise understanding of anomalinids as well. At the time, it became clear that a much wider study had to be prepared including a much larger number of genera if any grip on the various problems was to be achieved. Because of the fluidity in the classification of genera in families in this group, the scope of this study includes a number of well defined and well understood genera, the restudy of which was carried out to help justify the reclassification of more difficult taxa.

When Toulmin (1941) proposed the new genus *Alabamina*, he distinguished this new taxon from *Pulvinulinella* and *Eponides* on the basis of the peculiarities of the apertural morphology. The infolding of the chamberwall near the periphery and adjacent to the uppermost part of the aperture is highly characteristic and diagnostic and clearly separates *Alabamina* from the other genera.

Hofker (1951a) proposed a separate family to accommodate *Alabamina* and *Gyroidina*. This family was subsequently recognised by Reiss (1958), Loeblich & Tappan (1964, 1987) and Haynes (1981). However, the member taxa changed dramatically from the original intent. Reiss included only *Alabamina* and *Osangularia* in the family. Loeblich & Tappan (1964) included *Alabamina (=Eponidoides), Gyroidina, Oridorsalis, Rotaliatina, Svratkina* and *Trichohyalus*, while their classification of 1987 saw the Alabaminidae composed of *Alabamina (=Eponidoides), Clinapertina, Svratkina* and *Valvalabamina*. Hansen (1970) added the new genus *Paralabamina* to the group. Haynes (1981) restructured the family by restricting it to *Alabamina, Globorotalites, Conorotalites, Charltonina* and *Osangularia*. Because some of these genera have been classified as anomalinids or gavelinellids and vice versa, a revisional study of alabaminids is here presented as well.

DISCUSSION

The proposed retypification of *Anomalina* and consequent circumscription of the genus also led to a more precise definition of the family Anomalinidae. This redefinition of the anomalinids allows at the same time a proper differentiation from the gavelinellids. Anomalinids are characterised by apertural extensions, flaps, grooves, and other modifications on the spiral side, while in gavelinellids analogous features are present on the umbilical side. Using the terminology advocated by Haynes, the ventral side is on opposite sides of the trochospire in these two groups, here considered to be a difference of major importance, hence the separation of the two groups on family level. This point of view naturally leads to drawing the cibicidids closer to the anomalinids, as has been proposed previously by Cushman and Haynes. However, at this point in time, the morphological differences on the spiral, and in this case, ventral side due to the attached life mode of *Cibicides* are the main grounds for keeping both groups separate. Much needed further study of *Cibicides* and allied taxa may well reverse this decision.

The Anomalinidae are herein recognised to accommodate those taxa which possess an extraumbilical aperture which spills over onto the spiral side and in which the spiral part of at least some of the earlier apertures remain open as relict apertures. Within the family, there is a group of closely related genera clustering round *Anomalina*: *Anomalinoides, Cibicidoides, Hanzawaia, Riminopsis* and to a lesser extent *Orithostella*. The remaining genera differ by the extent of the spiral part of the aperture and the speed with which the earlier spiral apertures are closed off throughout ontogeny, i.e., the spiral lips are poorly developed and previous spiral apertures are closed off very quickly. The relations within this group as well as with the *Anomalina*-cluster of genera is at present utterly unclear. The temptation to recognise them as a separate subfamily within the Anomalinidae was resisted as it is quite clear that such an arrangement would be wholly artificial. The concepts herein proposed, based on the respective type species, are well circumscribed but problems could surface when attempting to apply these to the large and varied number of species which belong somewhere in this group of genera. Therefore, a real need has arisen for a complete revisional study of the species variously classified as *Anomalina, Anomalinoides* and *Cibicidoides*. Because of the absence of this information, it is not yet possible to present an in-depth discussion of these genera.

The study and discussion *Anomalina ariminensis*, aimed at clarifying the plea to the ICZN for a redesignation of *Anomalina*'s type species (Revets, 1994), described the morphological features in great detail. The proposed type species is a Recent taxon, but preliminary critical searches both in the literature and in actual collections, indicate that the genus *Anomalina* possesses a substantial fossil record, certainly going back to the Cretaceous.

The genus *Anomalinoides* was erected by Brotzen (1942) to accommodate nearly planispirally coiled, very inflated taxa, up till then variously classified as *Anomalina, Planulina, Cibicides* or *Cibicidoides* species. Curiously, Brotzen differentiated *Anomalinoides* from *Anomalina* by the presence of an 'Umbilicalmündung' in *Anomalinoides*, a point of view reiterated by Vasilenko (1954). This is very likely the result of viewing the side with the boss and adjacent groove as the umbilical side, illustrating the confusing and often misleading nature of external morphological elements. Loeblich & Tappan (1964) held the contrary view, i.e., that the aperture in *Anomalinoides* continues onto the spiral side, while they described the aperture of *Anomalina* as being entirely peripheral. Although Haynes (1981) did not mention *Anomalina*, his description of the *Anomalinoides* aperture agreed with that of Loeblich & Tappan. As shown previously (Revets, 1994) and herein, the position and extent of the aperture in both *Anomalina* and *Anomalinoides* is the same. Hence, the differences between the two genera are mainly the obvious difference in shape of the chambers and the details of the umbilical morphology, respectively umbonate and sunken.

The genus *Cibicidoides* fits morphologically speaking between *Anomalina* and *Anomalinoides*. It is clear from the literature at large that serious difficulties are encountered in assigning species to these genera in a consistent fashion. As herein described, *Cibicidoides* is closer to *Anomalina* than to *Anomalinoides*. The complete involuteness of the umbilical side in *Cibicidoides*, together with the lack of definition of a central spiral umbo, differentiate species of this genus from *Anomalina*. In practice, this means that a great many species currently attributed to *Cibicidoides* would have to be transferred to *Anomalina*. One of the consequences of these more restrictive views of the concept of these two genera is that very likely the fossil record of *Cibicidoides* will become restricted to the Cenozoic, while *Anomalina* definitely ranges into the Cretaceous (e.g., *Anomalinoides canaliculus* Belford, 1960 from the Santonian of Western Australia clearly belong in *Anomalina* as here redefined). The characteristics of *Rhodanopeza* are such that a differentiation from *Cibicidoides* is not possible. The more compressed nature of the type species and the ornamentation is fairly distinctive but insufficiently so to warrant generic recognition.

The genus *Hanzawaia* has been plagued by instability and a certain amount of confusion. The ICZN conserved the generic name *Hanzawaia* in favour of *Florilus*, acting upon a proposal by Hansen & Rögl (ICZN, 1990). These authors showed in their revisional study of the original von Fichtel & von Moll collection that the genus *Florilus* had been misunderstood, in that the generally accepted concept bore no resemblance to the features of the actual type specimens. They argued that *Nautilus asterizans* would now be classified in *Hanzawaia*, and therefore lodged an appeal to conserve the subjective junior synonym *Hanzawaia*. Unfortunately, they did not discuss why *Nautilus asterizans* should be seen as a *Hanzawaia* species, and, as argued for previously (Revets, 1996), the morphological differences are such that it is advisable to keep these taxa generically distinct. Furthermore, *N. asterizans*-like taxa occur much earlier in the fossil record than do *Hanzawaia* species. This led to the proposal of the new name *Riminopsis* Revets, 1996. Both taxa clearly belong in the Anomalinidae.

Orithostella is the last genus in the list with pronounced affinities with *Anomalina*. Although all authors since Eicher & Worstell (1970) proposed this genus have classified it as a gavelinellid (i.e., with the flaps and plug described as umbilical), it is herein shown to possess anomalinid features. The actual shape and size of the spiral flaps hiding the spiral extension of the aperture is very different from that in *Anomalina, Anomalinoides* or *Cibicidoides*, but rather similar to that in *Hanzawaia*. The imbricate nature of these flaps echoes that in *Hanzawaia* as well, although the coalescence typical in the latter does not occur.

Heterolepa is a very simple anomalinid, in which the extension of the aperture onto the spiral side does not lead to any modification of the features on the spiral side. Its fossil record is apparently restricted from the Eocene to the Recent. If the relationship with *Anomalina* and allied taxa as herein proposed is correct, then the genesis of *Heterolepa* is one through simplification rather than increase in complexity. *Heterolepa* was used as basis for a separate family created by Gonzáles-Donoso (1969) in an attempt to improve the classification scheme proposed by Loeblich & Tappan (1964). The Heterolepidae included taxa which were optically granular and possessed a septal flap. Loeblich & Tappan (1987) retained this family, including in it the genera *Anomalinoides, Gemellides, Heterolepa, Loisthostomata* and *Talpinella*. The optical nature of the test is not a reliable characteristic above species level, and, as shown by Hansen & Lykke Andersen (1976), the presence of a septal flap is very often a matter of degree rather than kind. From the descriptions herein provided, the characteristics of the Heterolepidae fall well within the concept of the Anomalinidae.

Another simple genus is *Loisthostomata*. The genus is for the moment still monospecific, and its stratigraphic range consequently very short (Upper Eocene). Although its simplicity is reminiscent of *Heterolepa*, it is clearly different. The much wider spiral extensions of the aperture and especially the upwards and outwards curved lip are very distinctive. The extent of the spiral part of the aperture is more reduced than in *Heterolepa*. Contrary to *Heterolepa* species, *Loisthostomata* is rather variable in overall shape of the test, especially as far as the degree of involution and hence demarcation of the umbilicus is concerned.

Parrelloides differs from all the other genera in the Anomalinidae in being clearly cone-shaped, with a rather flattened umbilical side. The aperture is surprisingly small and the extension onto the spiral side is almost negligable. In this respect, it forms the end of a trend in reduction of the spiral aperture, starting from *Heterolepa*, over *Loisthostomata* to *Parrelloides*. Although consistent with the order in which these genera appear in the fossil record, it is not clear if this observation reflects the actual evolutionary history of these taxa. The inclusion of the Upper Eocene *Cibicides cookei* by Hofker (1956) in *Parrelloides* is herein not supported.

The Alabaminidae, as herein understood, have been assembled first and foremost on the basis of their apertural morphology. The interiomarginal slit, further developed in an areal extention of the aperture in some of the taxa, with an inframarginal sulcus of variable extent are the unifying, and diagnostic, characteristics.

Conorotalites aptiensis is an interesting taxon in many respects. It is not only the likely stem species of the entire group, but it also exhibits a most intriguing set of phenomena. The morphological variablity of the very large type series of this species is almost uncomfortably large. Characters like the pseudoumbilicus, ranging from completely closed to a well-defined, proper umbilicus, show a morphological plasticity that otherwise would receive recognition on generic level and maybe even higher. The marking of the sutures on the spiral side is likewise highly variable, ranging as it does between being clearly depressed to raised and marked as ridges. Some of the latter specimens superficially recall the genus *Eponides*. However, the absence of a 'bipartitor' from the foramina refutes this idea. Later in its history, the morphology of *Conorotalites* stabilised considerably, reaching more usual levels of variability. The inframarginal sulcus is barely developed, but the persistent little triangular overhang of the chamberwall indicates already where future developments will take place, maybe an example of preadaptation.

The early *Alabamina* species show this very restricted inframarginal sulcus as well, but once into the Palaeocene, a conspicuous infold is present. Another quite interesting observation is the change in overall shape in *Alabamina* through its historic development. Most of the Cretaceous species of *Alabamina* are compact, quite rotund and very unequally biconvex. The Caenozoic species are much more equally convex and lenticular. This morphological trend runs in parallel with the development of the inframarginal sulcus. Notwithstanding this, the distinction between *Eponidoides* (Cretaceous forms) and *Alabamina* (Caenozoic forms) cannot really be argued for. The analysis of *Eponidoides* as synonymous with *Alabamina* by Brotzen (1948) is fully supported here.

Charltonina is very likely a continuation of the *Conorotalites* line. The simple nature of the foramina, i.e., without bipartitor, adds indirect support to the views herein expressed as to the nature of *Conorotalites*. The actual extension of the aperture in a peripheral-areal direction can be seen as the next step, following on the development of an inframarginal sulcus in *Conorotalites*. In this respect, there seems to be a case of parallelism in development with the situation in *Alabamina*.

The other main line of taxa in the Alabaminidae is formed by the osangulariid genera. As is the case for *Conorotalites*, *Osangularia* ranges deep into the lower Cretaceous, although *Conorotalites* seems to be somewhat older. From a nomenclatorial point of view, there is confusion surrounding the status and the various synonymies of *Osangularia*. In a discussion of *Parrella* Finlay, 1939, Brotzen (1948) synonymised his own *Osangularia*. When it transpired that *Parrella* was preoccupied by *Parrella* Ginsburg, 1938, Reiss (1958) used *Osangularia* as the next available name to cover Finlay's *Parrella* concept, and all classifications since have accepted this proposal. However, as shown here, Finlay's *Parrella*, based on *Anomalina bengalensis* is better accommodated in *Cribroparrella*, hence the more narrow concept of *Osangularia* herein described. There appears to be a slight problem in the description of the aperture, especially for descriptions predating the SEM. As correctly pointed out by Toulmin, very often extraneous material remains lodged in the crevice at the base of the apertural face, which obscures the otherwise very characteristic aperture. It seems that the presence of this extraneous material is to be blamed for the inaccurate view that the aperture has no interiomarginal part. Furthermore, the internal morphology of *A. bengalensis* differs from *Osangularia*, not only because of the presence of an areal trematophore but also due to the presence of coverplate-like feature. Therefore, most descriptions of *Osangularia* in the literature are too wide. *Osangularia*, and to a lesser extent other alabaminids, have sometimes been associated with taxa such as *Epistominella*. The main reason for doing so seems to have been an analogy in apertural morphology, i.e., epistominellids are characterised by a slit-like aperture running parallel with the peripheral margin, but they always lack the interiomarginal part. This point of view is not followed in here. While it is theoretically conceivable that the reduction of the interiomarginal aperture could have led to epistominellid forms, there is not enough information available to argue either way.

The genus *Cribroparrella* very likely developed from *Osangularia*, a suggestion which follows naturally in view of the previous inclusion of *A. bengalensis*, here shown to belong in *Cribroparrella*, in *Osangularia*. Whittaker (1988) reported that juvenile specimens of *C. bengalensis* from the Ecuadorian Tertiary do not possess the areal trematophore and hence are indistinguishable from *Osangularia*. Observations on topotypes of this species herein reported indicate that the trematophore is more than just an adult or gerontic feature. Furthermore, the deposition of a purely internal coverplate has no equivalent in *Osangularia*.

Oridorsalis poses some difficulties for its suprageneric classification. The type species is highly characteristic and the combination of spiral relict apertures with a separate re-entrant umbilical aperture besides the interiomarginal aperture is unique. It is precisely this uniqueness that causes the problem in finding related taxa. The presence of the single relict aperture, remnant of the penultimate aperture, on the spiral side seems to be a consistent feature throughout the genus. The presence of this opening is due to the peculiar shape of the apertural face and the details of the construction of the apertural lip and the peripheral edge. The fact that this opening is closed off when the next chamber is built argues against a functional role. On the other hand, the umbilical supplementary aperture, and at least in the type species the presence of a re-entrant umbilical-sutural aperture seems to be of a greater physiological value. Interestingly, early representatives of *Oridorsalis* are often more inflated rather than sharply lenticular, and the umbilical re-entrant aperture barely or not developed. The overall habitus becomes quite similar to some of the more rounded *Alabamina* species. The modifications of the apertural face close to the periphery also begin to resemble a restricted version of the inframarginal sulcus encountered in the Cretaceous species of *Alabamina.*

Goupillaudina is a very unusual taxon, here classified in the Alabaminidae mainly on the basis of the apertural complex. The combination of characteristics has no equivalent amongst the smaller benthic hyaline foraminifera. The classification here proposed is artificial, but any other proposal would suffer from the same or worse inadequacies. In a description of *G. lecointrei* Marie, Hottinger (1966) discussed the nature of *Goupillaudina* from the point of view of other, larger rotaliids. Hottinger could not detect any trace of peripheral canals, nor *Daviesina*-like fissures. While the resulting simplicity of construction argues against a relationship with the complex, larger rotaliids, Hottinger expressed serious doubts as to the inclusion by Loeblich & Tappan (1964) of *Goupillaudina* with *Osangularia* in the same family. Despite the fact that this argument was based at least in part on the confused description of *Osangularia* by Reiss, Hottinger's analysis still stands today: it remains utterly unclear where *Goupillaudina* originated from, and this will continue to be the case until more in depth studies of the species in this genus become available. Until such time, the familial classification of *Goupillaudina* will continue to be unsatisfactory.

The Gavelinellidae are herein considered as very different from the Anomalinidae. As first discussed by Brotzen (1942), the wide open umbilicus, the interiomarginal aperture which extends into the umbilicus and continues along the umbilical margin of the chamber, and the presence of open relict apertures in the umbilicus, is fundamentally different from typical *Anomalina, Rosalina* or *Discorbis* species. Before Brotzen created *Gavelinella,* species of this genus were variously classified in especially *Anomalina* and *Rosalina.* The fossil record for *Gavelinella* apparently stretches from the Hauterivian to the Maastrichtian, and only one or two species cross into the Caenozoic, becoming extinct by the Eocene. Interestingly, the currently earliest known species, *Gavelinella sigmoicosta* (ten Dam, 1948) from the Upper Hauterivian is quite similar to the type species, a very late representative of the genus, *Gavelinella pertusa* (study of paratypes of *G. bettenstaedti* Dieni & Massari, 1966, described from the Upper Valanginian of Sardinia, shows them to be agglutinated and likely of a trochamminid nature). In both species, the umbilicus is very widely open, and the apertural characteristics are nearly identical, in contrast to a large proportion of species occurring in the intervening time in which the umbilicus is much more restricted. When Hofker (1956b) proposed the Gavelinellidae, he included in it the genera *Gavelinella, Gavelinopsis, Gavelinonion* and *Stensioeina.* As shown by Hansen & Revets (1992), *Gavelinopsis* is a rosalinid genus, unrelated to the gavelinellids, while *Gavelinonion* remains a *nomen inquaerendum.* Hofker also proposed that there exists a close relationship between *Gyroidinoides, Valvulineria* and the gavelinellids, although he did classify *Valvulineria* in the Valvulineriidae, following Brotzen, and *Gyroidinoides* in the Alabaminidae. Various genera have in the past been synonymised in *Gavelinella* (*Brotzenella, Pseudogavelinella* and *Pseudovalvulineria*). The restudy of the respective type species shows that a case can be made only for the inclusion of *Pseudovalvulineria* in *Gavelinella*; the other genera are distinct. *Rosalina lorneiana,* designated as type species of *Pseudovalvulineria* by Brotzen, was originally described by d'Orbigny as possessing a wide open umbilicus with the apertures clearly opening into the umbilicus. The lectotype selected by Loeblich & Tappan (1964) appears in this respect somewhat misleading: although the specimen illustrated clearly shows a deep umbilicus, it is much smaller than indicated in d'Orbigny's drawing.

Angulogavelinella is a highly distinctive genus, combining typical gavelinellid features with an extra *Osangularia*-like aperture. Nevertheless, the presence of an open umbilicus and interiomarginal aperture which continues into the umbilicus and with an umbilical part that remains open in earlier chambers, all point towards a gavelinellid alliance. The fossil record of *Angulogavelinella* is short, extending from the Campanian to the Lower

Palaeocene. Perhaps *Angulogavelinella* attempted to invade the niche occupied by alabaminids, but failed.

Berthelina was split off from *Gavelinella* by Malapris (1965), originally as a subgenus only. However, the more involute spiral side but especially the very small and narrow umbilicus, accompanied by the distinct thickening of the earlier umbilical sutures and fusing of the earlier umbilical flaps into a hyaline mass of calcite, is more than sufficient to give *Berthelina* full generic status. Observations here reported show that, contrary to Malapris' original description, a true umbilicus is always present: however, it is often very small. Malapris reported that the *Berthelina* plexus of the lower Albian in France was very variable, which she took to be indicative of evolutionary ferment. In view of the relative nature of the variability of the actual specimens, and of a comparable variability of the same species in other geographic regions this may be a bit of an overstatement. *Berthelina* species also seem to have had somewhat more specific requirements environmentally, making them potentially useful for palaeoecological purposes.

Boldia and the closely allied *Scarificatina* occur only rarely in mainly Palaeocene but also in Eocene deposits. The truncate nature of the test is reminiscent of some of the *Globorotalites* species, but the presence of umbilical flaps puts this genus firmly in the gavelinellids. There is an interesting parallel in the overall habitus pattern between *Boldia* and the anomalinid *Orithostella.* When not looking too closely at morphological details, *Boldia* could be seen as an 'upside-down' version of *Orithostella.*

Cocoarota is a highly distinctive gavelinellid, especially with its clearly concave spiral side and the ring of boss-like terminations of the sutures on the umbilical side. The central boss on the umbilical side is not a continuous mass of calcite, but an incomplete coalescing of the diminutive umbilical flaps of the inner whorl. It is possible still to gain access to these earlier chambers, in the same way as the later chambers retain umbilical relict apertures. As pointed out by Loeblich & Tappan (1987), the discussion by van Morkhoven *et al.* (1986, p. 267) of *Cibicidoides micrus* (Bermúdez, 1949) is incorrect and also confusing. This also means that the extent of the fossil record of *Cocoarota* is not well defined. However, it seems likely at present that it does not extend substantially outside the Eocene-Oligocene time interval.

The genus *Hansenisca* replaces the misunderstood and redefined *Gyroidina.* Most species until now considered to belong to *Gyroidina* will have to be transferred to *Hansenisca* or possibly *Gyroidinoides.* The imbricate disposition of the umbilical teeth, partially shielding the relict umbilical aperture, and the consistently open umbilicus supports its inclusion in the gavelinellids. It is also this imbricate pattern and the relict apertures which allow the unambiguous separation of *Hansenisca* from *Gyroidina.* Of all the gavelinellid genera, *Hansenisca* is the only one which ranges from at least the Maastrichtian into the Recent.

Lingulogavelinella was created by Malapris (1965) for very small gavelinellid-like forms encountered in the French Albian. Distinctive features of this genus include the slight central depression on the spiral side but especially the, for a gavelinellid, extensive umbilical flaps which form an imbricate pattern at the overlap at their distal-most part. Despite the large flaps, the centre of the umbilicus remains open, and access to the previous chambers remains assured through the relict umbilical apertures. In her description and justification for the creation of *Lingulogavelinella,* Malapris pointed out that since the position of *Pseudovalvulineria* had become untenable, species which were referred to it and did not fit in *Gavelinella* should be reclassified in *Lingulogavelinella.* As discussed previously, *Pseudovalvulineria* is herein also considered a synonym of *Gavelinella,* thereby underwriting further the recognition of *Lingulogavelinella* as a separate taxon.

Notoplanulina is something of an oddity, comparable in that respect with *Angulogavelinella.* The combination of osangulariid and gavelinellid features, together with the rather compressed test makes for a distinctive habitus.

The resurrection of the Cancrisidae, separate from the Bagginidae by Haynes (1981) is herein fully supported. Whittaker (1988, p. 112) also followed Haynes' proposal, stressing even more strongly a supposed discorbid alliance of both these families. Loeblich & Tappan (1987, p. 544) retained their position of 1964, classifying *Cancris* and *Valvulineria* along with other genera with *Baggina* in the Bagginınae, Bagginidae. As shown previously, discorbids are morphologically indistinct from rotaliids (Hansen & Revets, 1992) and hence very different from the taxa here under scrutiny. *Baggina* differs substantially from *Cancris,* especially with respect to umbilical development and extensions of the umbilical chamber wall. Hence *Baggina* is here excluded from the discussion, and the use of the family name Cancrisidae fully supported. As is the case for the gavelinellids, the umbilicus in the Cancrisidae is primarily open, but obstructed, either through the development of umbilical flaps extending over the umbilicus or through the presence of an umbilical plug. However, these developments generally lead to an imbricate pattern of flaps, not a closing off of the umbilicus through a coalescing and fusing of flaps and secondary lamination. Access to the earlier chambers remains possible via the relict umbilical apertures, although these are hidden from direct view.

Brotzenella is here considered to be a cancrisid genus, with some intriguing affinities with *Pseudogavelinella.* Most authors included *Brotzenella* in *Gavelinella*, following the lead of Loeblich & Tappan (1964). However, as shown here, the presence of a well defined umbilical plug, separate from any umbilical flaps, is sufficient to recognise *Brotzenella* in its own right. The amount of specimens available for study and their state of preservation precluded an exhaustive and in-depth analysis of the features, explaining the tentative nature of its reclassification in the Cancrisidae.

The inclusion of *Gyroidinoides* in the Cancrisidae, as first proposed by Haynes (1981) is here fully underwritten: the imbricate pattern of the crescentic umbilical flaps convincingly indicates its affinities.

The incomplete knowledge of the apertural complex in *Stensioeina* is to be blamed for the recurring and often drastic reclassification of this genus over the years. While the recognition of the genus has become straightforward, especially since the study by Cita (1966), its higher taxonomy has been very unstable. The presence of extensive umbilical flaps covering the umbilicus completely in *Stensioeina* is shown here for the first time. This feature, coupled with the presence of relict apertures in the umbilicus unambiguously identifies the genus as a cancrisid with affinities with *Pseudogavelinella.*

Valvulineria is here reclassified alongside *Stensioeina*, as Cushman proposed in 1940, and Haynes underwrote in 1981. The separation of *Valvulineria* away from these taxa by Loeblich & Tappan (1964, 1987) relied solely on the optical nature of the test. Specimens of the type series showed them to be granular rather than radial. Because of the unreliability of the optical nature of the test, no particular importance is attached to this observation. At the same time, the grounds on which *Valvulineria* was kept separate by Loeblich & Tappan disappear.

Unfortunately, some of the genera investigated proved to elude a satisfactory classification in the proposed framework. The analysis of SEM observations of *Gyroidina* showed for the first time the presence of an eponidid bipartitor in the foramina of the type species. Together with the primarily closed umbilicus and absence of apertural developments on either side of the test remove *Gyroidina* from all the family taxa here studied. This observation reinforces the view that our concept of the eponidids has to be revised and that revisional studies of this group have become highly desirable. As the necessary information is not as yet available it would be hasty to reclassify *Gyroidina* in the Eponididae.

The taxonomic difficulties encountered with the classification of *Hollandina* are due entirely to the extremely simple nature of its test. The complete absence of morphological features and the 'primitive' nature of its habitus in contrast to the features exhibited by all the other taxa here under scrutiny preclude the taking of an informed decision as to its taxonomic affinities.

An analogous reasoning lies behind the non classification of the genus *Holmanella.* The seams of the chambers on the umbilical side which protrude only slightly over the chamber surface bear no relation to apertures or relict apertures. The L-shaped aperture and essentially planispiral coiling do not fit with any of the taxa studied.

SYSTEMATIC DESCRIPTIONS

SUBORDER ROTALIINA LANKESTER, 1885

FAMILY ANOMALINIDAE CUSHMAN, 1927

1927 Anomalininae Cushman: 92.
1956a Parrelloididae Hofker: 936.
1964 Anomalinidae Cushman; Loeblich & Tappan: 753.
1969 Heterolepidae Gonzáles-Donoso: 6.
1981 Anomalinidae Cushman; Haynes: 261.
1984 Oridorsalidae Loeblich & Tappan: 53.
1987 Parrelloididae Hofker; Loeblich & Tappan: 572.
1987 Oridorsalidae Loeblich & Tappan; Loeblich & Tappan: 630.
1987 Heterolepidae Gonzáles-Donoso; Loeblich & Tappan: 631.

Description. Test free, multilocular, low trochospiral, spiral side evolute to partially evolute, umbilical side involute, umbilicus may be filled with a small plug; aperture extraumbilical, extending onto the spiral side, partially shielded by more or less strongly developed spiral lips, with relict spiral apertures; wall calcareous, perforate.

GENUS *Anomalina* D'ORBIGNY, 1826

1826 *Anomalina* d'Orbigny: 282.
1941 *Anomalina* d'Orbigny; Marie: 243.
1964 *Anomalina* d'Orbigny; Loeblich & Tappan: 754.
non 1987 *Epistomaroides* Uchio; Loeblich & Tappan: 604, *partim.*
1994 *Anomalina* d'Orbigny; Revets: 296.

Type species. Anomalina punctulata d'Orbigny, 1826, type by monotypy, suppression pending, *Anomalina ariminensis* d'Orbigny, 1902, designation pending.

Anomalina ariminensis d'Orbigny, 1902
Pl. 1, Figs. 1-4

1826 *Anomalina ariminensis* d'Orbigny: 282, *nomen nudum.*
non 1884 *Anomalina ariminensis* (d'Orbigny); Brady: 674, pl. 93, figs. 10-11.
1902 *Anomalina ariminensis* d'Orbigny; Fornasini: 61, fig. 62.
non 1904 *Anomalina ariminensis* (d'Orbigny); Millett: 495.
non 1915 *Anomalina ariminensis* (d'Orbigny); Cushman: 44, figs. 49a-c.
1994 *Anomalina ariminensis* d'Orbigny; Revets: 298, pl. 2, figs. 1-9.

Holotype. FO437, Muséum National d'Histoire Naturelle, Paris; from Rimini, Recent.

Material examined. Topotypes, courtesy H. J. Hansen.

Description. Test large, unequally biconvex, low trochospire, 2 whorls, spiral side flattened, partially evolute, obscured by a large central plug, umbilical side moderately convex, involute, with a small ill-defined plug, periphery angled but well rounded, with imperforate band, flush; chambers narrow, crescentic, flush with the surface, towards the periphery tending to retrograde, 14 chambers in final whorl; sutures wide, raised, gently arcuate, more strongly arcuate towards the periphery; aperture equatorial, a low arch bordered by a small slightly everted lip, aperture continues onto the spiral side along the entire length of the chamber, earlier sutural apertures gradually closed off; wall optically granular, rather coarsely and densely perforate, except for the wide imperforate sutures.

Remarks. As shown previously (Revets, 1994), the concept of *Anomalina* could not be properly fixed through the original type species, *A. punctulata.* The ICZN has been asked to set aside the original type species in favour of *A. ariminensis.* If this proposal is accepted, it will entail a slight shift away from the commonly understood concept of the genus, but the firm foundation of the concept through a type species which is actually recognised (and underpinned by type specimens) seems by far preferable.

The new concept is rather close to that of *Anomalinoides*, but the presence of a small umbilical plug, the very different shape of the chambers and the dissimilarities on the spiral side allow the recognition of *Anomalina* as separate from *Anomalinoides.*

GENUS *Anomalinoides* BROTZEN, 1942

1942 *Anomalinoides* Brotzen: 23.
1954 *Cibicides (Anomalinoides)* Brotzen; Vasilenko: 140.
1964 *Anomalinoides* Brotzen; Loeblich & Tappan: 755.
1987 *Anomalinoides* Brotzen; Loeblich & Tappan: 631.

Type species. Anomalina pinguis Jennings, 1936, original designation.

Anomalinoides pinguis Jennings, 1936
Pl. 1, Figs. 5-8

1932 *Anomalina grosserugosa* (Gümbel); Plummer: 201, pl. 14, figs. 9a-c.
1936 *Anomalina pinguis* Jennings: 37, pl. 5, fig. 1.
1942 *Anomalinoides plummerae* Brotzen: 23, fig. 7:3.
1964 *Anomalinoides pinguis* (Jennings); Loeblich & Tappan: 755, figs. 619/1*a* – *c*.
1987 *Anomalinoides pinguis* (Jennings); Loeblich & Tappan: 631, pl. 708, figs. 18-20.

Type specimen. Walker Museum, University of Chicago, U.S.A.; from Station 226-T-9, right bank of Onion Creek, East of Jones' Crossing on the Austin-Bastrop highway, Travis County, Texas; basal Navarro, Maastrichtian.

Material examined. Topotypes, courtesy A. R. Loeblich; Kjølby Gård, Denmark; Maastrichtian, courtesy H. J. Hansen.

Description. Test unequally biconvex, very low trochospiral, 1.5 whorls, spiral side slightly convex, partially evolute, with central plug, umbilical side gently convex, involute, umbilicus small and open, periphery broadly rounded, lobulate, with imperforate band; chambers moderately inflated, oblate to spherical, gradually increasing in size, 9 chambers in final whorl; sutures on spiral side arcuate, depressed, becoming raised and marked as wide imperforate bands, umbilical sutures arcuate, depressed, becoming raised; aperture a very low arch, equatorial, continuing onto the spiral side, bordered by a low thickened lip, on spiral side hidden under the narrow but more protruding continuation of the apertural lip, spiral lip running along the entire length of the chamber, previous spiral apertures gradually closed off, lip forwards projecting with denticulate border; wall optically granular, densely and coarsely perforate.

Remarks. Brotzen (1942) differentiated *Anomalinoides* from the, in his opinion, related genera *Cibicides* and *Cibicidoides* by the symmetrical inflation and flat, nearly convex sides; from *Planulina* with great difficulty (*sic!*); from *Anomalina* by the umbilical aperture; and from *Pseudovalvulineria* by the involute spiral side.

Whittaker (1988) defined it as 'biconvex, periphery rounded; almost involute spirally, with large plug; aperture a low equatorial slit, extending along spiral suture under flaps'.

It appears from the literature in general that persistent problems are encountered in the differentiation of *Anomalinoides* from *Cibicidoides.* The clearly defined spiral groove, the small but clearly open umbilicus, and the more extended interiomarginal aperture separate *Anomalinoides* from *Cibicidoides.* Brotzen's observation is quite accurate too; *Anomalinoides* is more equally convex and inflated.

GENUS *Cibicidoides* THALMANN, 1939

1936 *Cibicides (Cibicidoides)* Brotzen: 186, *nomen nudum*, ICZN art. 13 (b).
1939 *Cibicides (Cibicidoides)* Thalmann: 448.
1951 *Cibicidoides* Thalmann; McLean: 28.
1964 *Cibicidoides* Thalmann; Loeblich & Tappan: 757.
1986 *Rhodanopeza* Loeblich & Tappan: 253.
1987 *Cibicidoides* Thalmann; Loeblich & Tappan: 572.

Type species. Truncatulina mundula Brady, Parker & Jones, 1888, original designation.

Cibicidoides mundulus (Brady, Parker & Jones, 1888)
Pl. 1, Figs. 9-12

1888 *Truncatulina mundula* Brady, Parker & Jones: 228, pl. 45, figs. 25a-c.
1939 *Cibicidoides mundulus* (Brady, Parker & Jones); Thalmann: 448.
1955 *Cibicidoides mundulus* (Brady, Parker & Jones); Loeblich & Tappan: 25.
1964 *Cibicidoides mundulus* (Brady, Parker & Jones); Loeblich & Tappan: 757, figs. 621/1*a* – *c* only.
1987 *Cibicidoides mundulus* (Brady, Parker & Jones); Loeblich & Tappan: 572, pl. 626, figs. 1-3.

Lectotype. ZF3585, The Natural History Museum, London, designated by Loeblich & Tappan, 1955; from *Plumper* station 4, 22°54'S 40°37'W, Abrohlos Bank, Brazil; 260 faths, Recent.

Material examined. Lectotype and ZF3584, paralectotypes; The Natural History Museum, London.

Description. Test lenticular to planoconvex, low trochospiral, 1.5 to 2 whorls, spiral side slightly convex, nearly flat, evolute, umbilical side convex, involute, periphery bluntly angled, somewhat lobulate, with imperforate band, umbilicus closed; chambers crescentic, equidimensional, flush, slowly increasing in size, 10 chambers in final whorl; sutures depressed, arcuate, becoming flush, spiral suture limbate; aperture elliptical, equatorial, extending onto the spiral side, bordered by a thickened lip, lip continues onto the spiral side hiding the spiral sutural part of the aperture, spiral apertures quickly closed off, apparently no modifications occur when converted into a foramen; wall very coarsely and sparsely perforate on the spiral side, finely perforate on the umbilical side.

Remarks. Mead (1985) stated 'The genera *Cibicides, Cibicidoides* and *Planulina* have many features in common and are often misunderstood and disagreed upon in the literature. All have a coarsely punctate spiral side and an interiomarginal aperture. The umbilical side of *Planulina*, however, is partly evolute, whereas the umbilical sides of *Cibicides* and *Cibicidoides* are completely involute, and the aperture of *Planulina* extends onto the umbilical side while those of *Cibicides* and *Cibicidoides* extends onto the spiral side. The major differences between *Cibicides* and *Cibicidoides* are in general shape (*Cibicides* is planoconvex whereas *Cibicidoides* is biconvex), the arrangement of punctae in the two genera, and the aperture, which in *Cibicidoides* does not extend onto the spiral side as in *Cibicides*, instead remaining at the periphery. Corliss (1979) separated *Cibicides* from *Planulina* on the basis of greater compression in *Planulina*, the flat to excavated nature of the spiral side of *Cibicides*, and the stronger convexity of *Cibicides*. However, all these features are incidental characteristics of the type species, and depend on whether a species (or individual of a species) is attached or free, and the nature of the substrate ...'.

Whittaker (1988) reiterated the difficulties in assigning species to *Cibicides, Cibicidoides* and *Planulina*. He deplored the arbitrary nature of the generic criteria used, but maintained their use. He defined *Cibicidoides* as 'biconvex, periphery rounded to carinate, usually bi-umbonate; spiral side evolute; aperture a low interiomarginal, equatorial arch with projecting lip, sometimes 'relict' aperture with lips on spiral keel'. Note also his synonymising of *Fontbotia* (type species *A. wuellerstorfi* Schwager, 1866) into *Cibicidoides*. (*Fontbotia* is herein considered a subjective synonym of *Planulina* rather than *Cibicidoides*. As this genus does not belong in any of the families looked at, *Planulina* and its synonyms are not discussed.)

Cibicides can be recognised easily because of the absence of lappets on the spiral side: the aperture continues as a simple slit in the spiral suture. Furthermore, the attached life mode of this genus has led to the development of a characteristic completely flat spiral side. *Planulina* is strongly compressed, with highly diminutive spiral lappets and both sides are clearly evolute. Both these genera are not considered here as they belong to quite different families. *Cibicidoides* has a more rounded, less extensive aperture which continues on the spiral side well hidden under spiral lappets, and not as a sunken slit in the spiral suture. As already pointed out earlier, differentiating *Cibicidoides* from *Anomalinoides* is relatively straightforward in view of the differences in extent of the aperture, and overall habitus of the test.

Cibicidoides natlandi (Beck, 1943)
Pl. 2, Figs. 1-4

1924 *Truncatulina wuellerstorffi* (Schwager); Hanna & Hanna: 59, pl. 13, figs. 13, 18.
1943 *Cibicides natlandi* Beck: 612, pl. 109, figs. 1, 5, 13.
1986 *Rhodanopeza natlandi* (Beck); Loeblich & Tappan: 253.
1987 *Rhodanopeza natlandi* (Beck); Loeblich & Tappan: 584, pl. 638, figs. 4-8.

Holotype. 7521, Paleo collection, Leland Stanford University, California; from west bank of Cowlitz River, E0.5 SE 0.24, Sec. 28, T. 11N, R. 2W, Lewis County, Washington, Upper Eocene.

Material examined. CC39850, 4 paratypes, Smithsonian Institution, Washington, D.C.

Description. Test rather large, planoconvex, almost planispiral, spiral side very flat, may be slightly convex, evolute, umbilical side slightly convex, involute, periphery sharply angled, carinate, often plate-like extended, clearly lobulate, 2.5 whorls; chambers very gently arcuate, flush with the surface on both sides, 10 chambers in final whorl; sutures on spiral side gently arcuate, raised and thickened, continuing along the peripheral edge and forming the carina, more strongly arcuate on umbilical side, raised into almost plate-like ridges, becoming ornamented in earlier parts with corrugations; aperture equatorial, a semicircular opening straddling the periphery, continuing onto the spiral side under a diminutive flap, flap arcuate, running the entire length of the chamber, flaps apparently allowing direct access to some of the earlier chambers, spiral relict apertures gradually closed off, no trace of spiral coverplates; wall perforate, appearing optically granular.

Remarks. C. natlandi is the type species of *Rhodanopeza* Loeblich & Tappan, 1986. *Rhodanopeza* was originally classified in the Cibicidinae but the differentiation from *Cibicides* put forward by the authors is substantial to the point of suggesting an alliance different from the proposed one. Interestingly, a differentiation from *Planulina* is also provided but no mention is made of *Cibicidoides*. The unequally biconvex test, the semi-circular aperture straddling the periphery and the arcuate lappets on the spiral side are so similar to the morphological features of *Cibicidoides* that the separation of these two taxa cannot be maintained: ornamentation alone is insufficient for the recognition of genera.

GENUS *Hanzawaia* ASANO, 1944

non 1808 *Florilus* de Montfort: 134, suppressed, ICZN, 1990.
1944 *Hanzawaia* Asano: 97.
1964 *Hanzawaia* Asano; Loeblich & Tappan: 759.
1980 *Hanzawaia* Asano; Hansen & Rögl: 174.
1987 *Hanzawaia* Asano; Loeblich & Tappan: 639.
1996 *Hanzawaia* Asano; Revets:

Type species. Hanzawaia nipponica Asano, 1944, original designation.

Hanzawaia nipponica Asano, 1944
Pl. 2, Figs. 5-8

1944 *Hanzawaia nipponica* Asano: 98, pl. 4, figs. 1-2.
1964 *Hanzawaia nipponica* Asano; Loeblich & Tappan: 759, figs. 623/1 – 2.
1987 *Hanzawaia nipponica* Asano; Loeblich & Tappan: 639, pl. 719, figs. 1-4.
1996 *Hanzawaia nipponica* Asano; Revets: , pl. 2, figs. 7-9.

Holotype. 66016, Tohoku University, Sendai; from Yamaguti, Kakio-tyô, Kawasaki-si, Kanagawa Prefecture; Pliocene.

Material examined. Topotypes, courtesy J. E. Whittaker; also from Kochi Prefecture, Ananai formation, Pliocene.

Description. Test strongly compressed, very low trochospiral, spiral side flat, with small spiral plug, evolute, umbilical side moderately convex, partially evolute, periphery bluntly angular, slightly lobulate, with imperforate band, umbilicus closed, 1.5 to 2 whorls; chambers narrow, crescentic, flush, 10 chambers in final whorl; sutures raised, rather wide, strongly arcuate; aperture equatorial, an elliptical opening bordered by a thickened lip, aperture continuing on spiral side under a folium-like flap, flap subrectangular, projecting in a posterior direction, fusing with previous flap, succession of fused flaps forming a continuous spiralised imperforate band, often with extra apertures, earlier umbilical apertures remain open as relicts; wall optically indistinctly radial, finely perforate.

Remarks. Difficulties are often experienced in the differentiation between *Hanzawaia, Planulina, Fontbotia* and *Cibicidoides* (see Whittaker, 1988, p. 138). Whittaker (*ibid.*) defined *Hanzawaia* as 'biconvex to plano-convex, sometimes keeled; spiral side involute with prominent lappets or septal flaps under which peripheral interiomarginal aperture extends; with supplementary openings under flaps'.

The spiral lappets are highly characteristic in the type species because they are so strongly developed. Whittaker maintained that this develoment is variable and included a number of species in this genus with non-overlapping lappets.

As discussed previously (Revets, 1996), the progressive widening of the concept of *Hanzawaia* can be argued against. Correlated morphological differences allow a sharp line to be drawn between *Hanzawaia* and *Riminopsis* (*q.v.*), the latter genus name proposed to salvage the original *Florilus* concept.

Planulina differs by being much more compressed, with a nearly truncate periphery and being evolute on both sides, furthermore, the flaps occur on the umbilical side and are diminutive compared to those in *Hanzawaia*. *Cibicidoides* is unequally biconvex rather than compressed and the spiral lappets diminutive compared to those in *Hanzawaia*.

GENUS *Heterolepa* FRANZENAU, 1884

1884 *Heterolepa* Franzenau: 214.
1884 *Pseudotruncatulina* Andreae: 122.
1898 *Dendrina* Costa, *in* Fornasini: 206.
1962 *Heterolepa* Franzenau; Loeblich & Tappan: 72.
1964 *Heterolepa* Franzenau; Loeblich & Tappan: 759.
1975 *Cibusoides* Saidova: 267.
1981 *Crawfordoides* McCulloch: 174.
1987 *Heterolepa* Franzenau; Loeblich & Tappan: 632.

Type species. Rotalina dutemplei d'Orbigny, 1846, subsequent designation by Loeblich & Tappan (1962).

Heterolepa dutemplei (d'Orbigny, 1846)
Pl. 2, Figs. 9-12

1846 ***Rotalina dutemplei*** d'Orbigny: 157, pl. 8, figs. 19-21.
1884 ***Heterolepa simplex*** Franzenau: 215, pl. 5, figs. 1a-c.
1885 ***Heterolepa dutemplei*** (d'Orbigny); Franzenau: 152.
1962 ***Heterolepa dutemplei*** (d'Orbigny); Loeblich & Tappan: 72.
1964 ***Heterolepa dutemplei*** (d'Orbigny); Loeblich & Tappan: 759, figs. 623/3$a-c$.
1985 ***Heterolepa dutemplei*** (d'Orbigny); Papp & Schmid: 61, pl. 52, figs. 1-6.
1987 ***Heterolepa dutemplei*** (d'Orbigny); Loeblich & Tappan: 632, pl. 709, figs. 1-8.

Lectotype. GBA1981/03/240, Geologische Bundesanstalt Wien, designated by Papp & Schmid, 1985; from Nußdorff, Vienna; Tortonian.

Material examined. Topotypes, courtesy F. Rögl.

Description. Test unequally biconvex to lenticular, low trochospiral, spiral side flat to slightly convex, evolute, umbilical side convex, involute, periphery bluntly angled, with imperforate band, lobulate in the last stage, umbilicus closed, 2.5 to 3 whorls; chambers oblate, somewhat oblique, flush, 7 chambers in final whorl; sutures depressed, arching backwards on spiral side, gently arched on umbilical side, spiral suture limbate, well defined; aperture slit-like, interiomarginal, in the uppermost part of the leading face, seamed by a low, partially everted lip, aperture continuing onto the spiral side, for about half the chamber length, partially hidden under a continuation of the lateral apertural lip, earlier sutural apertures closed off by secondary lamellae; wall optically granular, densely perforate.

GENUS *Loisthostomata* LOEBLICH & TAPPAN, 1986

1986 *Loisthostomata* Loeblich & Tappan: 255.
1987 *Loisthostomata* Loeblich & Tappan; Loeblich & Tappan: 632.

Type species. Loisthostomata exiguum Loeblich & Tappan, 1986, original designation.

Loisthostomata exiguum Loeblich & Tappan, 1986
Pl. 3, Figs. 1-4

1986 ***Loisthostomata exiguum*** Loeblich & Tappan: 255, figs. 22-27.
1987 ***Loisthostomata exiguum*** Loeblich & Tappan; Loeblich & Tappan: 632, pl. 710, figs. 7-11.

Holotype. USNM383482, Smithsonian Institution, Washington, D.C.; from 0.8 km east of US Highway 45, just north of the road to Carmichael from Shubuta, Clarke County, Mississippi; Shubuta Member, Yazoo Formation, Upper Eocene.

Material examined. USNM383482, holotype, USNM383483 & 484, paratypes, Smithsonian Institution, Washington, D.C.

Description. Test unequally biconvex to lenticular, low trochospiral, spiral side gently convex, evolute, umbilical side less convex to flattened, involute, periphery broadly rounded, with a small imperforate band, lobulate, small open umbilicus, 2.5 to 3 whorls; chambers oblate, wide, flush to slightly inflated, 7 chambers in the final whorl; sutures depressed, on spiral side strongly arcuate, becoming limbate, on umbilical side gently curved, becoming flush, spiral suture limbate; aperture a small equatorial arch, straddling the periphery, bordered by a thickened lip, and continuing on the spiral side for about a third of the length of the chamber, still bordered by a clearly everted lip, with the addition of a new chamber, the spiral part of the aperture remains open, sutural apertures gradually closed off; wall optically granular, finely and densely perforate.

Remarks. Loisthostomata was originally proposed as a member of the Parrelloididae, alongside *Cibicidoides, Hollandina* and, of course, *Parrelloides*. Subsequently, Loeblich & Tappan (1987) reclassified *Loisthostomata* in the Heterolepidae, alongside amongst others *Anomalinoides*, differentiating it from *Hollandina* and *Cibicidoides*.

Hollandina clearly belongs somewhere else. The very simple aperture and almost featureless spiral extension, the clearly open and depressed umbilicus, together with the lower trochospiral coiling of *Loistostomata* is very different from the well defined spiral lips, even showing on the relict apertures, the closed umbilicus and the higher coiling in *Cibicidoides*. The diminutive spiral relict apertures and open umbilicus, besides the more lenticular test shape, differentiate it unambiguously from *Heterolepa*.

GENUS *Orithostella* EICHER & WORSTELL, 1970

1970 *Orithostella* Eicher & Worstell: 294.
1987 *Orithostella* Eicher & Worstell; Loeblich & Tappan: 641.

Type species. Orithostella viriola Eicher & Worstell, 1970, original designation.

Orithostella viriola Eicher & Worstell, 1970
Pl. 3, Figs. 5-8

1970 ***Orithostella viriola*** Eicher & Worstell: 295, pl. 6, figs. 6-8.
1987 ***Orithostella viriola*** Eicher & Worstell; Loeblich & Tappan: 641, pl. 723, figs. 1-7.

Holotype. 27972, University of Colorado Museum, Boulder; from Bull Creek, Crook County, Wyoming; Greenhorn Formation, Upper Cenomanian to Lower Turonian.

Material examined. Topotypes, courtesy D. Eicher.

Description. Test planoconvex, low trochospiral, spiral side flattened, evolute, with a well defined central plug, umbilical side strongly convex, involute, umbilicus narrow, clearly depressed, periphery truncate and well rounded, lobulate, 2 whorls; chambers narrow and crescentic, moderately inflated on umbilical side, flush on spiral side, 8-9 chambers in final whorl; sutures strongly arcuate and backswept, at first depressed, becoming flush, on umbilical side remaining depressed; aperture equatorial, semi-circular, with a thick low lip, aperture continuing onto the spiral side, hidden under a substantial spiral flap, spiral flaps imbricate, allowing access to previous chambers, earlier flaps slowly coalescing and forming the central spiral plug; wall finely and distinctly perforate, optically granular.

Remarks. Orithostella was originally seen as having strong gavelinellid affinities. The classification of the genus in the Anomalininae by Eicher & Worstell reflects the then current classification of Loeblich & Tappan (1964). As shown here, *Orithostella* is much closer to *Anomalina* than to *Gavelinella* (as the classification by Loeblich & Tappan, 1987 suggests), especially in view of the reinterpretation of the apertural complex as occurring on the spiral side rather than the umbilical side.

GENUS *Parrelloides* HOFKER, 1956

1956b *Parrelloides* Hofker: 936.
1964 *Cibicidoides* Thalmann; Loeblich & Tappan: 757, *partim*.
1987 *Parrelloides* Hofker; Loeblich & Tappan: 573.

Type species. Cibicides hyalinus Hofker, 1951a, original designation.

Parrelloides hyalinus (Hofker, 1951)
Pl. 3, Figs. 9-12

1951a *Cibicides hyalina* Hofker: 359, figs. 244-245.
1956b *Parrelloides hyalinus* (Hofker); Hofker: 936.
1964 *Cibicidoides hyalinus* (Hofker); Loeblich & Tappan: 757, figs. 621/2a-d only!
1987 *Parrelloides hyalinus* (Hofker); Loeblich & Tappan: 573, pl. 625, figs. 1-7.

Lectotype. Zoological Museum, Amsterdam, The Netherlands; from 2°17'S, 99°27'E, 377 fathoms, Southwest of Sumatra; Recent, herein designated.

Material examined. Specimens from 2°17'S, 99°27'E, 377 fathoms and 8°15'S 118°56'E, 340 fathoms, Zoological Museum Amsterdam. Also USNM434730, from the Sahul Shelf, Smithsonian Institution, Washington, D.C..

Description. Test lenticular to unequally biconvex, low trochospiral, spiral side generally less convex, evolute, umbilical side clearly convex, involute, umbilicus closed, periphery bluntly angled, may be marked by an imperforate band, gently lobulate, 2.5 whorls; chambers oblate, wide, flush, final chamber may be slightly inflated, on spiral side almost rectangular, 7-8 chambers in the final whorl; sutures slightly depressed if at all, gently arcuate on spiral side, straight on umbilical side, becoming flush and somewhat wider, spiral suture limbate to raised; aperture a small short narrow slit, with distinctly thickened lip, equatorial, extending onto the spiral side over a very short distance, spiral relict apertures quickly closed off; wall hyaline, optically granular, finely perforate, although the umbilical side is nearly poreless.

Remarks. Parrelloides adds a further complication to the untangling of the *Planulina-Cibicidoides* problem. Hofker apparently defined the genus when looking at *Cibicides cookei* Cushman & Garrett, 1939 in the Eocene of Ecuador, but the actual type species is from the Recent of Sumatra. The type specimens of *C. cookei* (CC24692 & 24821, Smithsonian Institution) show that this taxon should be referred to *Heterolepa*, rather than to *Parrelloides*. Hofker also included in *Parrelloides* the species *Rotalina ungeriana* d'Orbigny, 1846; *Truncatulina mundula* Brady, Parker & Jones, 1888 and *Anomalina wuellerstorffi* Schwager, 1866. Loeblich & Tappan (1964) synonymised it in *Cibicidoides*, but in 1987 split them again, on the grounds that the wall structure of *Parrelloides* is radial, the test smaller, with an arched spiral side, prominent umbilical filling and a rounded non-carinate periphery.

The very restricted extension of the aperture onto the spiral side is quite different from that encountered in *Cibicidoides*, and added to the often much more domed spiral side and flattened umbilical side provide enough grounds to support the generic separation of these two taxa.

GENUS *Riminopsis* REVETS, 1996

1808 *Florilus* de Montfort: 134, suppressed, ICZN, 1990.
1996 *Riminopsis* Revets:

Type species. Nautilus asterizans von Fichtel & von Moll, 1798.

Description. Test compressed lenticular, spiral side partially but not completely evolute, slightly convex with central part depressed, umbilical side involute, slightly convex, with a barely depressed umbilicus, periphery very bluntly angular, may appear somewhat keeled in earlier parts due to an imperforate band of secondary laminations, flush to slightly lobulate, commonly 1.5 to 2 whorls in very low trochospiral coils; chambers narrow, oblique but regularly so, increasing in height during ontogeny but barely in width, flush with the surface; sutures gently and regularly arcuate, commonly initially depressed, later becoming raised; aperture an extraumbilical interiomarginal low arch, surrounded by a thickened lip, aperture continuing onto the spiral side, running along the entire width of the chamber, shielded by a small flap-like extension of the spiral chamber wall hovering over the spiral aperture, successive flaps imbricate but no fusing occurs during ontogeny; wall usually rather coarsely perforate, distinctly less perforate on the umbilical side.

Remarks. The subsuming of *Florilus asterizans* into *Hanzawaia*, enforced by the ICZN (1990), further widened the concept of that genus. As shown previously, consistent morphological differences between the type species of *Florilus* and *Hanzawaia* support their generic separation. Because of the suppression of the name *Florilus* for the sake of stability of the nomenclature, the name *Riminopsis* was proposed (Revets, 1996).

FAMILY ALABAMINIDAE HOFKER, 1951

1951a Alabaminidae Hofker: 389.
1958 Alabaminidae Hofker; Reiss: 61.
1964 Alabaminidae Hofker; Loeblich & Tappan: 748.
1964 Osangulariidae Loeblich & Tappan: 752.
1981 Alabaminidae Hofker; Haynes: 260.
1984 Oridorsalidae Loeblich & Tappan: 53.
1987 Alabaminidae Hofker; Loeblich & Tappan: 627.

Description. Test free, multilocular, low trochospiral, spiral side evolute, umbilical side completely involute; umbilicus commonly closed; aperture an interiomarginal slit, with areal extension or supplementary areal aperture, extension may be incipient and only marked as an inframarginal sulcus; wall perforate.

GENUS *Alabamina* TOULMIN, 1941

1941 *Alabamina* Toulmin: 602.
1942 *Eponidoides* Brotzen: 20.
1964 *Alabamina* Toulmin; Loeblich & Tappan: 748.
1987 *Alabamina* Toulmin; Loeblich & Tappan: 627.

Type species. Alabamina wilcoxensis Toulmin, 1941, original designation, objective junior synonym of *Pulvinulinella exigua* var *westraliensis* Parr, 1938.

Alabamina westraliensis (Parr, 1938)
Pl. 4, Figs. 1-4

1926 *Pulvinulina exigua* Brady; Plummer: 150, pl. 11, figs. 3a-c.
1932 *Pulvinulinella exigua* var. *obtusa* (Burrows & Holland); Cushman & Ponton: 71, pl. 9, fig. 9.
1936 *Pulvinulinella exigua* var. *obtusa* (Burrows & Holland); Jennings: 192, pl. 31, fig. 4.
1938 *Pulvinulinella obtusa* var. *westraliensis* Parr: 84, pl. 3, figs. 1a-c.
1939 *Pulvinulinella exigua* var. *obtusa* (Burrows & Holland); Howe: 81, pl. 11, figs. 4-6.
1939 *Pulvinulinella obtusa* (Burrows & Holland); Cushman & Garrett: 87, pl. 15, figs. 12-13.
1941 *Alabamina wilcoxensis* Toulmin: 603, pl. 81, figs. 10-14.
1964 *Alabamina wilcoxensis* Toulmin; Loeblich & Tappan: 749, figs. 614/11a-c.
1965 *Alabamina westraliensis* (Parr); McGowran: 45, pl. 2, fig. 8.
1987 *Alabamina wilcoxensis* Toulmin; Loeblich & Tappan: 627, pl. 705, figs. 10-12.

Holotype. 18903, from Perth, King's Park Bore No. 2, 728 feet, Palaeocene, King's Park formation; University of Western Australia. Of *Alabamina wilcoxensis* Toulmin: 52308, Princeton University, USA; from Railroad cut, 1 mi North of Ozark, Dale County, Alabama; Greensand Marl, Upper Wilcox Group, Palaeocene.

Material examined. Holotype and numerous topotypes; University of Western Australia. Of *A. wilcoxensis*: CC38519, paratypes; CC16231 (as *Pulvinulinella exigua* var. *obtusa sensu* Cushman & Ponton, 1932); 26 topotypes; Smithsonian Institution, Washington, D.C.

Description. Test lenticular, strongly compressed, spiral side flattened, evolute, umbilical side gently domed, involute, periphery bluntly angled, non-carinate, flush to barely lobate, umbilicus closed, 2 to 3 whorls in low trochospire; chambers crescentic but wide, flush, regularly increasing in size, 5 chambers in final whorl; sutures flush, limbate, on spiral side straight and obliquely set to the periphery, running straight to the peripheral margin, spiral suture appearing jagged, composed of straight intercameral suture fragments, on umbilical side almost straight, gently curved, may be slightly sigmoid; aperture interiomarginal, extraumbilical, a long narrow slit running up towards the periphery, uppermost end in the spiral part of a deeply sunken inframarginal sulcus, apertural border with a very low lip, lip continuing along the axial chamber wall about halfway to the foramen, a lower and broader, denticulate lip is also present on the axial side of the aperture; wall hyaline, optically granular, sparsely and very finely perforate.

Remarks. Juvenile specimens are more rounded, specimens become more compressed through ontogeny. The peculiar backwards extension of the inframarginal sulcus seen in sections and the apertural lip should not be confused with a toothplate-like structure, as Hofker (1951a) erroneously did. Haynes (1981, p. 240, 241) drew attention to Hofker's views but thought this feature to be adaptive rather than a relict.

The nomenclatorial history of the species is confused. Parr (1938) proposed a replacement name for the misidentification by Cushman & Ponton (1932) of *Pulvinulinella exigua* var. *obtusa*. In 1941, Toulmin also proposed a new name for the same misidentification, unaware of Parr's prior proposal. Hence, Toulmin's name is an objective junior synonym and the correct name for the species should be *westraliensis*.

Alabamina dorsoplana (Brotzen, 1940)
Pl. 4, Figs. 5-8

1940 *Eponides dorsoplana* Brotzen: 31, fig. 2a-c.
1942 *Eponidoides dorsoplanus* (Brotzen); Brotzen: 20.
1948 *Alabamina dorsoplana* (Brotzen); Brotzen: 102, pl. 16, fig.3, textfigs. 25-27.
1964 *Alabamina dorsoplana* (Brotzen); Loeblich & Tappan: 748.
1987 *Alabamina dorsoplana* (Brotzen); Loeblich & Tappan: 627.

Holotype. Naturhistoriska Riksmuseet, Stockholm; from Trelleborg Drilling, -14 m, S. Sweden; Upper Maastrichtian-Lower Danian.

Material examined. Trelleborg Drilling, -15 m, donated by Brotzen to the Smithsonian Institution; also Kjølby Gård, Denmark; Maastrichtian, courtesy H. J. Hansen.

Description. Test lenticular, spiral side flat, evolute, umbilical side convex, involute, periphery broadly angled, periphery flush, umbilicus closed, 1.5 whorls in low trochospire; chambers flush, rapidly increasing in length along the spiral suture, 4-5 chambers in final whorl; sutures depressed, straight, set oblique to the periphery on the spiral side; aperture an extraumbilical interiomarginal slit, rather wide, running into a ill-defined inframarginal sulcus; wall optically granular, sparsely and finely perforate.

Remarks. Eponides dorsoplana is the originally designated type species of *Eponidoides* Brotzen, 1942. This species is, together with most other Cretaceous species, more globose than the more typical Tertiary *Alabamina* species. Also, the inframarginal sulcus is less pronounced than later in the fossil record, supporting to some extent the view of Haynes (1981) that this feature is of adaptive value rather than just a relict. These two elements are the sole differences between *Eponidoides* and *Alabamina*, here deemed insufficient to warrant generic separation.

GENUS *Charltonina* BERMÚDEZ, 1952

1952 *Charltonina* Bermúdez: 69.
1964 *Charltonina* Bermúdez; Loeblich & Tappan: 752.
1987 *Charltonina* Bermúdez; Loeblich & Tappan: 629.
non 1987 *Transylvanina* Gheorgian, Iva & Gheorgian; Loeblich & Tappan: 629.

Type species. Pseudoparrella madrugaensis Cushman & Bermúdez, 1948, original designation.

Charltonina madrugaensis (Cushman & Bermúdez, 1948)
Pl. 4, Figs. 9-12

1948 *Pseudoparrella madrugaensis* Cushman & Bermúdez: 73, pl. 12, figs. 11-13.
1952 *Charltonina madrugaensis* (Cushman & Bermúdez); Bermúdez: 73.
1964 *Charltonina madrugaensis* (Cushman & Bermúdez); Loeblich & Tappan: 752, figs. 615/5a-c.
1987 *Charltonina madrugaensis* (Cushman & Bermúdez); Loeblich & Tappan: 629, pl. 707, figs. 4-6 only!

Holotype. CC57974, Smithsonian Institution, Washington, D.C.; from Station 76b, under a highway bridge on the Central San Antonio, Madruga, Cuba; Madruga Formation, Palaeocene

Material examined. Holotype CC57974 and 4 paratypes, CC57975 & 76; also specimens from Palmer St. 1214, 1 km W of Central San Antonio on the railroad to Central Hershey, Habana Province, Cuba, Upper Cretaceous, Smithsonian Institution, Washington, D.C.

Description. Test discoidal, unequally biconvex to planoconvex, low trochospiral, spiral side flattened to slightly convex, evolute, umbilical side more strongly convex, involute, periphery sharply angled, with a clear keel, distinctly lobulate, umbilicus closed, 2 whorls; chambers narrow crescentic, slightly inflated, gradually increasing in size, becoming more crecentic during ontogeny, 5 chambers in final whorl; sutures on spiral side flush to limbate, gently arcuate to straight, extending slightly into the keel, producing a small extension of the keel peripherally, on umbilical side depressed, gently arcuate, spiral suture well defined, limbate; aperture a narrow extraumbilical slit, running from just outside the umbilicus up to the periphery, veering away at the top to run along and parallel to the periperal margin over a short distance, a flap-like lip runs along the entire length of the aperture; wall optically granular, rather coarsely and relatively sparsely perforate; the central part on the spiral side tends to become raised due to secondary lamination.

Remarks. Bermúdez reported a similarity to *Pulsiphonina* and *Siphonina* as regards the spiral side, but the aperture was said to be a curved slit running from the umbilicus up to the periphery and running parallel to the margin.

The observations here reported rather point to affinities with *Conorotalites* and to a lesser extent *Alabamina*.

Loeblich & Tappan (1987) synonymised *Transylvanina* Georgian, Iva & Georgian, 1968 into this genus, but from the figures available, *Alabamina* seems to be more appropriate.

GENUS *Cribroparrella* TEN DAM, 1948

non 1938 *Parrella* Ginsburg.
1939 *Parrella* Finlay: 523.
1948 *Cribroparella* ten Dam: 486.
1949 *Cribroparrella* ten Dam; Thalmann: 653, *emend.*
1964 *Cribroparrella* ten Dam; Loeblich & Tappan: 752.
1987 *Cribroparrella* ten Dam; Loeblich & Tappan: 629.

Type species. Cribroparrella regadana ten Dam, 1948, original designation. Type species of *Parrella* Finlay: *Anomalina bengalensis* Schwager, 1866, original designation.

Remarks. ten Dam consistently misspelled the genus name as *Criboparella*, as he misspelled *Parrella* as *Parella*. Hence, Thalmann's emendation of the name is justified (ICZN art. 32, par. c & d).

Cribroparella regadana ten Dam, 1948
Pl. 5, Figs. 1-4

1948 *Cribroparrella regadana* ten Dam: 486, pl. 76, figs. 1-3.
1964 *Cribroparrella regadana* ten Dam; Loeblich & Tappan: 752, figs. 615/7a-c.
1987 *Cribroparrella regadana* ten Dam; Loeblich & Tappan: 629, pl. 707, figs. 10-12.

Holotype. Not traced; from ten Dam loc. 19, Ain Regada, W. Algeria, Blue Marls, Upper Miocene.

Material examined. CC57994, topotype; Smithsonian Institution, Washington, D.C.

Description. Test large, lenticular, very low trochospiral, spiral side slightly convex, evolute, umbilical side moderately convex, involute, periphery sharply angled, with a projecting keel, keel often irregularly denticulate, umbilicus closed, rarely with pseudoumbilicus, 2 whorls; chambers narrow, oblique, on spiral side almost triangular wedges, flush, more sigmoid and slightly inflated on umbilical side, 16 chambers in final whorl; sutures on spiral side strongly oblique, at first slightly raised, later flush, becoming indistinct, on umbilical side elegantly sigmoid, at first clearly depressed, later becoming raised, remaining distinct; aperture an *Osangularia*-like slit with distinct lip, two rows of irregular openings running up the apertural face, forming the supplementary trematophore, each opening seamed by a distinct, everted lip; wall appearing optically granular, very finely perforate.

Cribroparrella bengalensis (Schwager, 1866)
Pl. 5, Figs. 5-8

1866 *Anomalina bengalensis* Schwager: 259, pl. 7, fig. 111.
1939 *Parrella bengalensis* (Schwager); Finlay: 523.
1964 *Osangularia bengalensis* (Schwager); Loeblich & Tappan: 752, figs. 615/3 – 4 only!
1987 *Osangularia bengalensis* (Schwager); Loeblich & Tappan: 630, pl. 708, figs. 4-5 only!
1988 *Osangularia bengalensis* (Schwager); Whittaker: 135.

Neotype. Banares University, designated by Srinivasan & Sharma (1980); from Kar Nikobar, Indian Ocean; Upper Miocene.

Material examined. Topotypes, courtesy J. E. Whittaker.

Description. Test lenticular, low trochospiral, spiral side moderately convex, evolute, umbilical side convex, involute, periphery sharply angled and keeled, keel partially denticulate, umbilicus closed, 2 whorls; chambers narrow, oblique, flush, 13-14 chambers in final whorl; sutures on spiral side flush, at first gently depressed on umbilical side, gently arcuate; aperture composite, a narrow slit bordered by an everted periapertural lip stands perpendicular on the basal suture about halfway between umbilicus and periphery, in the peripheral-most region from the main aperture a trematophore composed of large circular openings, each seamed by a thickened lip, conversion of an aperture to a foramen results in the deposition of a incomplete sealing-off plate adjacent to the foramen on its umbilical side; wall very finely and densely perforate.

Remarks. Parrella is defined by *Anomalina bengalensis* Schwager, 1866, but the genus name is preoccupied by *Parrella* Ginsburg, 1938. *Osangularia* is often considered to be the next available name (Loeblich & Tappan, 1964, 1987; Whittaker, 1988). *Osangularia* is based on *O. lens* Brotzen, 1940, and the most obvious characteristic of the genus is the unusual shape of the aperture, which is made up of two parts, one of which stands nearly perpendicular on the basal suture of the chamber. A neotype was designated for *A. bengalensis* by Srinivasan & Sharma (1980) and topotypes donated to the BM(NH). These specimens are well in keeping with the description given by Schwager. Highly characteristic is the apertural face which sports besides an *Osangularia*-like main aperture an areal cribrate supplementary aperture. Sections reveal that this is not a feature restricted to the last few chambers, i.e. it is not a purely gerontic feature (as stated by Whittaker, 1988, p. 135). The fact that juvenile specimens of *O. bengalensis* (as well as *C. regadana* as mentioned by ten Dam) do not possess the cribrate part of the aperture does not diminish the value of this characteristic for taxonomic purposes. Furthermore, it seems that some kind of coverplate is deposited in the umbilical-most region of each chamber in *A. bengalensis*. Therefore, the subjective synonymy with *Osangularia* is herein rejected.

Comparing *A. bengalensis* with *Cribroparrella regadana* ten Dam, 1948, shows the two to be congeneric. The two species are however different, as *C. regadana* has more chamber in its final whorl and is more evenly lenticular.

GENUS *Conorotalites* KAEVER, 1959

1959 *Conorotalites* Kaever: 434.
1964 *Conorotalites* Kaever; Loeblich & Tappan: 752.
1987 *Conorotalites* Kaever; Loeblich & Tappan: 629.

Conorotalites aptiensis Bettenstaedt, 1952
Pl. 5, Figs. 9-12

1952 *Globorotalites bartensteini aptiensis* Bettenstaedt: 282, pl. 3, figs. 32a-c, pl. 4, figs. 59-72.
1959 *Conorotalites aptiensis* (Bettenstaedt); Kaever: 434.
1960 *Conorotalites aptiensis* (Bettenstaedt); Reiss:
1964 *Conorotalites aptiensis* (Bettenstaedt); Loeblich & Tappan: 752, figs. 616/1 – 2.
1987 *Conorotalites aptiensis* (Bettenstaedt); Loeblich & Tappan: 629, pl. 707, figs. 1-3.

Holotype. 3927, Senckenberg Museum, Frankfurt-am-Main; from 563.3-564.8 m, Georgsdorf well 81, near Lingen, NW Germany, lowermost Aptian, *bodei* zone.

Material examined. 10 paratypes, SMF XXVII3967 & 3968.

Description. Test conical, spiral side flat, sometimes even slightly irregularly concave, evolute, umbilical side broadly convex, involute, umbilicus closed, may show a more or less well defined pseudo-umbilicus, periphery sharply angled, well defined keel, lobulate, up to 2 whorls; chambers crescentic to oblique, moderately inflated, 7 chambers in final whorl; sutures on spiral side gently arched, at first depressed, becoming strongly raised, on umbilical side straight to gently sigmoid, depressed, becoming flush; aperture an interiomarginal slit running from pseudo-umbilicus to the periphery, stopping just before an incipient inframarginal sulcus, aperture rather wide, bordered on the peripheral side only by a well defined, cristate lip, no changes occur when converted to a foramen; wall optically granular, sparsely and finely perforate, apertural face imperforate.

Remarks. Kaever differentiated *Conorotalites* from *Globorotalites* because of the very coarse, irregular pores; the raised sutures on the spiral side; a wider interiomarginal aperture with a strong lip, and the free umbilical lip at the bottom of the aperture. Furthermore, the shape of the chambers was described as much more curved to sigmoid on the umbilical side.

The type series shows the high variability of these characters and are hence not very reliable for generic differentiation from *Globorotalites*. However, contrary to *Globorotalites*, no modifications occur to the aperture when it is converted into a foramen in *Conorotalites*, hence these two genera are maintained as distinct.

GENUS *Goupillaudina* MARIE, 1958

1957 *Goupillaudina* Marie: 247, *nomen nudum*.
1958 *Goupillaudina* Marie: 861.
1964 *Goupillaudina* Marie; Loeblich & Tappan: 753.
1987 *Goupillaudina* Marie; Loeblich & Tappan: 630.

Type species. Goupillaudina daguini Marie, 1958, original designation.

Goupillaudina daguini Marie, 1958
Pl. 6, Figs. 1-4

1958 *Goupillaudina daguini* Marie: 863, pl. 42, figs. 2a-c, textfigs. 1A-F.
1964 *Goupillaudina daguini* Marie; Loeblich & Tappan: 753, figs. 617/1 – 2.
1987 *Goupillaudina daguini* Marie; Loeblich & Tappan: 630, pl. 707, figs. 13-19.

Holotype. 6040, Muséum National d'histoire Naturelle, Paris; from a Lime Kiln, Bernon, Department of Charente-Maritime; Upper Campanian.

Material examined. Specimens from Le Caillaud, Talmont (France, Campanian), courtesy A. Dhondt; from the Pyrenees (Campanian), courtesy E. Caus; from Somalia (Campanian), courtesy J. Pignatti.

Description. Test very large, strongly compressed, apparently biumbonate, spiral side flat, partially evolute, with small plug, umbilical side flat, evolute, with a strong groove and large plug, periphery bluntly angled and flush, with imperforate band, umbilicus open, up to 4 whorls in almost planispiral coils; chambers very narrow, strongly crescentic and closely appressed, 13-15 chambers in final whorl; sutures flush, limbate, strongly arcuate, spiral suture indistinct; aperture slit-like, largely areal; wall sparsely and finely perforate.

Remarks. This is a very unusual taxon, with a surprising combination of characteristics. The *Operculina*-like outlook points towards a possible affinity with the 'larger' rotaliids, but the apertural morphology and absence of canals, etc., strongly argue against this. The presence of plug-like hyaline masses of calcite on both sides of the test is also very unusual. The deep groove on the umbilical side is not an indication of the presence of umbilical extensions of the aperture, echoing a comparable situation encountered in *Holmanella*.

GENUS *Oridorsalis* ANDERSEN, 1961

1961 *Oridorsalis* Andersen: 107.
1964 *Oridorsalis* Andersen; Loeblich & Tappan: 750.
1987 *Oridorsalis* Andersen; Loeblich & Tappan: 630.

Type species. Oridorsalis westi Andersen, 1961, original designation.

Oridorsalis westi Andersen, 1961
Pl. 6, Figs. 5-8

?1898 *Truncatulina tenera* var *stellata* Silvestri: 297, pl. 6, figs. 9a-c.
1961 *Oridorsalis westi* Andersen: 107, pl. 22, figs. 3a-c.
1964 *Oridorsalis westi* Andersen; Loeblich & Tappan: 750, figs. 614/4a-c.
1987 *Oridorsalis westi* Andersen; Loeblich & Tappan: 630, pl.708, figs. 6-8.

Holotype. 4443, Geology Museum, Louisiana State University; from Mudlump Island, off mouth of South Pass, Lower Mississippi River Delta; Recent.

Material examined. Topotypes, courtesy B. Kohl.

Description. Test lenticular, low trochospiral, spiral side convex, evolute, umbilical side more convex, involute, periphery angled, with a clear keel, lobulate, umbilicus closed, 2 whorls; chambers oblate, wide and flattened, flush, 4 chambers in final whorl; sutures barely depressed, on spiral side straight, normal to the spiral suture, on umbilical side strongly jagged halfway down towards the umbilicus, spiral suture well defined, raised; aperture interiomarginal, slit-like, with a very short extension onto the spiral side, previous spiral part of apertures remaining open as relict apertures, with a supplementary umbilical aperture positioned almost perpendicular to the main aperture; wall optically granular, sparsely and finely perforate.

Remarks. The combination of a clearly lenticular test with a variable number of supplementary spiral apertures, relicts of the previous apertures, is very characteristic. Andersen differentiated it from *Pseudoeponides* by the relict apertures being confined to the last whorl and by the absence of supplementary apertures on the umbilical side. Contrary to *Helenina*, it does not possess a ventral lobe nor septal apertures on the umbilical side (Andersen, 1961). Mead (1985, p. 237) claimed that the secondary apertures on the spiral side are not always present. In his opinion, the small opening at the umbilicus partly closed by a small flap is a more consistent key. From various photographs in the literature it seems that at least one spiral relict aperture is always present. Whittaker (1988) does not discuss Mead's nor Andersen's views, but his figure does support Mead's contention, although diminutive flaps of spiral relict apertures can be seen.

Silvestri's species from Pliocene deposits of the Siena region, Italy, is possibly a senior synonym, but no specimens were available for comparison (Silvestri mentioned finding only 2 specimens), hence the question mark in the synonymy of *O. westi*.

The familial classification of this genus is a very difficult problem and the solution here proposed is of a very tentative nature.

The proposal by Loeblich & Tappan (1987) of a separate family for only *Oridorsalis* and *Schwantzia* seems too strong a split, and is not underwritten herein.

GENUS *Osangularia* BROTZEN, 1940

1940 *Osangularia* Brotzen: 30.
1941 *Parrella* Finlay; Toulmin: 603.
1948 *Parrella* Finlay; Brotzen: 103.
1964 *Osangularia* Brotzen; Loeblich & Tappan: 752, *partim*.
1987 *Osangularia* Brotzen; Loeblich & Tappan: 630, *partim*.

Type species. *Osangularia lens* Brotzen, 1940, original designation.

Osangularia lens Brotzen, 1940
Pl. 6, Figs. 9-12

1940 *Osangularia lens* Brotzen: 30, figs. 8/1a-c.
1948 *Parrella lens* (Brotzen); Brotzen: 104, fig. 28a.
1964 *Osangularia lens* Brotzen; Loeblich & Tappan: 752, figs. 615/1 – 2 only!
1987 *Osangularia lens* Brotzen; Loeblich & Tappan: 630, pl. 708, figs. 1-3 only!

Holotype. Naturhistoriska Riksmuseet, Stockholm; from Trelleborg Gummifabrik Drilling, -13 m, Sweden; Uppermost Maastrichtian-Lower Danian.

Material examined. USNM433602, topotype, donated by Brotzen to the Smithsonian Institution; also Kjølby Gård, Denmark, Maastrichtian, courtsey H. J. Hansen.

Description. Test lenticular, low trochospiral, biconvex, spiral side flatter than umbilical side, evolute, umbilical side involute, periphery sharply angled, keeled, lobulate, umbilicus slightly depressed, 2 whorls; chambers oblate to crescentic, flush on spiral side, slightly inflated on umbilical side, 9 chambers in final whorl; sutures on spiral side flush, gently arcuate, on umbilical side depressed, sigmoid, spiral suture very distinct; aperture an interiomarginal slit running from umbilicus to periphery, close to the periphery splitting off perpendicular to the basal suture, making an overall L-shaped aperture, a small part of the chamber wall bulging downwards and separating both parts of the aperture, foramina unmodified; wall optically granular, finely perforate.

Remarks. The diagnosis provided by Loeblich & Tappan (1987) erroneously describes the presence of a deeply infolded 'murus reflectus' which is not open, i.e., not an aperture. This is based on observations by Reiss (1960) on *A. bengalensis*, type of *Parrella*, here subsumed into *Cribroparrella*.

FAMILY GAVELINELLIDAE HOFKER, 1956

1956b Gavelinellidae Hofker: 946.
1964 Anomalinidae Cushman; Loeblich & Tappan: 753, *partim*.
1981 Cancrisidae Chapman, Parr & Collins; Haynes: 259, *partim*.
1984 Gavelinellidae Hofker; Loeblich & Tappan: 54.
1987 Gavelinellidae Hofker; Loeblich & Tappan: 633.

Description. Test free, multilocular, low trochospiral, spiral side evolute, umbilical side partially to completely involute, open umbilicus; aperture interiomarginal, extending into the umbilicus, umbilical relict apertures present, hidden under umbilical flaps or smaller teeth; wall perforate.

GENUS *Gavelinella* BROTZEN, 1942

1942 *Gavelinella* Brotzen: 5.
1942 *Pseudovalvulineria* Brotzen: 20.
1954 *Anomalina (Gavelinella)* Brotzen; Vasilenko: 73.
1954 *Anomalina (Pseudovalvulineria)* Brotzen; Vasilenko: 83.
1964 *Gavelinella* Brotzen; Loeblich & Tappan: 759, *partim*.
1964 *Pseudovalvulineria* Brotzen; Loeblich & Tappan: 759.
1987 *Gavelinella* Brotzen; Loeblich & Tappan: 638, *partim*.
1987 *Pseudovalvulineria* Brotzen; Loeblich & Tappan: 638, *partim*.

Type species. *Discorbina pertusa* Marsson, 1878, original designation.

Gavelinella pertusa (Marsson, 1878)
Pl. 7, Figs. 1-4

1878 *Discorbina pertusa* Marsson: 166, pl. 4, figs. 35a-e.
1942 *Gavelinella pertusa* (Marsson); Brotzen: 5.
1954 *Anomalina (Gavelinella) pertusa* (Marsson); Vasilenko: 73.
1964 *Gavelinella pertusa* (Marsson); Loeblich & Tappan: 759, figs. 621/5a-c only!
1987 *Gavelinella pertusa* (Marsson); Loeblich & Tappan: 638, pl. 718, figs. 16-18 only!

Lectotype. Smithsonian Institution, Washington, D.C., herein designated; from Rügen, Germany; Maastrichtian.

Material examined. CC16278, part of syntypic series, Smithsonian Institution, Washington, D.C.; also topotypes, courtesy H. J. Hansen

Description. Test biconvex, low trochospire, spiral side slightly convex, evolute, umbilical side convex, involute, with deeply sunken wide umbilicus, periphery broadly rounded, slightly lobulate, 2 whorls; chambers spherical, equidimensional, flush, slowly increasing in size, becoming wider, somewhat oblique, 9-10 chambers in final whorl; sutures arcuate, at first slightly depressed, becoming raised and less well marked, spiral suture depressed, indistinct; aperture a narrow interiomarginal slit, extraumbilical-umbilical, continuing under a narrow projecting lip along the umbilical margin of the chamber, at the umbilical-most part hidden under a more developed subtriangular umbilical flange, previous umbilical teeth largely remaining separate, earlier umbilical apertures remaining open; wall optically granular, finely perforate.

Remarks. Brotzen (1942) discussed at great length his reasoning behind the creation of *Gavelinella*, presenting a careful assessment of the historic developments behind the taxa in which *G. pertusa* had been subsumed before. In his opinion, the details of the apertural complex, combined with differences in shape due to coiling, were enough to remove *Gavelinella* from the 'discorbids'. By drawing attention to the nature of the umbilicus and the relation of the aperture to the umbilicus, he distinguished and separated *Gavelinella, Gyroidina, Gyroidinoides, Pseudovalvulineria* and *Valvulineria*. Vasilenko (1954) reduced *Gavelinella* along with *Pseudovalvulineria* to subgeneric status, including them both in *Anomalina*. Loeblich & Tappan (1964) widened the concept considerably by their synonymising of *Pseudovalvulineria* and *Brotzenella* into *Gavelinella*.

Gavelinella is here considered distinct from *Brotzenella* because of the clearly open umbilicus without an umbilical knob, and the presence of relict apertures in the umbilicus, partially shielded by relatively small umbilical flaps. These features are herein used to constrain the concept of the genus, which, judging from the literature at large, has expanded to encompass taxa which should be considered as separate and valid in their own right.

Through his correspondence with A. Franke, Cushman managed to trace numerous collections in Europe, which he then visited in the 1930's. A. Franke had informed him that the collection of Marsson was held in Berlin, from where Cushman obtained original Marsson specimens for his own collection. These specimens are labelled as such in the Cushman collection, effectively demonstrating their syntypic nature.

Gavelinella lorneiana (d'Orbigny, 1840)
Pl. 7, Figs. 5-8

1840 *Rosalina lorneiana* d'Orbigny: 36, pl. 3, figs. 20-22.
1942 *Pseudovalvulineria lorneiana* (d'Orbigny); Brotzen: 20.
1962 *Gavelinella lorneiana* (d'Orbigny); Hofker: 61, textfigs. 1-5.
1964 *Gavelinella lorneiana* (d'Orbigny); Loeblich & Tappan: 749, figs. 621/6a-c.
1987 *Gavelinella lorneiana* (d'Orbigny); Loeblich & Tappan: 638, pl. 718, figs. 13-15.

Lectotype. Muséum National d'histoire Naturelle, Paris; Meudon, Paris Basin; Craie Blanche, Campanian; selected by Loeblich & Tappan, 1964.

Material examined. CC6981, from Gravesend, England (misidentified as *R. clementiana*); Smithsonian Institution, Washington, D.C.

Description. Test lenticular, well rounded, spiral side clearly sunken, individual whorls inflated, evolute, umbilical side convex, involute, with a small clearly depressed umbilicus, periphery very broadly rounded, lobulate, 2 to 2.5 low trochospiral coils; chambers inflated, oblique, flush on spiral side, inflated on umbilical side, 10 chambers in final whorl; sutures on spiral side arcuate and oblique, wide and raised, especially on axial side, becoming more pronounced, on umbilical side gently arcuate, raised, thickening towards the umbilicus, spiral suture distinctly depressed; aperture an interiomarginal slit, running from near the periphery into the umbilicus, bordered by a low, thickened lip, aperture continues into the umbilicus, running under a flap which is developed especially in a distal direction, drawn out from the thickened suture at the back of the chamber, successive flaps partially imbricate, thickening with secondary lamination into an almost stellate pattern; wall optically granular, very coarsely and rather sparsely perforate.

Remarks. Brotzen described *Pseudovalvulineria* (type species *Rosalina lorneiana*) as possessing a flat umbilicus, often closed by an umbilical knob, with an umbilical aperture present only in the very last chambers. Only in the juvenile stage does the umbilicus look like something akin to *Gavelinella.*

Vasilenko (1954) included *Rosalina clementiana* (type of *Pseudogavelinella*) and *Anomalina monterelensis* (type of *Brotzenella*) in *Pseudovalvulineria*, thereby widening the concept of this genus drastically. However, the description and drawings of *P. lorneiana* were taken directly from d'Orbigny, since no specimens seem to have been recovered from the material looked at by Vasilenko.

The contentious issue seems to be to what extent the umbilicus is depressed, hollow, covered over or filled by a plug. d'Orbigny's description mentions the large and deep umbilicus, in which small lips protrude under which the aperture of each chamber opens into the umbilicus. These lips are said to partially cover each other. On the strength of this description, the species should be classified in *Gavelinella.* The discussion by Hofker (1962), based on sections of topotypical specimens also points towards the gavelinellid nature of this species. Hofker rejected *Pseudovalvulineria* as a genus in its own right and synonymised it with *Gavelinella.* In particular, Hofker's sections demonstrate convincingly how the umbilical region is primarily open and allows direct access to the umbilical part of the proloculus. The illustrations by Loeblich & Tappan (1964) of the lectotype bear these descriptions out, hence the synonymy between *Pseudovalvulineria* and *Gavelinella* is herein underwritten.

GENUS *Angulogavelinella* HOFKER, 1957

1957 *Angulogavelinella* Hofker: 366.
1964 *Angulogavelinella* Hofker; Loeblich & Tappan: 755.
1987 *Angulogavelinella* Hofker; Loeblich & Tappan: 635.

Type species. Discorbina gracilis Marsson, 1878, original designation.

Angulogavelinella gracilis (Marsson, 1878)
Pl. 7, Figs. 9-12

1878 *Discorbina gracilis* Marsson: 166, pl. 4, figs. 34a-c.
1957 *Angulogavelinella gracilis* (Marsson); Hofker: 366, figs. 419-420.
1964 *Angulogavelinella gracilis* (Marsson); Loeblich & Tappan: 755, figs. 620/1 – 2.
1987 *Angulogavelinella gracilis* (Marsson); Loeblich & Tappan: 635, pl. 716, figs. 19-21.
1995 *Angulogavelinella gracilis* (Marsson); Weidich: 329, fig. 12, pl. 3, figs. 1-4, 7-8, pl. 4, figs. 1-3.

Lectotype. Smithsonian Institution, Washington, D.C., herein designated; from Rügen, Germany; White Chalk, Maastrichtian.

Material examined. CC16260, syntypes, Smithsonian Institution, Washington, D.C.

Description. Test lenticular, with a compressed appearance, a low trochospire, spiral side slightly to moderately convex, evolute, umbilical side moderately convex, involute, with a small slightly sunken umbilicus, periphery angled, with a blunt keel, flush, 2 whorls; chambers crescentic, oblique, quite narrow, flush on spiral side, barely inflated on umbilical side, 10 chambers in final whorl; sutures strongly oblique on spiral side, very slightly raised, gently arcuate and distinctly depressed on umbilical side; aperture a rather wide interiomarginal slit, surrounded by a low thickened lip, staying well clear from the periphery, continuing towards the umbilicus and into the umbilicus under a diminutive flap, the small flap developed at the umbilical-most tip of the chamber in part also in a distal direction, successive flaps imbricate, with the deposition of secondary lamination leading to a stellate pattern surrounding the umbilicus proper, part of the aperture osangulariid-like, standing almost perpendicular on the basal suture of the chamber; wall appearing optically granular, finely and moderately perforate.

Remarks. As illustrated here through the types, *Angulogavelinella* has a very small sunken umbilicus, unlike the very wide and deep umbilicus found in *Gavelinella.* Nevertheless, *Gavelinella*-like umbilical flaps are present and organised in the same way, supporting its inclusion in the Gavelinellidae. Most diagnostic, however, is the shape and positioning of the primary aperture, which, in conjunction with the umbilical flaps, unambiguously characterises species of this genus.

The revision of the genus *Angulogavelinella* by K. Weidich was published posthumously in 1995. In the revision, a neotype, from what are most likely syntypes kept in the Cushman Collection, was designated. This infringes art 75 par. (a) of the ICZN: only a lectotype could have been selected from syntypes, hence the neotype is invalid. Because of the untimely death of Dr. Weidich, no curatorial action had been taken with regards to the specimens. Unaware of the situation, I obtained the syntypes on loan, selected and separated the best preserved specimen as lectotype and photographed it (see pl. 7, figs. 9-12).

GENUS *Berthelina* MALAPRIS, 1965

1965 *Gavelinella (Berthelina)* Malapris: 138.
1987 *Berthelina* Malapris; Loeblich & Tappan: 636.

Type species. Anomalina intermedia Berthelin, 1880, original designation.

Berthelina intermedia (Berthelin, 1880)
Pl. 8, Figs. 1-4

1880 *Anomalina intermedia* Berthelin: 67, pl. 4, figs. 14a-c.
1954 *Gavelinella intermedia* (Berthelin); Bartenstein: 49, pl. 1, figs. 21-28.
1965 *Gavelinella (Berthelina) intermedia* (Berthelin); Malapris: 138, pl.1, figs. 1-7, pl. 2, figs. 1-7.
1987 *Berthelina intermedia* (Berthelin); Loeblich & Tappan: 636, pl. 715, figs. 16-18.

Holotype. 23-87, Berthelin coll., Muséum National d'histoire Naturelle, Paris; from Montcley, left bank of the Ognon, Doubs Department; Albian.

Material examined. Mesnil-St. Père, lower Albian; Villemoyenne, lower Albian; Le Gaty, middle Albian; Fresnoy-le-Château, middle Albian; departement de l'Aube; France. Courtesy F. Jannin.

Description. Test small, a low trochospire, spiral side flattened, central part slightly depressed, evolute, umbilical side barely convex, evolute, with an ill-defined umbilical plug, periphery broadly rounded, somewhat lobulate, 1.5 to 2 whorls; chambers spherical to prolate, equidimensional, slightly inflated, 9-10 chambers in final whorl; sutures on spiral side at first depressed, with an indication of limbateness, regularly arcuate, becoming raised, spiral suture not clearly defined, sutures on the umbilical side raised, fusing into an umbilical-most spiraling suture, very broad and thick; aperture a narrow interiomarginal and intraumbilical slit, runs along the entire umbilical edge of the chamber under a projecting lip, earlier umbilical apertures gradually closed off; wall finely and densely perforate, optically granular, ornamented by a raised periumbilical ridge.

Remarks. Malapris originally proposed *Berthelina* as a subgenus of *Gavelinella* because she deemed the differences insufficient, i.e., absence of a properly defined spiral or umbilical side and absence of a clear umbilicus. However, contrary to *Berthelina, Gavelinella* has a clearly defined depressed umbilicus and the umbilical side can be recognised further by the presence of foliar lappets projecting posteriorly, leaving the umbilicus clear. In *Berthelina*, the aperture seems relatively wide, starting very close if not over the periphery and continuing slit-like under the umbilical folium, while in *Gavelinella* it is a narrow interiomarginal slit, firmly limited to the umbilical side. Furthermore, the, at times substantial, thickening of the lowermost part of each chamber, coalescing into a thick spiralling ridge, and the nearly planispiral outlook of the test is very typical.

GENUS *Boldia* VAN BELLEN, 1946

non 1868 *Terquemia* Tate.
non 1932 *Terquemia* van Veen.
1946a *Terquemia* van Bellen: 86.
1946b *Boldia* van Bellen: 122.
1964 *Boldia* van Bellen; Loeblich & Tappan: 75.
1987 *Boldia* van Bellen; Loeblich & Tappan: 636.

Type species. Rotalina lobata Terquem, 1882, original designation.

Boldia lobata (Terquem, 1882)
Pl. 8, Figs. 5-8

1882 *Rotalina lobata* Terquem: 63, pl. 4, figs. 11a-c.
1946a *Terquemia lobata* (Terquem); van Bellen: 86.
1946b *Boldia lobata* (Terquem); van Bellen: 122.
1964 *Boldia lobata* (Terquem); Loeblich & Tappan: 755, figs. 619/2 – 3.
1987 *Boldia lobata* (Terquem); Loeblich & Tappan: 636, pl. 715, figs. 10-15.

Type specimen. Muséum National d'histoire Naturelle, Paris; from Septeuil, Paris; Calcaire Grossier, Lutetian, Eocene.

Material examined. Slide 11, sq. 7; The Natural History Museum. USNM433604, topotype, Smithsonian Institution.

Description. Test planoconcave, truncate, small, a very low trochospire, spiral side flat, evolute, umbilical side planoconcave, involute, with a small, usually obscured central umbilicus, periphery trucate, angled, with a double keel, clearly lobulate, 1.5 whorls; chambers crescentic, equidimensional, flush on both sides, 8 chambers in final whorl; sutures on spiral side arcuate, at first depressed, becoming distinctly raised, on umbilical side slightly depressed to flush, nearly straight; aperture umbilical, staying well clear from the periphery, partially hidden under a projecting flap, flap developed in an umbilical-distal direction, on the distal side running along about half the suture, successive flaps clearly imbricate, apparently remaining open and allowing access to the earlier chambers; wall very coarsely and sparsely perforate, appearing optically granular.

Remarks. The imbricate nature of the umbilical flaps and the umbilical relict apertures clearly show the gavelinellid alliance of this genus. It is similar to *Scarificatina* Moorkens, 1982, but *Boldia* is much more angular and lacks the umbilical ridges of *Scarificatina*.

GENUS *Cocoarota* LOEBLICH & TAPPAN, 1986

1986 *Cocoarota* Loeblich & Tappan: 257.
1987 *Cocoarota* Loeblich & Tappan; Loeblich & Tappan: 637.

Type species. Anomalina cocoaensis Cushman, 1928, original designation.

Cocoarota cocoaensis (Cushman, 1928)
Pl. 8, Figs. 9-12

1928 *Anomalina cocoaensis* Cushman: 75, pl. 10, figs. 4a-c.
1986 *Cocoarota cocoaensis* (Cushman); Loeblich & Tappan: 257, figs. 28-33.
1986 *Cibicidoides micrus* (Bermúdez); van Morkhoven, Berggren & Edwards: 267, pl. 88, figs. 1-2.
1987 *Cocoarota cocoaensis* (Cushman); Loeblich & Tappan: 637, pl. 717, figs. 1-7.

Holotype. CC10410, Smithsonian Institution, Washington, D.C.; from Cocoa Post Office, Alabama; Cocoa Sand, Eocene.

Material examined. The holotype, and CC37487 & 88, para- and topotypes; Smithsonian Institution, Washington, D.C.

Description. Test unequally biconvex to planoconvex, nearly planispiral, spiral side flattened, may be moderately concave, evolute, umbilical side convex, involute, umbilicus open but almost completely filled with umbilical plug, periphery bluntly angled, barely lobulate in the final part, about 2 whorls; chambers prolate, narrow, on spiral side excavated, earlier ones gradually becoming flush, on umbilical side flush throughout, 12 chambers in final whorl; sutures on spiral side raised, slightly oblique but straight to almost radial, umbilical sutures straight, thickening towards the umbilicus, spiral suture indistinct; aperture interiomarginal, almost equatorial, an elliptical opening surrounded by a thickened lip, straddling the periphery, continuing towards the umbilicus as a very narrow slit running under a narrow, low, forwards projecting lip, umbilical part of the aperture also hidden under a subtriangular umbilical flange, earlier umbilical apertures remain open; wall optically radial, distinctly and densely perforate except in the central part on the spiral side where secondary lamination builds up into an imperforate boss, usually continuous with the raised imperforate sutures, umbilical boss formed by the lowermost parts of the thickened previous sutures, coalescing through the deposition of secondary lamination.

Remarks. Loeblich & Tappan (1986) proposed this genus as a member taxon of the Gavelinellidae, expressly differentiating it from *Anomalinoides* by the strongly excavated spiral side and elevated sutures, the broad umbilicus and the prominent sutural umbilical bosses on the umbilical side and the different shape of the aperture. This distinction is here fully supported, especially in view of the occurrence of developments of the apertural complex on different sides of the trochospire, spiral for *Anomalinoides*, umbilical for *Cocoarota*.

Loeblich & Tappan (1987) pointed out that the discussion of this species by van Morkhoven *et al.* (1986) is incorrect and confusing. The specimens illustrated by van Morkhoven *et al.* are conspecific with *C. cocoaensis* and in actual fact topotypes. Comparison with the primary types of *Cibicides micrus* Bermúdez (CC62431 and 32) clearly shows the very different nature of both taxa, and confirms the misidentification of van Morkhoven *et al.*

GENUS *Hansenisca* LOEBLICH & TAPPAN, 1987

1987 *Hansenisca* Loeblich & Tappan: 639.

Type species. Gyroidina soldanii d'Orbigny, 1826, original designation.

Hansenisca soldanii (d'Orbigny, 1826)
Pl. 9, Figs. 1-4

1789 *Nautilus melo* Soldani: 59, pl. 46, figs. ss, rr, *nomen nudum.*
1826 *Gyroidina soldanii* d'Orbigny: 278.
1962 *Gyroidina orbicularis* d'Orbigny; Banner & Clarke: 1335.
1964 *Gyroidina orbicularis* d'Orbigny; Loeblich & Tappan: 750, figs. 614/5 – 6.
1970 *"Gyroidina" soldanii* d'Orbigny; Hansen: 105, pl. 27, fig. 5.
1987 *Hansenisca soldanii* d'Orbigny; Loeblich & Tappan: 639, pl. 719, figs. 5-9.

Type specimen. Muséum National d'histoire Naturelle, Paris; from Rimini; Recent.

Material examined. Topotypes, courtesy H. J. Hansen. 'Lectotype' and 'paralectotype' of *Gyroidina orbicularis* d'Orbigny selected by Banner & Clarke (1962), The Natural History Museum, London.

Description. Test subconical, trochoid, low trochospiral, spiral side flattened, partially depressed, evolute, umbilical side convex, involute, periphery bluntly angled, distinctly lobulate, umbilicus narrow and deeply sunken, 2.5 to 3 whorls; chambers oblate, wide, inflated, ending in clearly separated triangular umbilical tips, 10 chambers in final whorl; sutures depressed to rather deeply sunken, short but arcuate on spiral side, gently curved to straight on umbilical side, spiral suture sunken and clearly marked, especially in the last coil; aperture double, upper aperture an interiomarginal narrow slit bordered by a thickened, bluntly cristate lip, positioned in the middle of the basal suture, staying well clear from the periphery, a second aperture seamed by a triangular plate-like lip is present at the umbilical-most part of the chamber, umbilical teeth projecting into the open umbilicus without coalescing, leaving the umbilicus open, previous umbilical apertures remain open; wall optically granular, sparsely and finely perforate.

Remarks. The genus was created by Loeblich & Tappan (1987) to accommodate a very large number of *Gyroidina* species erroneously assigned to this genus as a result of the misinterpretation of *Gyroidina* by Loeblich & Tappan (1964). The lectotypification of *Gyroidina orbicularis* by Hansen(1967) showed that the specimens illustrated by Loeblich & Tappan (1964) belonged to *G. soldanii*, rather than *G. orbicularis*. The major morphological differences between these two species most certainly warrant generic recognition, and the proposed separation is herein fully underwritten.

GENUS *Lingulogavelinella* MALAPRIS, 1965

1965 *Lingulogavelinella* Malapris: 139.
1987 *Lingulogavelinella* Malapris; Loeblich & Tappan: 641.

Type species. Lingulogavelinella albiensis Malapris, 1965, original designation.

Lingulogavelinella albiensis Malapris, 1965
Pl. 9, Figs. 5-8

1965 *Lingulogavelinella albiensis* Malapris: 140, pl. 4, figs. 5-8, textfigs. 1, 2, 5-8.
1987 *Lingulogavelinella albiensis* Malapris; Loeblich & Tappan: 641, pl. 721, figs. 14-19.

Holotype. MMT1, Laboratoire de Géologie, Université de Dijon; from Villemoyenne, Department Aube; Lower Albian.

Material examined. Topotypes, courtesy F. Jannin.

Description. Test unequally biconvex, small, very low trochospiral, spiral side moderately convex, evolute, umbilical side flattened to slightly concave, largely involute, periphery bluntly angled, lobulate, barely more than 1 whorl; chambers prolate to crescentic, equidimensional, flush, regularly but slowly increasing in size, 8 chambers in final whorl; sutures depressed, becoming raised, regularly arcuate on spiral side, irregularly sigmoid on umbilical side, spiral suture indistinct, limbate; aperture elliptical, equatorial to interiomarginal, continuing under a drawn-out umbilical flap along the umbilical edge of the chamber, earlier umbilical apertures remaining open, on the proximal side of the umbilical flaps with a relatively dense cover of very low tubercles, tubercles remaining visible in depressions between earlier flaps; wall finely perforate, optically granular.

Remarks. Malapris separated *Lingulogavelinella* from *Gavelinella* and *Berthelina* using the complete absence of an umbilicus and the often very large umbilical tongues as distinguishing characters. She drew attention to the difficulties encountered in assigning many gavelinellid species to a genus, the result of inadequate and vague diagnoses of *Pseudovalvulineria* and *Gavelinopsis*, besides the variations in the *Gavelinella* concept.

GENUS *Notoplanulina* MALUMIAN & MASIUK, 1976

1976 *Notoplanulina* Malumian & Masiuk: 195.
1987 *Notoplanulina* Malumian & Masiuk; Loeblich & Tappan: 634.

Type species. Planulina rakauroana Finlay, 1939, original designation.

Notoplanulina rakauroana (Finlay, 1939)
Pl. 10, Figs. 1-4

1939 *Planulina rakauroana* Finlay: 326, pl. 29, figs. 154-156.
1976 *Notoplanulina rakauroana* (Finlay); Malumian & Masiuk: 197, pl. 6, fig. 2a-d.
1987 *Notoplanulina rakauroana* (Finlay); Loeblich & Tappan: 634, pl. 713, figs. 1-6.

Holotype. 1147/1, New Zealand Geological Survey Collection, Wellington; from locality 5664, Mid-Waipara, North Canterbury, Piripauan beds, Campanian.

Material examined. Holotype and 1147/2 – 3, paratypes. Also topotypes, courtesy C.P. Strong.

Description. Test strongly compressed, very low trochospiral, spiral side flattened, evolute, earlier whorls indistinct due to deposition of secondary lamination, umbilical side slightly more convex, partially involute, umbilicus clearly defined, narrow but open, periphery sharply angled, slightly carinate, barely lobulate, 2 whorls; chambers strongly crescentic, very narrow, moderately inflated, 7-8 chambers in final whorl; sutures strongly arcuate, broadly depressed, becoming raised, spiral suture obscured, limbate; aperture slit-like, with indistinct low lip, interiomarginal, continuing into the umbilicus under a subtriangular flap, a second extension of the aperture positioned high up the apertural face and at a clear angle with the interiomarginal suture, earlier umbilical apertures gradually closed off; wall finely and sparsely perforate.

Remarks. *Notoplanulina* is a very peculiar genus in that it combines features of an osangulariid and a gavelinellid nature.

GENUS *Pseudogavelinella* VOLOSHINA, 1981

1981 *Pseudogavelinella* Voloshina, *in* Subbotina *et al.*: 85.
1987 *Pseudogavelinella* Voloshina; Loeblich & Tappan: 642.

Type Species. Rosalina clementiana d'Orbigny, 1840, original designation

Pseudogavelinella clementiana (d'Orbigny, 1840)
Pl. 9, Figs. 9-12

1840 *Rosalina clementiana* d'Orbigny: 37, pl. 3, figs. 23-25.
1954 *Anomalina (Pseudovalvulineria) clementiana* (d'Orbigny); Vasilenko: 91, pl. 9, figs. 6a-c.
1981 *Pseudogavelinella clementiana* (d'Orbigny); Voloshina, *in* Subbotina *et al.*:85.
1987 *Pseudogavelinella clementiana* (d'Orbigny); Loeblich & Tappan: 642, pl. 719, figs. 10-15.

Type specimen. Muséum National d'histoire Naturelle, Paris; from Saint-Germain, bassin de Paris; Craie blanche, Campanian.

Material examined. The Natural History Museum, London. Pinswager Graben, near Neubauern, Germany, Upper Campanian, donation by H. Hagn to the Smithsonian Institution.

Description. Test lenticular, broadly rounded, low trochospiral, spiral side somewhat convex, evolute, earliest part often obscured by ornamentation, umbilical side convex, involute umbilicus apparently filled with a small central plug, periphery broadly rounded, lobulate, with imperforate band, 2 whorls; chambers oblate, equidimensional to wide, slightly oblique, moderately inflated, more flush on the spiral side, 8 chambers in final whorl; sutures on spiral side depressed at first, quickly becoming raised into ridges, gently arcuate, on umbilical side gently arcuate, depressed, usually flanked by thickened ridges on the adjacent chamber walls, spiral suture strongly depressed; aperture an interiomarginal slit, staying well clear from the periphery, continuing into the umbilicus underneath very diminutive flaps, flaps drawn out from the umbilical-most part of each chamber, quickly thickening with secondary lamination, not imbricate, earlier thickened flaps remaining separate and yielding a spiral pattern; wall rather coarsely perforate on the umbilical side, imperforate on spiral side; centre of the spiral side ornamented with interrupted ridges

Remarks. This genus resembles to some extent *Stensioeina*, the main differences being the formation of the peculiar spiral pattern of thickened umbilical flaps which remain separate, the thickening of the umbilical sutures, the less developed umbilical flaps and the less truncate outlook of the test. *Pseudogavelinella* is here considered a genus in its own right, separate from *Gavelinella*: the non-imbricate nature of the umbilical flaps and the seemingly filled-in umbilicus are considered sufficient to warrant this differentiation.

FAMILY CANCRISIDAE CHAPMAN, PARR & COLLINS, 1934

1934 Cancrisinae Chapman, Parr & Collins: 567.
1942 Valvulineriidae Brotzen: 16.
1956b Valvulineriidae Brotzen; Hofker: 942.
1956b Marginolamellidae Hofker: 949, not available.
1981 Cancrisidae Chapman, Parr & Collins; Haynes: 237.
1981 Gyroidinoidinae Saidova: 41.

Description. Test free, multilocular, low trochospiral, spiral side at least partially evolute, umbilical side involute, umbilicus secondarily obstructed or filled in; aperture interiomarginal, and intraumbilical, with relatively substantial umbilical flaps partially shielding umbilical aperture, earlier umbilical aperture remain open as relict apertures; wall finely perforate.

GENUS *Cancris* DE MONTFORT, 1808

1808 *Cancris* de Montfort: 267.
1839 *Rotalina* d'Orbigny: 71.
1899 *Pulvinulinella* Eimer & Fickert: 628.
1942 *Cancris* de Montfort; Cushman & Todd: 72.
1964 *Cancris* de Montfort; Loeblich & Tappan: 586.
1981 *Cancris* de Montfort; Haynes: 260.
1984 *Cancris* de Montfort; Rögl & Hansen: 67.
1987 *Cancris* de Montfort; Loeblich & Tappan: 545.

Type species. Nautilus auricula von Fichtel & von Moll, 1798, original designation.

Cancris auriculus (von Fichtel & von Moll, 1798)
Pl. 10, Figs. 5-8

1798 *Nautilus auricula* von Fichtel & von Moll: 108, pl. 20, figs. a-c.
1808 *Cancris auriculus* (von Fichtel & von Moll); de Montfort: 267.
1826 *Nonionina auricula* (von Fichtel & von Moll); d'Orbigny: 295, no. 24.
1826 *Rotalia brongniartii* d'Orbigny: 273, *nomen nudum.*
1846 *Rotalia brongniartii* d'Orbigny; d'Orbigny: 158, pl. 8, figs. 22-24.
1898 *Rotalia brongniartii* d'Orbigny; Fornasini: 248, fig. 1.
1942 *Cancris auriculus* (d'Orbigny); Cushman & Todd: 74, pl. 18, figs. 1-5 and 7-11, *partim.*
1964 *Cancris auriculus* (von Fichtel & von Moll); Loeblich & Tappan: 586, fig. 462/3$a-c$.
1984 *Cancris auriculus* (von Fichtel & von Moll); Rögl & Hansen: 67, pl. 26, figs. 3-8, text fig. 28.
1987 *Cancris auriculus* (von Fichtel & von Moll); Loeblich & Tappan: 545, pl. 591, figs. 1-4.

Lectotype. MI-564, Naturhistorisches Museum Wien, selected by Rögl & Hansen, 1984; from the Mediterranean Sea; Recent.

Material examined. Nußdorff, Vienna; Badenian. Courtesy F. Rögl.

Description. Test unequally biconvex, often large, low trochospiral, spiral side evolute, generally less convex than umbilical side, umbilical side involute, umbilicus small but open, periphery sharply angled, often with a small carina, lobulate, 1.5 to 2 whorls; chambers prolate to crescentic, flush, very rapidly expanding in size, increasing allometrically in height, producing auriculate nature, 7-8 chambers in final whorl; sutures on spiral side gently to strongly arcuate, more arcuate towards the periphery, limbate, becoming raised, on umbilical side straight to gently arcuate, depressed, becoming flush, spiral suture irregularly wavy, depressed; aperture a high interiomarginal umbilical arch, continuing into the umbilicus, under a projecting flap, successive flaps remaining free, leaving part of previous apertures open; wall densely and finely perforate, optically radial.

Remarks. de Montfort's very florid drawing of *Cancris auriculus* led to a complete neglect of this genus until the studies by Cushman. It is only from the 1940's onwards that new species were actually being described in *Cancris*. Cushman (1940) initially classified it with *Baggina* and *Neocribrella* in the Bagginiae, Rotaliidae. Loeblich & Tappan (1964) essentially agreed with this proposal although they classified the Bagginiae in the Discorbidae. Haynes

(1981) regarded the Bagginidae and Cancrisidae as distinct groupings, but retained them in the Discorbacea. Loeblich & Tappan (1987) upgraded the Bagginidae to full family status, still within the Discorbacea.

The study by Hansen & Revets (1992) on the discorbids combined with the information here presented shows that *Cancris* bears little relation to this group. The distinction put forward by Haynes (1991) is herein followed and *Baggina* is kept separate from *Cancris* on familial level.

GENUS *Brotzenella* VASILENKO, 1958

1954 *Anomalina (Pseudovalvulineria)* Brotzen; Vasilenko: 106.
1958 *Anomalina (Brotzenella)* Vasilenko *in* Bykova *et al.*: 52.
1964 *Gavelinella* Brotzen; Loeblich & Tappan: 759, *partim.*
1975 *Brotzenella* Vasilenko; Podobina: 134.
1987 *Gavelinella* Brotzen; Loeblich & Tappan: 638, *partim.*

Type species. *Anomalina monterelensis* Marie, 1941, original designation.

Brotzenella monterelensis (Marie, 1941)
Pl. 11, Figs. 1-4

1941 *Anomalina monterelensis* Marie: 243, pl. 37, figs. 342a-c.
1954 *Anomalina (Pseudovalvulineria) monterelensis* Marie; Vasilenko: 108, pl. 14, figs. 5-6.
1958 *Anomalina (Brotzenella) monterelensis* Marie; Vasilenko *in* Bykova *et al.*: 52.
1964 *Gavelinella monterelensis* (Marie); Loeblich & Tappan: 759, figs. 621/7a-c.
1987 *Gavelinella monterelensis* (Marie); Loeblich & Tappan: 638, pl. 718, figs. 10-12.

Holotype. 6245, Muséum National d'histoire Naturelle, Paris; from Monterau, Department Seine-et-Marne, Paris Basin; Zone Em-2, *Belemnitella mucronata* Chalk, Campanian.

Material examined. Specimens from Le Caillaud, Talmont; Campanian, courtesy A. V. Dhondt; also Pinswanger Graben, Neubeuern, Bayern, Upper Campanian, donated by H. Hagn to the Smithsonian Institution, Washington, D.C.

Description. Test lenticular, low trochospiral, spiral side gently convex, evolute, umbilical side flattened, involute, umbilicus wide and open, with large umbilical boss, periphery bluntly angled, with imperforate band, 2 whorls; chambers oblate, equidimensional to wide, oblique towards the periphery, flush, flattened, 11 chambers in final whorl; sutures on spiral side arcuate, depressed and rather wide, ill-defined, on umbilical side depressed, arcuate, spiral suture ill-defined, a wide depressed region between successive coils; aperture equatorial to interiomarginal, a wide arch bordered by a thickened lip, continuing towards the umbilicus and hidden under a forwards projecting lip, at the umbilical end with a small backwards projecting flap; wall sparsely and coarsely perforate.

Remarks. Originally proposed as a subgenus of *Anomalina*, it is said to differ from *Pseudovalvulineria* (in which the original species were at first subsumed by Vasilenko) by the presence of a boss or complex sculpture on the weakly evolute ventral side, the symmetric position of the leading face relative to the peripheral margin and the arcuate aperture.

The presence of a primary infilled umbilicus through the presence of an umbilical plug is here considered to be of sufficient importance not only to recognise *Brotzenella* as separate from *Gavelinella* but to classify it in a different family.

GENUS *Cibicorbis* HADLEY, 1934

1934 *Cibicorbis* Hadley: 26.
1964 *Cibicorbis* Hadley; Loeblich & Tappan: 678.
1987 *Cibicorbis* Hadley; Loeblich & Tappan: 546.
1988 *Cibicorbis* Hadley; Whittaker: 112.

Type species. *Cibicorbis herricki* Hadley, 1934, original designation.

Cibicorbis herricki Hadley, 1934
Pl. 10, Figs. 9-12

1934 *Cibicorbis herricki* Hadley: 26, pl. 5, figs. 1-3.
1940 *Valvulineria collis* Coryell & Rivero: 338, pl. 43, figs. 24a-c.
1941 *Cibicides kugleri* Cushman & Renz: 27, pl. 4, figs. 11a-c.
1945 *Valvulineria crassisepta* Keijzer: 203, pl. 4, figs, 56a-c.
1964 *Cibicorbis herricki* Hadley; Loeblich & Tappan: 678, figs. 544/2a-c.
1987 *Cibicorbis herricki* Hadley; Loeblich & Tappan: 546, pl. 591, figs. 8-10.

Holotype. Paleontological Research Institute, Ithaca, New York; from basal marl of the Yumuri River Gorge, Matanzas, Cuba, Oligocene.

Material examined. USNM P3315, paratype and CC62934, from Bravo 9, Core 3, Yaguate Area, Dominican Republic, Upper Oligocene; Smithsonian Institution, Washington, D.C.

Description. Test planoconvex, rather large, spiral side flattened to slightly concavoconvex, evolute, umbilical side strongly flaring and convex, narrow well-defined umbilicus, periphery sharply angled and keeled, lobulate, 1.5 whorls; chambers crescentic, narrow, rapidly increasing in height, flush on spiral side, inflated on umbilical side, 8 chambers in final whorl; sutures on spiral side strongly arcuate, wide and clearly raised, forming the carina on the periphery of the test, on umbilical side nearly straight, wide and raised, becoming flush, spiral suture indistinct, depressed; aperture semi-circular, interiomarginal to umbilical, starting from below the peripheral edge towards the umbilicus, continuing into the umbilicus underneath a strongly developed umbilical flap, umbilical flap very large, not confined to its chamber but spilling over onto previous chambers, imbricate, most of the previous flaps hidden due to the degree of overlap of the succeeding chambers; wall finely and densely perforate, optically granular.

Remarks. Loeblich & Tappan (1964) included without comments *Cibicorbis* in the Eponididae, moving it later (1987) to the Bagginінae. Whittaker (1988) reclassified *Cibicorbis* in the Cancrisidae, following the analysis of the position of the cancrisids versus the bagginids by Haynes (1981). Whittaker also accepted the synonymy suggested by Crouch & Poag (1979) between *Rosalina hitchcockae* Galloway & Wissler, 1927 and *C. herricki*. However, there are clear morphological differences between both species, the most obvious one being the nature of the umbilical flap and covering up of the umbilicus. In *C. herricki*, the umbilical flaps are very large and wide, essentially obscuring the umbilicus from direct view. Also, because of the extensive embracing nature of the chambers, previous flaps are almost completely subsumed into the lumen of the following chambers. In contrast, *R. hitchcockae* possesses rather diminutive flaps, which leave the umbilicus clearly open and the chambers are far less embracing, leaving the periumbilical region open. While it is not impossible that there is a direct evolutionary lineage leading from the Oligocene *C. herricki* to the Pliocene *R. hitchcockae*, more in-depth studies are necessary to support this view and in the mean time both taxa are deemed separate.

GENUS *Gyroidinoides* BROTZEN, 1942

1942 *Gyroidinoides* Brotzen: 19.
1963 *Valvalabamina* Reiss: 62.
1964 *Gyroidinoides* Brotzen; Loeblich & Tappan: 753.

1984 *Gyroidina (Gyroidinoides)* Brotzen; Reiss & Hottinger: 290.
1987 *Gyroidinoides* Brotzen; Loeblich & Tappan: 633.
1987 *Valvalabamina* Reiss; Loeblich & Tappan: 628.

Type species. Rotalina nitida Reuss, 1844, original designation.

Gyroidinoides nitidus (Reuss, 1844)
Pl. 11, Figs. 5-8

1844 *Rotalina nitida* Reuss: 214.
1942 *Gyroidinoides nitidus* (Reuss); Brotzen: 19.
1964 *Gyroidinoides nitidus* (Reuss); Loeblich & Tappan: 753, figs. 615/6a-c.
1970 *Gyroidinoides nitidus* (Reuss); Hansen: 105, pl. 28, fig. 6.
1987 *Gyroidinoides nitidus* (Reuss); Loeblich & Tappan: 633, pl. 713, figs. 7-9.

Type specimen. Originally in the Fürstlich Lobkowitz Mineralien Kabinet, Bilin. This collection was subsequently moved to Budapest, where it was destroyed during the Soviet invasion of 1956; from Rannay, NW Bohemia; Plänerschichten, Turonian.

Material examined. Specimens from Locality 32, 18th European Micropalaeontological Colloquium, Kystra, Ohre Region, Czech Republic; Jizera Formation, Middle Turonian, courtesy H. J. Hansen. Also USNM433601, Skalitz, Sweden, Upper Turonian, identified by F. Brotzen; Smithsonian Institution.

Description. Test nearly globular, low trochospire, spiral side flattened, evolute, umbilical side very convex, involute, umbilicus hidden, periphery very broadly rounded, flush, about 2 whorls; chambers oblate, wide, inflated, 6 to 7 chambers in final whorl; sutures depressed, slightly arcuate on spiral side, depressed for the umbilical half and straight on umbilical side, spiral suture clearly depressed; aperture a long narrow interiomarginal slit, running from within the umbilicus to the periphery, aperture seemingly continuing into the umbilicus, hidden by a broad, crescentic flap, flap covering the whole of the umbilicus, including previous flaps; wall optically granular, very finely perforate.

Remarks. Brotzen (1942) differentiated *Gyroidinoides* from *Gyroidina* on account of the open umbilicus and the clearly visible umbilical lips belonging to the umbilical apertures, and from *Gavelinella* through the very narrow umbilicus and the reduced umbilical apertures.

Loeblich & Tappan (1964) discussed the relation between *Gyroidina* and *Gyroidinoides*, unfortunately based on a *lapsus* in regard to the *Gyroidina* type species. Nevertheless, the description of *Gyroidinoides* is accurate, only the differentiation from *Gyroidina* is not. The differentiation from *Pseudovalvulineria* (synonymised by them into *Gavelinella*) is only partially correct, i.e., the claimed absence of umbilical relict apertures in *Gyroidinoides* is inaccurate.

Mead (1985) followed Loeblich & Tappan (1964) and defined *Gyroidinoides* as possessing a single continuous apertural opening from the periphery to the umbilicus, whereas *Gyroidina* supposedly had two. Mead synonymised *Gyroidina neosoldanii* with *soldanii*, which according to Whittaker (1988) is much closer to *Gyroidina orbicularis*. Since Mead's analysis was based on Loeblich & Tappan (1964), his concept of *Gyroidina* reflects the *lapsus* of the latter authors. Mead's analysis draws attention to the different criteria which have been used: Brotzen thought the number of whorls to be significant as well as the shape of the spiral intercameral sutures. Parker (1958) considered the angle of the intercameral sutures to the spiral suture constant within a species, while Todd (1958) regarded all this as falling within the variability of the taxon.

Haynes (1981) considered *Gyroidinoides* to be closely allied to *Gyroidina*, but also to *Gavelinella* and *Valvulineria*. This group was classified in the Cancrisidae rather than dispersed over the Osangulariidae, Anomalinidae and Discorbidae as proposed by Loeblich & Tappan (1964).

Whittaker (1988) disagreed with the Haynes proposal and followed Loeblich & Tappan (1984) amended classification.

Gyroidinoides lenticulus (Reuss, 1845)
Pl. 11, Figs. 9-12

1845 *Rotalina lenticula* Reuss: 35, pl. 12, figs, 17a-c.
1963 *Valvalabamina lenticula* (Reuss); Reiss: 62.
1987 *Valvalabamina lenticula* (Reuss); Loeblich & Tappan: 628.

Type specimen. Originally in the Fürstlich Lobkowitz Mineralien Kabinet, Bilin. This collection was subsequently moved to Budapest, where it was destroyed during the Soviet invasion of 1956; from Lüschitz, Bohemia, Czech Republic; Plänermergel, Turonian.

Material examined. Topotypes, courtesy H. J. Hansen.

Description. Test lenticular, low trochospiral, spiral side convex to nearly plane, evolute, umbilical side flattened, involute, umbilicus small but hidden, periphery broadly rounded, 1.5 to 2 whorls; chambers flush, 11 chambers in final whorl; sutures depressed, gently arcuate, spiral suture clearly sunken especially in the final parts; aperture a narrow interiomarginal slit, umbilical-extraumbilical, running to the periphery, a small foliar umbilical extension of the chamber not hiding part of the aperture; wall optically granular, very finely perforate.

Remarks. The illustrations by Loeblich & Tappan (1987) are not of *G. lenticulus*, but presumably similar species from the American Cretaceous. As pointed out by Reuss, the main difference between *Gyroidinoides nitidus* and this species is the much flatter nature of the overall shape of the test. Apart from this single feature, similarities are overwhelming and probably too great to warrant generic separation from *Gyroidinoides*. Therefore, *Valvalabamina* is herein synonymised into *Gyroidinoides*.

The observations here reported point towards substantial similarities with *Valvulineria*. Also, the apparently first documentation of relict umbilical apertures underpins the drastic reclassification herein proposed.

GENUS *Scheibnerova* QUILTY, 1984

1984 *Scheibnerova* Quilty: 234.
1987 *Scheibnerova* Quilty; Loeblich & Tappan: 642.

Type species. Scheibnerova protindica Quilty, 1984, original designation.

Scheibnerova protindica Quilty, 1984
Pl. 12, Figs. 1-4

1973 *Praeglobotruncana stephani* (Gandolfi); Quilty: pl. 1, figs. 12-13.
1984 *Scheibnerova protindica* Quilty: 234, figs. 5A-K.
1987 *Scheibnerova protindica* Quilty; Loeblich & Tappan: 642, pl. 723, figs. 8-14.

Holotype. CPC24607, Commonwealth Palaeontological Collection, Canberra; from F/S *Sonne* Cruise 8A, 18°25.4-26.3'S 112°21.8-23.6'E, sample 72KD-A, 3920-3450 m Exmouth Plateau; Early Cenomanian.

Material examined. DSDP 766A, Exmouth Plateau, Cenomanian, courtesy D. Haig.

Description. Test unequally biconvex to lenticular, trochospiral, spiral side strongly convex, evolute, umbilical side flattened to slightly depressed, involute, very small sunken umbilicus, periphery broadly rounded, lobulate, 2 whorls; chambers crescentic, narrow, becoming more crescentic during ontogeny, flush to slightly inflated, 5 chambers in final whorl; sutures on spiral side obscured by ornamentation, on umbilical side gently arcuate, depressed; aperture slit-like, with low indistinct lip, umbilical-extraumbilical, not reaching the periphery, on umbilical-most end partially hidden under an umbilical flange; wall optically granular, sparsely and finely perforate, spiral side ornamented by a dense rugose-hispid cover.

Remarks. Quilty differentiated *Scheibnerova* from *Valvulineria* by the more hispid spiral side and a, perhaps, more sharply angled periphery, and from *Vernonina* by the presence of an interiomarginal arched aperture, staying clear from the umbilical area.

Superficially close to *Vernonina*, the umbilical region shows important differences: in *Scheibnerova* there is no umbilical plug but there are umbilical flaps which are absent in *Vernonina*. For these reasons, it is here classified in the Cancrisidae.

GENUS *Stensioeina* BROTZEN, 1936

1936 *Stensioeina* Brotzen: 164.
1940 *Stensioeina* Brotzen; Cushman: 263.
1964 *Stensioeina* Brotzen; Loeblich & Tappan: 763.
1987 *Stensioeina* Brotzen; Loeblich & Tappan: 635.

Type species. Rotalia exsculpta Reuss, 1860, original designation.

Stensioeina exsculpta (Reuss, 1860)
Pl. 12, Figs. 5-8

1860 *Rotalia exsculpta* Reuss: 222, pl. 11, figs. 4a-c.
1936 *Stensioeina exsculpta* (Reuss); Brotzen: 165, pl. 11, figs. 8a-c.
1964 *Stensioeina exsculpta* (Reuss); Loeblich & Tappan: 763, figs. 627/7a-c.
1966 *Stensioeina exsculpta* (Reuss); Cita: 251, figs. 1-4.
1987 *Stensioeina exsculpta* (Reuss); Loeblich & Tappan: 635, pl. 715, figs. 4-6.

Type specimen. Probably at Naturhistorisches Museum Wien; from Hamm, Westfalen; Mucronatenkreide, Campanian.

Material examined. The Natural History Museum, courtesy J. E. Whittaker. Also CC35110, CC35142, CC35109, CC35104, and USNM433611, topotypes; Smithsonian Institution, Washington, D.C.

Description. Test sublenticular to planoconvex, low trochospiral, spiral side slightly convex to flat, evolute, umbilical side broadly convex, involute, umbilicus hidden, periphery sharply angled, flush, 2 to 2.5 whorls; chambers crescentic, becoming narrower during ontogeny, flush, 11 chambers in final whorl; sutures on spiral side raised, distinct, gently curved, marked by bead-like thickenings, on umbilical side indistinct, slightly depressed, gently curved, spiral suture raised, accentuated by raised beads; aperture elliptical, bordered by a rounded and thickened lip, umbilical-extraumbilical, staying well away from the periphery, continuing into the umbilicus under an umbilical flap, umbilical flap covering the whole of umbilicus proper, successive flaps partially imbricate, earlier umbilical apertures gradually closed off; wall optically granular, sparsely and finely perforate.

Remarks. Initially, Brotzen considered *Stensioeina* to be closely allied to *Gyroidina* and *Globorotalia* (in this case in the sense of *Globorotalites*), drawing on the features of aperture, overall shape and nature of the umbilicus. In his discussion of *Gavelinella*, Brotzen (1942) revised his opinion and included *Stensioeina* with *Valvulineria, Gavelinella, Gyroidinoides, Gyroidina, Rotaliatina, Eponides, Pseudovalvulineria* and *Streblus* in the Valvulineriinae. Cushman (1940) followed this lead and classified *Stensioeina* next to *Gyroidina* in the Discorbinae. Loeblich & Tappan (1964) put it in the Anomalininae, not expanding on the original description.

Haynes (1981) saw a closer relation between *Stensioeina* and *Heterolepa*, still in the Anomalinidae.

Loeblich & Tappan (1987) proposed a rather major reclassification of *Stensioeina* in the Gyroidinoidinae, Gavelinellidae, together with *Notoplanulina, Nummodiscorbis* and *Rotaliatina* amongst others. As before, the description of the morphology was essentially that of Brotzen.

The observations here reported point towards substantial similarities with *Valvulineria*. The apparently first documentation of relict umbilical apertures is an important element in the drastic reclassification herein proposed.

GENUS *Valvulineria* CUSHMAN, 1926

1926 *Valvulineria* Cushman: 59.
1964 *Valvulineria* Cushman; Loeblich & Tappan: 587.
1987 *Valvulineria* Cushman; Loeblich & Tappan: 547.
1988 *Valvulineria* Cushman; Whittaker: 112.

Type species. Valvulineria californica Cushman, 1926, original designation.

Valvulineria californica Cushman, 1926
Pl. 12, Figs. 9-11

1926 *Valvulineria californica* Cushman: 60, pl. 9, figs. 1a-c.
1957 *Valvulineria californica* Cushman; Reiss: 129, pl. 18, fig. 5.
1964 *Valvulineria californica* Cushman; Loeblich & Tappan: 587, figs. 462/5 – 7.
1987 *Valvulineria californica* Cushman; Loeblich & Tappan: 547, pl. 593, figs. 12-17.

Holotype. CC5798, Smithsonian Institution, Washington, D.C.; from Section 24, T28S, R14E, San Luis Obispo County, California; Upper Monterey, Miocene.

Material examined. Holotype, also CC5799-5803, CC5841, CC59444 and USNM393466, topotypes, Smithsonian Institution, Washington, D.C.

Description. Test unequally to equally biconvex, low trochospiral, spiral side nearly flat, tending towards concavity, evolute, umbilical side convex, involute, with a clearly depressed central umbilicus, periphery broadly rounded, strongly lobulate, 2.5 whorls; chambers spherical, strongly inflated, rapidly increasing in size, 7 chambers in final whorl; sutures gently arcuate, strongly depressed, becoming flush, spiral suture clearly depressed, somewhat undulate; aperture elliptical, umbilical extra-umbilical, restricted to lowermost part of leading chamber face, continuing into the umbilicus, hidden under an umbilical folium, successive folia partially coalescing, but leaving a relict foramen in previous chambers, relict apertures gradually closed off; wall optically granular, finely perforate.

Remarks. Valvulineria was originally classified in the proximity of *Gyroidina* and *Stensioeina* by Cushman (1940). Loeblich & Tappan (1964) retained *Valvulineria* with *Cancris* in the Discorbidae because of the optical nature of the test. Haynes (1981) returned to a large extent to Cushman's original ideas and grouped *Valvulineria* with *Gyroidina, Gyroidinoides* and *Cancris*. The latest proposal by Loeblich & Tappan (1987) reflects their earlier proposal, notwithstanding the discrediting of the optical nature of the test wall as a useful taxonomic characteristic above species level.

The sections and broken specimens herein examined clearly show the presence of umbilical relict apertures, reminiscent of *Gavelinella* but especially *Cancris*. *Valvulineria* is classified together with *Cancris* rather than *Gavelinella* because of the complete obstruction of the umbilicus by the very large umbilical flaps.

Incertae Sedis

GENUS *Globorotalites* BROTZEN, 1942

1942 *Globorotalites* Brotzen: 31.
1964 *Globorotalites* Brotzen; Loeblich & Tappan: 752.
1987 *Globorotalites* Brotzen; Loeblich & Tappan: 629.

Type species. *Globorotalia multisepta* Brotzen, 1936, original designation.

Globorotalites multiseptus (Brotzen, 1936)
Pl. 13, Figs. 1-4

1936 *Globorotalia multisepta* Brotzen: 161, pl. 11, figs. 6-7, text figs. 59-61.
1942 *Globorotalites multiseptus* (Brotzen); Brotzen: 31.
1960 *Globorotalites multiseptus* (Brotzen); Reiss:
1964 *Globorotalites multiseptus* (Brotzen); Loeblich & Tappan: 752, figs. 615/8 – 9.
1987 *Globorotalites multiseptus* (Brotzen); Loeblich & Tappan: 629, pl. 706, figs. 13-17.

Holotype. 58, Naturhistoriska Riksmuseet, Stockholm; from Eriksdal; Eriksdal Marl, Maastrichtian.

Material examined. Holotype, and 58a, paratype. Also USNM P48, topotypes, donated by Brotzen to the Smithsonian Institution.

Description. Test inverted conical, trochospiral, spiral side flat, evolute, umbilical side convex, involute, periphery flush, angular, marked by a slightly thickened keel, 1.5 to 2 whorls in trochospiral coils, umbilicus closed; chambers narrow, flush, crescentic to nearly oblique; sutures flush, on spiral side limbate, arcuate, on umbilical side less clearly defined, often becoming gently sigmoid; aperture a long narrow interiomarginal slit running from the umbilicus to the periphery, bordered by a small, low lip, when converted into a foramen, a distinct bipartitor is deposited in the foramen; wall very finely perforate.

Remarks. Brotzen mentioned in his description a similarity in apertural reduction between *Globorotalites* and *Gyroidinoides, Gyroidina* and *Eponides.*

Reiss (1960) reported the presence of a 'murus reflectus' apparently dividing the aperture into two, an observation included in the description of the genus by Loeblich & Tappan. However, Reiss investigated specimens of *G. michelinianus* rather than *G. multiseptus.* This remark also applies to the study by Hauser & Grünig (1993): the authors did not investigate the type species of *Globorotalites.* However, the observations herein presented support these views about the nature of *Globorotalites.* While an alliance with *Eponides* is possible, it is deemed prudent as yet not to venture any proposal in this direction. A synonymy with *Eponides* cannot be supported.

GENUS *Gyroidina* D'ORBIGNY, 1826

1826 *Gyroidina* d'Orbigny: 278.
1927 *Gyroidina* d'Orbigny; Cushman: 190.
1929 *Rotalia (Gyroidina)* d'Orbigny; Yabe & Hanzawa: 155.
1964 *Gyroidina* d'Orbigny; Loeblich & Tappan: 750.
1967 *Gyroidina* d'Orbigny: Hansen: 7.
1968 *Serovaina* Sliter: 91.
1987 *Gyroidina* d'Orbigny; Loeblich & Tappan: 638.
1987 *Serovaina* Sliter; Loeblich & Tappan: 545.

Type species. *Gyroidina orbicularis* Parker, Jones & Brady, 1865, subsequent designation by Cushman, 1927.

Gyroidina orbicularis Parker, Jones & Brady, 1865
Pl. 13, Figs. 5-8

1826 *Gyroidina orbicularis* d'Orbigny: 278, *nomen nudum.*
1865 *Gyroidina orbicularis* d'Orbigny; Parker, Jones & Brady: 20, pl. 3, fig. 85.
non 1962 *Gyroidina orbicularis* d'Orbigny; Banner & Clarke: 1335.
non 1964 *Gyroidina orbicularis* d'Orbigny; Loeblich & Tappan: 750, figs. 614/5 – 6.
1967 *Gyroidina orbicularis* d'Orbigny; Hansen: 7, pl. 2, figs. 1, 2.
1987 *Gyroidina orbicularis* d'Orbigny; Loeblich & Tappan: 638, pl. 716, figs. 8-13 only!
1994 *Gyroidina orbicularis sensu* Parker, Jones & Brady; Jones: 114.
1994 *Rosalina orbicularis* Parker, Jones & Brady; Jones: 114, *err. cit.*

Lectotype. MMH 10.319, Mineralogic Museum, Copenhagen, selected by Hansen (1967); from Rimini; Recent.

Material examined. Topotypes, courtesy H. J. Hansen.

Description. Test lenticular, low trochospiral, spiral side slightly convex, nearly flat, evolute, umbilical side convex, involute, periphery broadly rounded, flush, umbilicus very small but open, 2 whorls; chambers flush with the surface, 9 chambers in final whorl; sutures depressed, gently arcuate on spiral side, straight on umbilical side; aperture a long narrow interiomarginal slit, running from the umbilicus to the periphery, bordered by a clearly everted lip, a little flap is present at the umbilical-most part of the chamber, just below the lower end of the aperture, projecting over but only partially covering the umbilicus, no aperture seems to be present under this flap, when the aperture is converted to a foramen, a bipartitor is laid down, splitting the foramen into two, without giving rise to a canal system; wall optically granular, very finely perforate.

Remarks. *Gyroidina* has always been a problematical taxon, due to the inadequate original proposal of the genus and the nature of its type species. The absence of subsequent study of the original material, but plenty of reinterpretation at the hand of specimens purportedly being *G. orbicularis*, led to a vague, unstable concept. The proposal of the separate genus *Gyroidinoides* by Brotzen compounded the problem considerably, since the criteria to do so rested on details of the apertural complex, which had not been described for *G. orbicularis.* Loeblich & Tappan (1964) discussed the features of both genera in great depth, but unfortunately based their discussion of *Gyroidina* on a misidentification, something that came to light when Hansen (1967) selected and illustrated a lectotype for *G. orbicularis.*

In 1962, Banner & Clarke published a note with a wholesale selection of lectotypes and the designation (invalid, art. 75, ICZN, 1985) of 3 neotypes. As regards the *Gyroidina* type, Banner & Clarke wrote "Syntypes of *Gyroidina orbicularis* (d'Orbigny, 1826) Parker, Jones & Brady, 1865, exist in Paris, but their nature is such that a lectotype for this species, the type species of *Gyroidina*, has had to be selected from the Parker, Jones & Brady collection in London (The Natural History Museum)." However, that specimen is not a lectotype, because the Parker, Jones & Brady collection is not part of the original type series. Furthermore, that specimen is here identified as *G. soldanii*, the type species of *Hansenisca.* Jones (1994) also accepts the Hansen specimen as the valid lectotype.

The observation of an eponidid bipartitor in the foramina raises great difficulties as to the proper classification of this genus. The current turmoil in classification of the smaller, low trochoid rotaliids is sufficient to caution an *incertae sedis* proposal for this genus. The absence of this structure in *Heterolepa* and *Parrelloides* confirms the distinction between these genera and *Gyroidina.*

Gyroidina orbicella Bandy, 1951
Pl. 13, Figs. 9-12

1951 *Gyroidina globosa* var *orbicella* Bandy: 505, pl. 74, figs. 2a-c
1968 *Serovaina orbicella* (Bandy); Sliter: 92, pl. 13, fig. 12.

1987 *Serovaina orbicella* (Bandy); Loeblich & Tappan: 545, pl. 590, figs. 13-21.

Holotype. USNM231417, Smithsonian Institution, Washington, D.C.; from Letterbox Canyon, I.J. Kelly Ranch, Carlsbad, San Diego Co., California; Panoche group, Los Gatos stage, Campanian.

Material examined. Holotype, and USNM237418, paratypes.

Description. Test lenticular, low trochospiral, spiral side very slightly convex, evolute, umbilical side strongly convex, involute, small sunken umbilicus, periphery flush, well rounded, 2 whorls; chambers flush, 8 chambers in final whorl; sutures barely arcuate, flush, spiral suture marked, slightly sunken; aperture a long interiomarginal slit, running from near the periphery into the umbilicus, bordered by a very low lip; wall appearing optically granular.

Remarks. The genus *Serovaina* was created by Sliter to accomodate a *Gyroidina* species that exhibited optically radial behaviour, rather than the usual granular one. My observations of the holotype of the species show it to be optically granular. No other criteria were put forward, and neither Bandy's nor Sliter's drawings show any features which would allow a distinction to be drawn. Irrespective of this observation, it has been demonstrated repeatedly that the optical nature of the wall is an unreliable characteristic above species level. Therefore, *Serovaina* is synonymised into *Gyroidina*.

GENUS *Hollandina* HAYNES, 1956

1956 *Hollandina* Haynes: 94.
1964 *Heterolepa* Franzenau; Loeblich & Tappan: 759, *partim.*
1987 *Hollandina* Haynes; Loeblich & Tappan: 640.

Type species. Hollandina pegwellensis Haynes, 1956, original designation.

Hollandina pegwellensis Haynes, 1956
Pl. 14, Figs. 9-12

1956 *Hollandina pegwellensis* Haynes: 94, pl. 17, figs. 5a-g.
1964 *Heterolepa pegwellensis* (Haynes); Loeblich & Tappan: 759, figs. 623/6a-c.
1987 *Hollandina pegwellensis* Haynes; Loeblich & Tappan: 640, pl. 720, figs. 1-9.

Holotype. P42605, The Natural History Museum, London; from Pegwell Bay, Kent; Thanet Formation, Thanetian.

Material examined. Holotype and paratypes, courtesy J. E. Whittaker.

Description. Test lenticular, very low trochospiral, spiral side convex, evolute, umbilical side convex but rather flattened, involute, periphery angled, lobulate, umbilicus closed, 2.5 whorls; chambers flush, gradually increasing in size, 8 chambers in final whorl; sutures flush, gently arcuate on spiral side, nearly straight on umbilical side, spiral suture indistinct; aperture a narrow interiomarginal slit, staying clear from the umbilical-most region, running up to the periphery without crossing it, bordered by a slightly thickened lip, no modifications occur during conversion to a foramen; wall sparsely perforate.

Remarks. Proposed by Haynes (1956) as a member of the Anomalininae, it was synomymised into *Heterolepa* by Loeblich & Tappan (1964), but later (1987) separated off again and classified in the Gavelinellinae. The very simple, almost primitive, morphology of this genus poses a major problem for a properly argued supra-generic classification.

GENUS *Holmanella* LOEBLICH & TAPPAN, 1962

1962 *Holmanella* Loeblich & Tappan: 72.
1964 *Holmanella* Loeblich & Tappan; Loeblich & Tappan: 760.
1987 *Holmanella* Loeblich & Tappan; Loeblich & Tappan: 640.

Type species. Discorbinella valmonteensis Kleinpell, 1938, original designation.

Holmanella valmonteensis (Kleinpell, 1938)
Pl. 14, Figs. 1-4

1938 *Discorbinella valmonteensis* Kleinpell: 350, pl. 21, figs. 14-16
1962 *Holmanella valmonteensis* (Kleinpell); Loeblich & Tappan: 72.
1964 *Holmanella valmonteensis* (Kleinpell); Loeblich & Tappan: 760, figs. 625/1 – 4.
1987 *Holmanella valmonteensis* (Kleinpell); Loeblich & Tappan: 640, pl. 719, figs. 16-24.

Holotype. 497214, Smithsonian Institution, Washington, D.C.; from Woodring, Bramlette, California; Valmonte diatomite, Upper Miocene

Material examined. USNM 497214, holotype, CC42316 topotypes, Smithsonian Institution, Washington, D.C.

Description. Test strongly compressed, nearly planispiral, spiral side flat, evolute, umbilical side very slightly concave, evolute, umbilicus open, 2 whorls; chambers compressed, becoming more and more arched backwards towards the periphery, 9 chambers in final whorl; sutures strongly depressed, arcuate; aperture a long equatorial slit, the lower end running up the apertural face parallel to the umbilical side, on the umbilical side with low narrow seaming lips, not connected to the aperture, hence not harbouring relict apertures either; wall optically granular, coarsely perforate.

Remarks. All specimens, including the holotype, have at least the final chamber broken off, so no primary aperture could be seen. The umbilical lips along the chambers are not related to umbilical apertures, nor canal systems or other such features. Therefore, the classification in the Gavelinellinae, as proposed by Loeblich & Tappan (1964, 1987) cannot be supported.

GENUS *Nummodiscorbis* HORNIBROOK, 1961

1961 *Nummodiscorbis* Hornibrook: 106.
1964 *Nummodiscorbis* Hornibrook; Loeblich & Tappan: 763.
1987 *Nummodiscorbis* Hornibrook; Loeblich & Tappan: 634.

Type species. Nummodiscorbis novozealandica Hornibrook, 1961, original designation.

Nummodiscorbis novozealandica Hornibrook, 1961
Pl. 14, Figs. 5-8

1961 *Nummodiscorbis novozealandica* Hornibrook: 106, pl. 13, figs. 257-259.
1964 *Nummodiscorbis novozealandica* Hornibrook; Loeblich & Tappan: 763, figs. 626/2a-c.
1987 *Nummodiscorbis novozealandica* Hornibrook; Loeblich & Tappan: 634, pl. 714, figs. 1-6.

Holotype. TF1406/1, New Zealand Geological Survey; from Weka Pass Stream, North Canterbury, South Island; Altonian, Lower Miocene.

Material examined. Topotypes, The Natural History Museum, courtesy J. E. Whittaker; paratypes, New Zealand Geological Survey, courtesy C. P. Strong.

Description. Test strongly compressed, circular, very low trochospiral, spiral side very slightly convex, evolute, umbilical side flat, involute, periphery subangular, marked by an imperforate band, flush, a small sunken umbilicus, 2.5 to 3 whorls; chambers strongly crescentic, very narrow, flush, increase in size mainly due to enlarging of radial length, width nearly constant, 20 chambers in final whorl; sutures on spiral side slightly depressed, strongly arcuate, quickly obscured, on umbilical side depressed, central half straight, then strongly arcuate in posterior direction, spiral suture ill-defined; aperture umbilical, a small opening; wall finely perforate, spiral side ornamented by dense covering of very low tubercles.

Remarks. Originally proposed as a genus in the Discorbinae by Hornibrook, it was reclassified first in the Anomalininae by Loeblich & Tappan, 1964 (close to *Gavelinella*), and subsequently (1987) in the Gyroidinoidinae, but in both cases little was presented in the way of argument in favour of these decisions. The unusual morphological features and combination of characteristics pose a difficult problem for its classification. The aperture seems to be restricted to the umbilical-most part of the leading face, contradicting Hornibrook's description of the aperture: there is no interiomarginal slit running from periphery into the umbilicus and the basal suture has no aperture. The two paratypes studied show that both specimens underwent reproduction, and from the features of the test, this seems to have been plastogamic reproduction. In conjunction with the overall test shape, this seems to indicate a glabratellid affinity.

Nomen Inquaerendum

GENUS *Gavelinonion* HOFKER, 1957

1951b *Gavelinonion* Hofker: 17, *nomen nudum.*
1952 *Gavelinonion* Bermúdez: 150, *nomen nudum.*
1953 *Gavelinonion* Thalmann: 876, *nomen nudum.*
1956a *Gavelinonion* Hofker: 116, *nomen nudum.*
1957 *Gavelinonion* Hofker: 368.
1964 *Melonis* de Montfort; Loeblich & Tappan: 761, *partim.*
1987 *Gavelinonion* Hofker; Loeblich & Tappan: 701.

Type species. Nautilus umbilicatulus Walker & Jacob, 1798, original designation.

Gavelinonion umbilicatulus (Walker & Jacob, 1798)

1798 *Nautilus umbilicatulus* Walker & Jacob, *in* Kanmacher: 641, pl. 14, fig. 34.
1957 *Gavelinonion umbilicatulus* (Walker & Jacob); Hofker: 368.
1964 *Melonis umbilicatulus* (Walker & Jacob); Loeblich & Tappan: 761.

Type specimen. Unavailable; from Sandwich, Kent; Shore sands.

Remarks. The genus *Gavelinonion* is a *nomen dubium* as the type species is unrecognisable. Two options are available to rescue the name. The first is to try and retrieve specimens identified by Hofker as *G. umbilicatulus* from the Virgin Islands and use those to neotypify the species, solving the problem. Alternatively, since the type species is unrecognisable, the ICZN could be asked to set aside the original designation of a type species and to designate the other species mentioned in the original description of the genus *Gavelinonion*, as the new type species, i.e., *Anomalinoides nobilis* Brotzen, 1948.

ACKNOWLEDGEMENTS

I gratefully acknowledge the cooperation under the shape of loans, donations and exchanges from many colleagues and curators without which this study would have been impossible. In particular, I wish to thank G. Blom, Naturhistoriska Riksmuseet, Stockholm, Sweden; M. A. Buzas, Smithsonian Institution, Washington, D.C., USA; E. Caus, University of Barcelona, Spain; A. Dhondt, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium; D. L. Eicher, University of Colorado, Boulder, USA; D. W. Haig, University of Western Australia, Perth, Australia; H. J. Hansen, Københavns Universitet, Denmark; F. Jannin, Université de Bourgogne, Dijon, France; B. Kohl, Tulane University, New Orleans, USA; A. R. Loeblich, University of California, Los Angeles, USA; H. Malz, Naturmuseum Senckenberg, Frankfurt am Main, Germany; J. Pignatti, Universit La Sapienza, Rome, Italy; F. Rögl, Naturhistorisches Museum Wien, Austria; C. P. E. Strong, Institute of Geological & Nuclear Sciences, Wellington, New Zealand; R. van Soest, Zoologisch Museum, Vrije Universiteit Amsterdam, the Netherlands; M.-T. Vénec-Peyré, Muséum National d'Histoire Naturelle, Paris, France; and J. E. Whittaker, The Natural History Museum, London, Great Britain. Photography was carried out using the SEM and ESEM facilities of the University of Western Australia. This study was carried out under a fellowship granted by the Australian Research Council.

REFERENCES

ANDERSEN, H. V., 1961, Genesis and paleontology of the Mississippi River mudlumps, Part II. Foraminifera from the mudlumps, lower Mississippi River delta: Geological Bulletin Louisiana Department of Conservation, v. 35, p. 1-208.

ANDREAE, A., 1884, Beitrag zur Kenntniss des Elsässer Tertiärs; Theil II, Die Oligocänschichten: Geologische Spezialkarte Elsass-Lotharingen, Abhandlungen, v. 2, p. 1-239.

ASANO, K., 1944, *Hanzawaia*, a new genus of Foraminifera from the Pliocene of Japan: Journal Geological Society of Japan, v. 51, p. 97-98.

BANDY, O. L., 1951, Upper Cretaceous Foraminifera from the Carlsbad area, San Diego County, California: Journal of Paleontology, v. 25, p. 488-513.

BANNER, F. T. and CLARKE, W. J., 1962, Type species of foraminiferal genera: Nature, v. 196, p. 1334-1335.

BARTENSTEIN, H., 1954, Revision von Berthelin's Mémoire 1880 über die Alb-Foraminiferen von Moncley: Senckenbergiana Lethaea, v. 35, p. 37-50.

BECK, R. S., 1943, Eocene foraminifera from Cowlitz River, Lewis County, Washington: Journal of Paleontology, v. 17, p. 584-614.

BELFORD, D. J., 1960, Upper Cretaceous foraminifera from the Toolonga Calcilutite and Gingin Chalk, Western Australia: Bureau of Mineral Resources Bulletin, v. 57, p. 1-198.

BERMÚDEZ, P. J., 1949, Tertiary smaller Foraminifera of the Dominican Republic: Cushman Laboratory for Foraminiferal Research, Special Publication, v. 25, p. 1-322.

—, 1952, Estudio sistematico de los foraminiferos rotaliformes: Boletín de Geología, Venezuela, v. 2, p. 1-230.

BERTHELIN, G., 1880, Mémoire sur les foraminifères fossiles de l'étage Albien de Montcley (Doubs): Mémoires de la Société Géologique de France, v. 1, p. 1-84.

BETTENSTAEDT, F., 1952, Stratigraphisch wichtige Foraminiferen-Arten aus dem Barrême vorwiegend Nordwest-Deutschlands: Senckenbergiana, v. 33, p. 263-295.

BRADY, H. B., 1884, Report on the Foraminifera dredged by H.M.S. *Challenger*, during the years 1873-1876: Reports on the Scientific Results of the Voyage of the H.M.S. *Challenger* during the years 1873-1876, Zoology, v. 9, p. 1-814.

BRADY, H. B., PARKER, W. K. and JONES, T. R., 1888, On some foraminifera from the Abrohlos Bank: Transactions of the Zoological Society of London, v. 12, p. 211-239.

BROTZEN, F., 1936, Foraminiferen aus dem schwedischen untersten Senon von Eriksdal in Schonen: Årsbok Sveriges Geologiska Undersökning, v. 30, p. 1-206.

—, 1940, Flintrännans och Trindeltrännans Geologi: Årsbok Sveriges Geologiska Undersökning, v. 34, p. 1-33.

—, 1942, Die Foraminiferengattung *Gavelinella* nov. gen. und die Systematik der Rotaliiformes: Årsbok Sveriges Geologiska Undersökning, v. 36, p. 1-60.

—, 1948, The Swedish Palaeocene and its foraminiferal fauna: Årsbok Sveriges Geologiska Undersökning, v. 42, p. 1-140.

BYKOVA, N. K., BALAKHMATOVA, V. T., VASILENKO, V. P., VOLOSHINOVA, N. A., GRIGELIS, A., DAIN, L. G., IVANOVA, L. V., KUZINA, V. I., KUZNETSOVA, Z. V., KOZYREVA, V. F., MOROZOVA, V. G., MYATLYUK, E. V. and SUBBOTINA, N. N., 1958, Novye rody i vidy foraminifer: Trudy Vsesoyuznogo Neftyanogo Nauchno-issledovatel'skogo Geologo-razvedochnogo Instituta, v. 115, p. 4-81.

CHAPMAN, F., PARR, W. J. and COLLINS, A. C., 1934, Tertiary foraminifera of Victoria, Australia - The Balcombian deposits of Port Phillip, Part III: Journal of the Linnaean Society for Zoology, v. 38, p. 553-577.

CITA, M. B., 1966, Le genre *Stensioeina* dans le Crétacé supérieur italien: Eclogae Geologicae Helvetiae, v. 59, p. 245-257.

CORYELL, H. N. and RIVERO, F. C., 1940, A Miocene microfauna of Haiti: Journal of Paleontology, v. 14, p. 324-344.

CROUCH, R. W. and POAG, C. W., 1979, *Amphistegina gibbosa* d'Orbigny from the California borderlands: Journal of Foraminiferal Research, v. 9, p. 85-105.

CUSHMAN, J. A., 1915, A monograph of the Foraminifera of the North Pacific Ocean. Part 5. Rotaliidae: Bulletin U.S. National Museum, p. 1-81.

—, 1926, Foraminifera of the typical Monterey of California: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 2, p. 53-69.

—, 1927, The designation of some genotypes in Foraminifera: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 3, p. 188-190.

—, 1928, Additional foraminifera from the Upper Eocene of Alabama: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 4, p. 73-79.

—, 1940, Foraminifera, their classification and economic use: Harvard University Press, Cambridge, Massachusetts, ix + 535 p.

CUSHMAN, J. A. and BERMÚDEZ, P. J., 1948, Some Paleocene foraminifera from the Madruga formation of Cuba: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 24, p. 68-75.

CUSHMAN, J. A. and GARRETT, J. B., 1939, Eocene Foraminifera of Wilcox age from Woods Bluff, Alabama: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 15, p. 77-89.

CUSHMAN, J. A. and PONTON, G. M., 1932, An Eocene foraminiferal fauna of Wilcox age from Alabama: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 8, p. 51-72.

CUSHMAN, J. A. and RENZ, H. H., 1941, New Oligocene-Miocene foraminifera from Venezuela: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 17, p. 1-27.

CUSHMAN, J. A. and TODD, R., 1942, The genus *Cancris* and its species: Contributions from the Cushman Laboratory for Foraminiferal Research, v. 18, p. 72-94.

DE MONTFORT, D., 1808, Conchyliologie Systématique et Classification Méthodique des Coquilles: Schoell, Paris, 410 p.

DIENI, I. and MASSARI, F., 1966, I foraminiferi del Valanginiano superiore do Orosei (Sardegna): Paleontolographia Italica, v. 61, p. 75-186.

D'ORBIGNY, A., 1826, Tableau méthodique de la classe des Céphalopodes: Annales des Sciences Naturelles, v. 7, p. 245-314.

—, 1839, Foraminifères *in* RAMON DE LE SAGRA. Histoire physique, politique et naturelle de l'ile de Cuba. Bertrand, Paris, p. xlviii + 224

—, 1840, Mémoire sur les foraminifères de la craie blanche du bassin de Paris: Mémoires de la Société Géologique de France, v. 4, p. 1-51.

—, 1846, Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche): Gide et Comp., Paris, 312 p.

EICHER, D. L. and WORSTELL, P., 1970, Cenomanian and Turonian foraminifera form the Great Plains, United States: Micropaleontology, v. 16, p. 269-324.

EIMER, G. H. and FICKERT, C., 1899, Die Artbildung und Verwandtschaft bei den Foraminiferen. Entwurf einer natürlichen Eintheilung derselben: Zeitschrift für Wissenschaftliche Zoologie, v. 65, p. 527-636.

FINLAY, H. J., 1939, New Zealand Foraminifera: Key species in stratigraphy-No. 1: Transactions Royal Society of New Zealand, Geology, v. 68, p. 504-543.

FORNASINI, C., 1898, Contributo alla conoscenza della microfauna terziaria italiana. Foraminiferi del Pliocene superiore di San Pietro in Lama presso Lecce: Memorie della Reale Accademia della Scienze dell'Instituto di Bologna, Scienze Naturali, v. 7, p. 205-212.

—, 1902, Sinossi metodica dei foraminiferi sin qui rinvenuti nella sabbia del lido di Rimini: Memorie della Reale Accademia della Scienze dell'Instituto di Bologna, Scienze Naturali, v. 10, p. 1-68.

FRANZENAU, A., 1884, *Heterolepa*, egy uj genus a Foraminiferák rendjében: Természetrajzi Füzetek, v. 8, p. 181-184; 214-217.

—, 1885, Adalék nehány foraminifera héjszerkezetének ismeretéhez: Természetrajzi Füzetek, v. 9, p. 92-94; 151-153.

GALLOWAY, J. J., 1933, A manual of Foraminifera: Principia Press, Bloomington, Indiana, xii + 483 p.

GALLOWAY, J. J. and WISSLER, S. G., 1927, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journal of Paleontology, v. 1, p. 35-87.

GHEORGIAN, M., IVA, M. and GHEORGIAN, M., 1968, *Transylvanina* et *Hidina*, foraminifères nouveaux dans le Miocène de Transylvanie (Roumanie): Revue de Micropaléontologie, v. 10, p. 193-199.

GLAESSNER, M. F., 1945, Principles of Micropalaeontology: Melbourne University Press, Melbourne, xvi + 296 p.

GONZÁLES-DONOSO, J. M., 1969, Données nouvelles sur la texture et la structure du test de quelques foraminifères du Bassin de Grenade (Espagne): Revue de Micropaléontologie, v. 12, p. 3-8.

HADLEY, W. H., 1934, Some Tertiary foraminifera from the north coast of Cuba: Bulletin American Paleontology, v. 20, p. 1-40.

HANNA, G. D. and HANNA, M. A., 1924, Foraminifera from the Eocene of Cowlitz River, Lewis County, Washington: Publications in Geology, Washington University, v. 1, p. 57-64.

HANSEN, H. J., 1967, Description of seven type specimens of Foraminifera designated by d'Orbigny, 1826: Kongelige Danske Videnskabernes Selskab Biologiske Meddelelser, v. 23, p. 1-11.

—, 1970, Danian foraminifera from Nugssuaq, West Greenland: Grønlands Geologiske Undersøgelse Bulletin, v. 93, p. 1-132.

HANSEN, H. J. and LYKKE ANDERSEN, A., 1976, Wall structure and classification of fossil and recent elphidiid and nonionid foraminifera: Fossils and Strata, v. 10, p. 1-37.

HANSEN, H. J. and REVETS, S. A., 1992, A critical revision and reclassification of the Discorbidae, Rosalinidae and Rotaliidae: Journal of Foraminiferal Research, v. 22, p. 166-180.

—, 1980, What is *Nonion*? Problems involving foraminiferal genera described by Montfort, 1808 and the type species of Fichtel and Moll, 1798: Journal of Foraminiferal Research, v. 10, p. 173-179.

Hauser, E. H. and Grünig, A. K., 1993, *Eponides* and some related genera (Cretaceous to Recent): a taxonomic revision: Journal of Foraminiferal Research, v. 23, p. 238-253.

Haynes, J. R., 1956, Certain smaller British Palaeocene Foraminifera, Part 1. Nonionidae, Chilostomellidae, Epistominidae, Discorbidae, Amphisteginidae, Globigerinidae, Globorotaliidae and Guembelinidae: Contributions from the Cushman Foundation for Foraminiferal Research, v. 7, p. 79-101.

—, 1981, Foraminifera: MacMillan Publishers, London, xii + 433 p.

—, 1990, The classification of the Foraminifera-A review of historical and philosophical perspectives: Palaeontology, v. 33, p. 503-528.

Hofker, J., 1951a, The Foraminifera of the Siboga Expedition. Part III. Ordo Dentata, subordines Protoforaminata, Biforaminata, Deuteroforaminata: Brill, Leiden, 513 p.

—, 1951b, On foraminifera from the Dutch Cretaceous: Publikaties van het Natuurhistorisch Genootschap in Limburg, v. 4, p. 1-40.

—, 1956a, Foraminifera Dentata: Foraminifera of Santa Cruz and Thatch Island, Virginia Archipelago, West Indies: Spolia Zoologica Musei Hauniensis, v. 15, p. 1-237.

—, 1956b, Tertiary foraminifera of coastal Ecuador: Part II, Additional notes on the Eocene species: Journal of Paleontology, v. 30, p. 891-958.

—, 1957, Foraminiferen der Oberkreide von Nordwestdeutschland und Holland: Beihefte zum Geologischen Jahrbuch, v. 27, p. 1-464.

—, 1962, What is *Pseudovalvulineria* Brotzen, 1942: Contributions from the Cushman Foundation for Foraminiferal Research, v. 13, p. 61-63.

Hornibrook, N. de B., 1961, Tertiary Foraminifera from the Oamaru district (N.Z.), Part 1-Systematics and distribution: Palaeontological Bulletin, Wellington, v. 34, p. 1-192.

Hottinger, L., 1966, Foraminifères rotaliformes et orbitoïdes du Sénonien inférieur Pyrénéen: Eclogae Geologicae Helvetiae, v. 59, p. 277-302.

Howe, H. V., 1939, Louisiana Cook Mountain Eocene Foraminifera: Louisiana Geological Survey, Geological Bulletin, v. 14, p. xi + 122.

International Commission on Zoological Nomenclature, 1990, *Hanzawaia* Asano, 1944 (Foraminiferida): conserved: Bulletin of Zoological Nomenclature, v. 47, p. 55-56.

Jennings, P. H., 1936, A microfauna from the Monmouth and basal Rancocas Groups of New Jersey: Bulletin American Paleontology, v. 23, p. 161-232.

Jones, R. W., 1994, The *Challenger* Foraminifera: Oxford University Press, Oxford, 149 p.

Kaever, M., 1959, Über *Globorotalites* Brotzen 1942 und *Conorotalites* nov. gen: Geologisches Jahrbuch, v. 75, p. 433-435.

Kanmacher, F., 1798, Adam's Essays on the Microscope; the Second Edition, with Considerable Additions and Improvements: Dillon & Keating, London, 176 p.

Keijzer, F. G., 1945, Outline of the geology of the eastern part of the Province of Oriente, Cuba (E of 76° WL), with notes on the geology of other parts of the island: Geografische en Geologische Mededeelingen, Utrecht, v. 6, p. 1-238.

Kleinpell, R. M., 1938, Miocene stratigraphy of California: American Association of Petroleum Geologists, Tulsa, 450 p.

Lankester, E. R., 1885, Protozoa *in* Encyclopedia Britannica, p. 830-866.

Loeblich, A. R. and Tappan, H., 1955, Revision of some Recent foraminiferal genera: Smithsonian Miscellaneous Collections, v. 128, p. 1-37.

—, 1961, Suprageneric classification of the Rhizopodea: Journal of Paleontology, v. 35, p. 245-330.

—, 1962, The foraminiferal genera *Cibicides, Heterolepa, Planulina* and *Holmanella*, new genus: Contributions from the Cushman Foundation for Foraminiferal Research, v. 13, p. 71-73.

—, 1964, Sarcodina, chiefly "Thecamoebians" and Foraminiferida, *in* Moore, R. C. (ed.), Treatise on invertebrate paleontology: University of Kansas Press, Kansas, 900 p.

—, 1984, Suprageneric classification of the Foraminiferida (Protozoa): Micropaleontology, v. 30, p. 1-70.

—, 1986, Some new and revised genera and families of hyaline calcareous Foraminiferida (Protozoa): Transactions American Microscopical Society, v. 105, p. 239-265.

—, 1987, Foraminiferal Genera and their Classification: Van Nostrand Reinhold, New York, x + 970, viii + 1059 p.

Malapris, M., 1965, Les Gavelinellidae et formes affines du gisement Albien de Courcelles (Aube): Revue de Micropaléontologie, v. 8, p. 131-150.

Malumian, N. and Masiuk, V., 1976, Foraminiferos de la formacion Cabeza de Leon (Cretacico Superior, Tierra del Fuego, Rep. Argentina): Revista Asociacion Geologica Argentina, v. 31, p. 180-202.

Marie, P., 1941, Foraminifères de la Craie: Les foraminifères de la Craie à *Belemnitella mucronata* du Bassin de Paris: Mémoires Muséum National d'histoire Naturelle, v. 12, p. 1-296.

—, 1957, *Goupillaudina*, nouveau genre de foraminifère du Crétacé supérieur: Comptes Rendus de l'Academie des Sciences, p. 247-248.

—, 1958, *Goupillaudina*, nouveau genre de foraminifère du Crétacé supérieur: Bulletin Société Géologique de France, v. 7, p. 861-876.

Marsson, T., 1878, Die Foraminiferen der weissen Schreibkreide der Inseln Rügen: Mitteilungen des naturwissenschaftlichen Vereins Neu-Vorpommeren und Rügen in Greifswald, v. 10, p. 115-196.

McCulloch, I., 1981, Qualitative observations on Recent foraminiferal tests. Part IV. with emphasis on the Allan Hancock Atlantic expedition collections: University of Southern California, Los Angeles, 363 p.

McGowran, B., 1965, Two Palaeocene foraminiferal faunas from the Wangerrip Group, Pebble Point Coastal Section, Western Victoria: Proceedings of the Royal Society of Victoria, v. 79, p. 9-74.

McLean, J. D., 1951, Paleocene foraminifera from the Atlantic Coastal Plain: Contributions from the Cushman Foundation for Foraminiferal Research, v. 2, p. 20-29.

Mead, G. A., 1985, Recent benthic foraminifera in the Polar Front region of the Southwest Atlantic: Micropaleontology, v. 31, p. 221-248.

Millett, F. W., 1904, Report on the Recent foraminifera of the Malay Archipelago collected by Mr. A. Durrand; Part XVI: Journal of the Royal Microscopical Society, v., p. 489-506.

Moorkens, T. L., 1982, Foraminifera of the Montian stratotype and of subjacent strata in the "Mons Well 1969", with a review of some Belgian Paleocene stratigraphy: Mémoires pour servir à l'Explication des Cartes Géologiques et Minières de la Belgique, v. 17, p. 1-186.

Papp, A. and Schmid, M. E., 1985, Die fossilen Foraminiferen des Tertiaren Beckens von Wien. Revision der Monographie von Alcide d'Orbigny (1846): Abhandlungen Geologischen Bundesanstalt, v. 37, p. 1-311.

Parker, F. L., 1958, Eastern Mediterranean foraminifera. Sediment cores from the Mediterranean Sea and the Red Sea: Reports of the Swedish Deep-Sea Expedition 1947-1948, v. 8, p. 217-283.

Parker, W. K., Jones, T. R. and Brady, H. B., 1865, On the nomenclature of the Foraminifera. Part XII. The species enumerated by d'Orbigny in the "Annales des Sciences Naturelles" vol. vii. 1826: Annals and Magazine of Natural History, v. 16, p. 15-41.

Parr, W. J., 1938, Upper Eocene foraminifera from deep borings in King's Park, Perth, Western Australia: Journal Royal Society of Western Australia, v. 24, p. 69-101.

Plummer, H. J., 1926, Foraminifera of the Midway Formation in Texas: University of Texas Bureau of Economic Geology and Technology Bulletin, v. 2644, p. 1-206.

—, 1932, Some Cretaceous Foraminifera in Texas: University of Texas Bulletin, v. 3103, p. 109-203.

Podobina, V. M., 1975, Foraminifery Verkhnego Mela i Paleogena zapadno-Sibirskoy nizmennosti, ikh znachenie dlya stratigrafii: Tomskiy Ordena Trudovogo Krasnogo Znameni Gosudarstvennyy Universitet, p. 220.

Quilty, P. G., 1973, Cenomanian-Turonian and Neogene sediments from Northeast of Kerguelen Ridge, Indian Ocean: Journal Geological Society Australia, v. 20, p. 361-371.

—, 1984, Cretaceous foraminiferids from Exmouth Plateau and Kerguelen Ridge, Indian Ocean: Alcheringa, v. 8, p. 225-241.

Reiss, Z., 1957, The Bilamellidea, nov. superfam., and remarks on Cretaceous Globorotaliids: Contributions from the Cushman Foundation for Foraminiferal Research, v. 8, p. 127-145.

—, 1958, Classification of lamellar foraminifera: Micropaleontology, v. 4, p. 51-70.

—, 1960, Structure of so-called *Eponides* and some other rotaliiform Foraminifera: Bulletin Israel Geological Survey, v. 29, p. 1-28.

—, 1963, Reclassification of perforate foraminifera: Bulletin of the Geological Survey of Israel, v. 35, p. 1-111.

Reiss, Z. and Hottinger, L., 1984, The gulf of Aqaba. Ecological micropalaeontology: Springer Verlag, Berlin, 50, v., viii + 354 p.

Reuss, A. E., 1844, Geognostische Skizzen aus Böhmen: C.W. Medau, Prague, 304 p.

—, 1845, Die Versteinerungen der böhmische Kreideformation, Abt.1: E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 58 p.

—, 1860, Die Foraminiferen der Westphälischen Kreideformation: Sitzungsberichte der österreichischen Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse, Abt. 1, v. 40, p. 147-238.

Revets, S. A., 1994, The status of *Anomalina* d'Orbigny, 1826: Journal of Foraminiferal Research, v. 24, p. 296-304.

—, 1996, The generic concept of *Hanzawaia* Asano, 1944 and the new genus *Riminopsis*: Journal of Foraminiferal Research, v. 26, in press.

Rögl, F. and Hansen, H. J., 1984, Foraminifera described by Fichtel & Moll in 1798. A revision of Testacea Microscopica. 1st ed. F: Berger & Söhne, Wien, 143 p.

Saidova, K. M., 1975, Bentosnye Foraminifery Tikhogo Okeana: Institut Okeanologii Moskva, Akademiya Nauk SSSR, Moskva, 875 p.

—, 1981, O sovromennom sostoyanii sistemy nadvidovyk taksonov Kaynozoyskikh bentosnykh foraminifer: Institut Okeanologii Moskva, Akademiya Nauk SSSR, Moskva, 73 p.

Schwager, C., 1866, Fossile Foraminiferen von Kar Nikobar, Reise der österreichischen Fregatte *Novara* um Erde in den Jahren 1857-1859: Paläontologische Mitteilungen, v. 2, p. 187-268.

Silvestri, A., 1898, Foraminiferi pliocenici della Provincia di Siena; Parte II: Memorie Accademia Pontifica dei Nuovi Lincei, v. 15, p. 155-381.

Sliter, W. V., 1968, Upper Cretaceous foraminifera from southern California and northwestern Baja California, Mexico: Paleontological Contributions, Protozoa, v. 7, p. 1-141.

Soldani, A., 1789, Testaceographiae ac Zoophytographiae parvae et microscopicae: Rossi, Senis, xxxii+80 p.

Srinivasan, M. S. and Sharma, V., 1980, Schwager's Car Nicobar Foraminifera in the Reports of the *Novara* Expedition-A revision: Today & Tomorrow's Printers & Publishers, New Dehli, 83 p.

Subbotina, N. N., Voloshinova, N. A. and Azbel', A. Y., (eds.), 1981, Vvedenie v izuchenie foraminifer (klassifikatsiya melkikh foraminifer Mezo-Kaynozoya): Vsesoyuznyy Neftyanoy Nauchno-issledovatel'skii Geologorazvedochnyy Institut, Leningrad, 211 p.

ten Dam, A., 1948, *Cribroparrella*, a new genus of foraminifera from the Upper Miocene of Algeria: Journal of Paleontology, v. 22, p. 486-487.

Terquem, O., 1882, Les foraminifères de l'Eocène des environs de Paris: Mémoires de la Société Géologique de France, v. 2, p. 1-193.

Thalmann, H. E., 1939, Bibliography and index to new genera, species and varieties of foraminifera for the year 1936: Journal of Paleontology, v. 13, p. 425-465.

—, 1949, Bibliography and index to new genera, species and varieties of foraminifera for the year 1948: Journal of Paleontology, v. 23, p. 641-668.

—, 1953, Bibliography and index to new genera, species and varieties of foraminifera for the year 1952: Journal of Paleontology, v. 27, p. 847-876.

Todd, R., 1958, Foraminifera from the Western Mediterranean deep-sea cores. Sediment cores from the Mediterranean Sea and the Red Sea: Reports of the Swedish Deep-Sea Expedition 1947-1948, v. 8, p. 167-215.

Toulmin, L. D., 1941, Eocene smaller foraminifera from the Salt Mountain limestone of Alabama: Journal of Paleontology, v. 15, p. 567-611.

van Bellen, R. C., 1946a, Foraminifera from the middle Eocene in the southern part of the Netherlands Province of Limburg: Mededeelingen van de Geologische Stichting, v. 5, p. 1-144.

—, 1946b, Some homonyms in "Foraminifera from the middle Eocene in the southern part of the Netherlands Province of Limburg": Contributions from the Cushman Laboratory for Foraminiferal Research, v. 22, p. 120-123.

van Morkhoven, F. P. C. M., Berggren, W. A. and Edwards, A. S., 1986, Caenozoic cosmopolitan deep-water benthic foraminifera: Bulletin des Centres de Recherches Exploration-Production ELF-Aquitaine, v. 11, p. 1-421.

Vasilenko, V. P., 1954, Iskopaemye Foraminifery SSSR, Anomalinidy: Trudy Vsesoyuznogo Neftyanogo Nauchno-issledovatel'skogo Geologo-razvedochnogo Instituta, v. 80, p. 1-282.

von Fichtel, L. and von Moll, J. P. C., 1798, Testacea microscopica, aliaque minuta ex generibus Argonauta et Nautilus, ad naturam picta et descripta: Camesina, Wien, 124 p.

Weidich, K. F., 1995, The genus *Angulogavelinella* Hofker, 1957, and its species (Foraminiferida: Rotaliina; Upper Cretaceous - Lower Tertiary): Journal of Foraminiferal Research, v. 25, p. 309-333.

Whittaker, J. E., 1988, Benthic Caenozoic Foraminifera from Ecuador: The Natural History Museum, London, xi + 194 p.

Yabe, H. and Hanzawa, S., 1929, Tertiary foraminiferous rocks of the Philippines: Science Reports of the Tohoku University, Sendai, Series 2, (Geology), v. 11, p. 137-190.

PLATE 1

Anomalina ariminensis d'Orbigny, 1902. Rimini, Adriatic Sea, Italy; Recent. BMNH ZF5059.
1 Spiral side (250 μm).
2 Umbilical side (250 μm).
3 Side view (250 μm).
4 Close-up of the aperture (100 μm).

Anomalinoides pinguis (Jennings, 1936). Onion Creek, Jones' Crossing, Travis County, Texas, USA; Maastrichtian. BMNH FP 53086.
5 Spiral side (125 μm).
6 Umbilical side (125 μm).
7 Side view (125 μm).
8 Close-up of the aperture (50 μm).

Cibicidoides mundulus (Brady, Parker & Jones, 1888). Abrohlos Bank, Brazil; Recent. BMNH ZF3585, lectotype.
9 Spiral side (100 μm).
10 Umbilical side (100 μm).
11 Side view (100 μm).
12 Close-up of the aperture (50 μm), BMNH ZF3584, paralectotype.

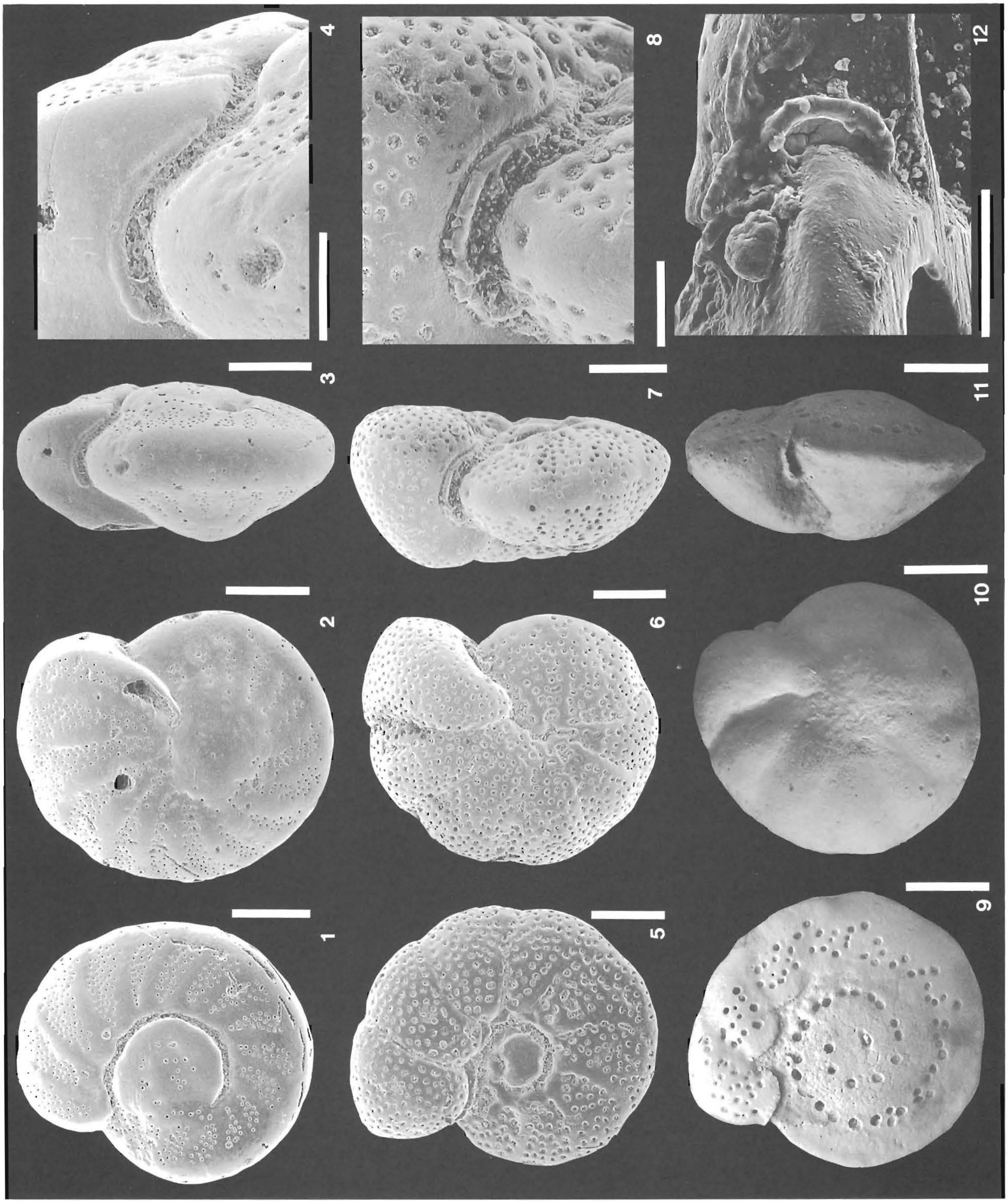

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 2

Cibicidoides natlandi (Beck, 1943). Cowlitz River, Lewis County, Washington, USA; Upper Eocene. CC39850, Paratype.
1 Spiral side (200 μm).
2 Umbilical side (200 μm).
3 Side view (200 μm).
4 Close-up of the foramen (50 μm).

Hanzawaia nipponica Asano, 1944. Kochi Prefecture, Japan; Ananai Formation, Pliocene. BMNH FP 53087.
5 Spiral side (200 μm).
6 Umbilical side (200 μm).
7 Side view (200 μm).
8 Close-up of the aperture (50 μm).

Heterolepa dutemplei (d'Orbigny, 1846). Nußdorff, Vienna, Austria; Tortonian. BMNH FP 53088.
9 Spiral side (200 μm).
10 Umbilical side (200 μm).
11 Side view (200 μm).
12 Close-up of the aperture (50 μm).

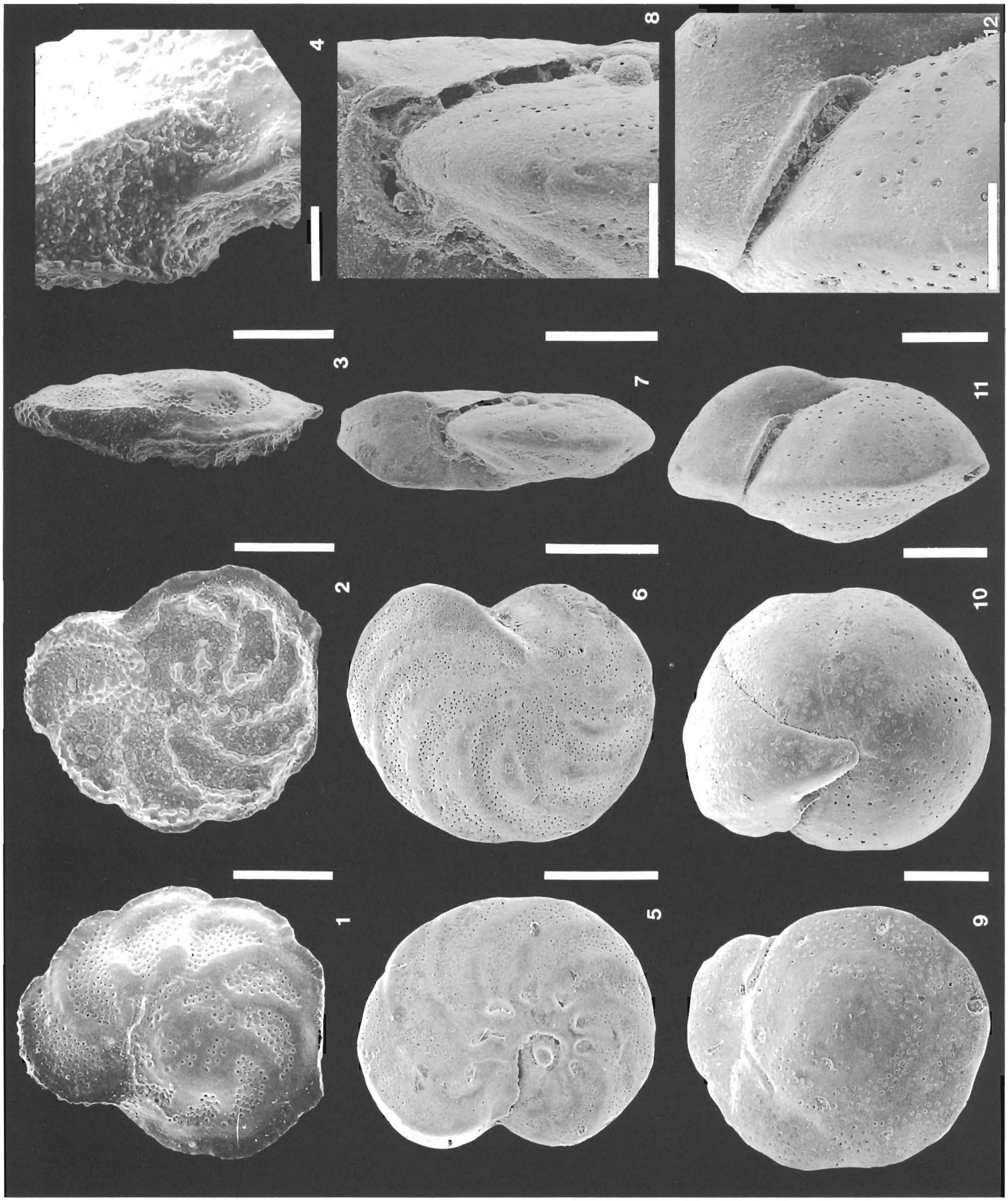

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 3

Loisthostomata exiguum Loeblich & Tappan, 1986. Shubuta, Clarke County, Mississippi, USA; Yazoo Formation, Upper Eocene.
1 Spiral side (100 μm), USNM383482, holotype.
2 Umbilical side (100 μm).
3 Side view (100 μm).
4 Section from the umbilical side (100 μm), USNM383483, paratype.

Orithostella viriola Eicher & Worstell, 1970. Bull Creek, Crook County, Wyoming, USA; Greenhorn Formation, Upper Cenomanian. BMNH FP53089.
5 Spiral side (125 μm).
6 Umbilical side (125 μm).
7 Side view (125 μm).
8 Close-up of the aperture (25 μm).

Parrelloides hyalinus (Hofker, 1951). off Southwest Sumatra, Indonesia; Recent. Lectotype.
9 Spiral side (100 μm).
10 Umbilical side (100 μm).
11 Side view (100 μm).
12 Close-up of the aperture (40 μm).

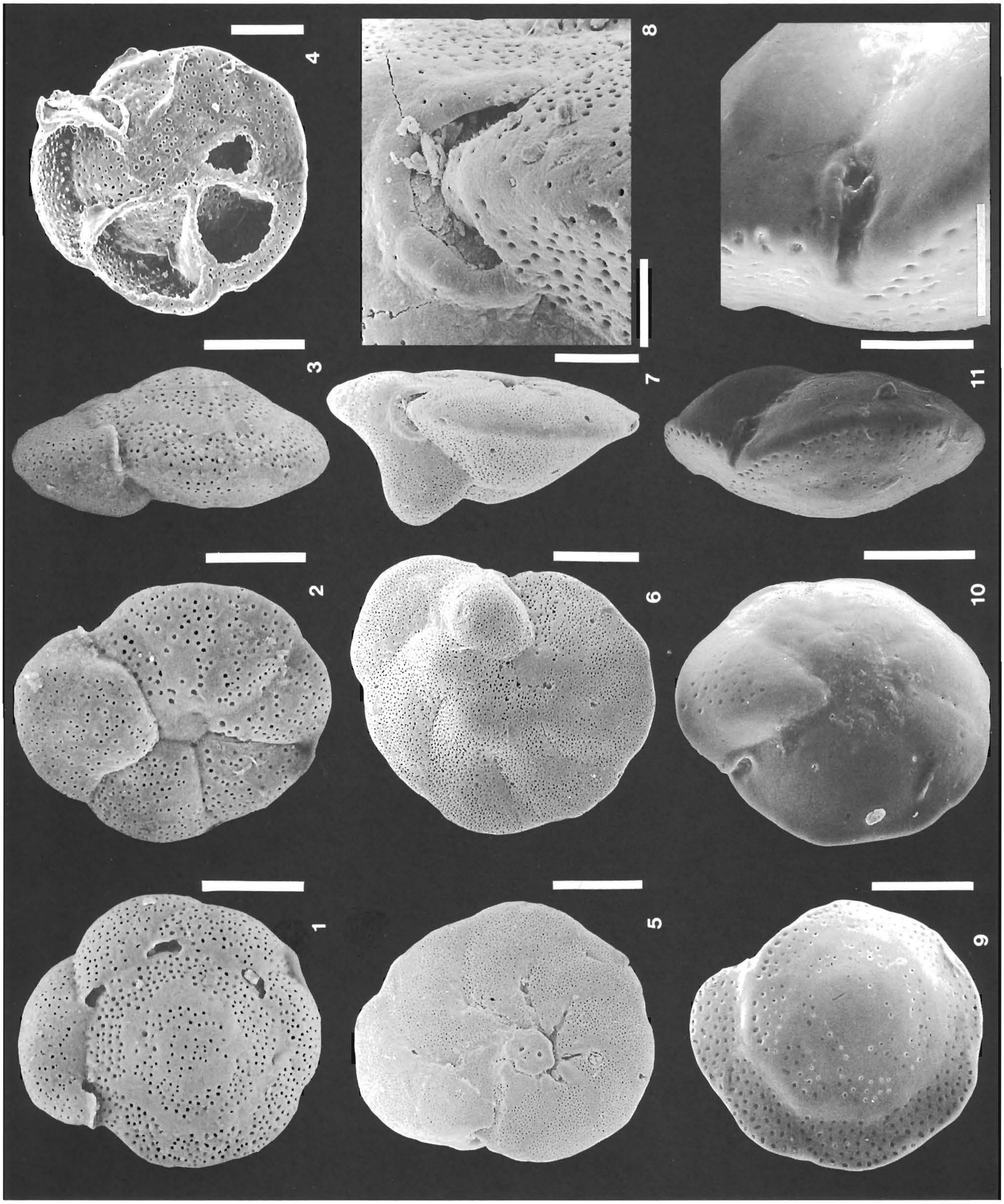

4
8
3
7
11
2
6
10
1
5
9

PLATE 4

Alabamina westraliensis (Parr, 1938). King's Park Bore No. 1, -728 feet, Western Australia; Palaeocene. BMNH FP53090.
1 Spiral side (100 μm).
2 Umbilical side (100 μm).
3 Side view (100 μm).
4 Close-up of the aperture (50 μm).

Alabamina dorsoplana (Brotzen, 1940). Kjølby Gård, Denmark; Maastrichtian. BMNH FP53091.
5 Spiral side (100 μm).
6 Umbilical side (100 μm).
7 Side view (100 μm).
8 Close-up of the aperture (50 μm).

Charltonina madrugaensis (Cushman & Bermúdez, 1948). Central San Antonio Highway, Madruga, Cuba; Madruga Formation, Palaeocene.
9 Spiral side (100 μm), CC57974, holotype.
10 Umbilical side (100 μm), CC57975, paratype.
11 Side view (100 μm).
12 Close-up of the aperture (40 μm).

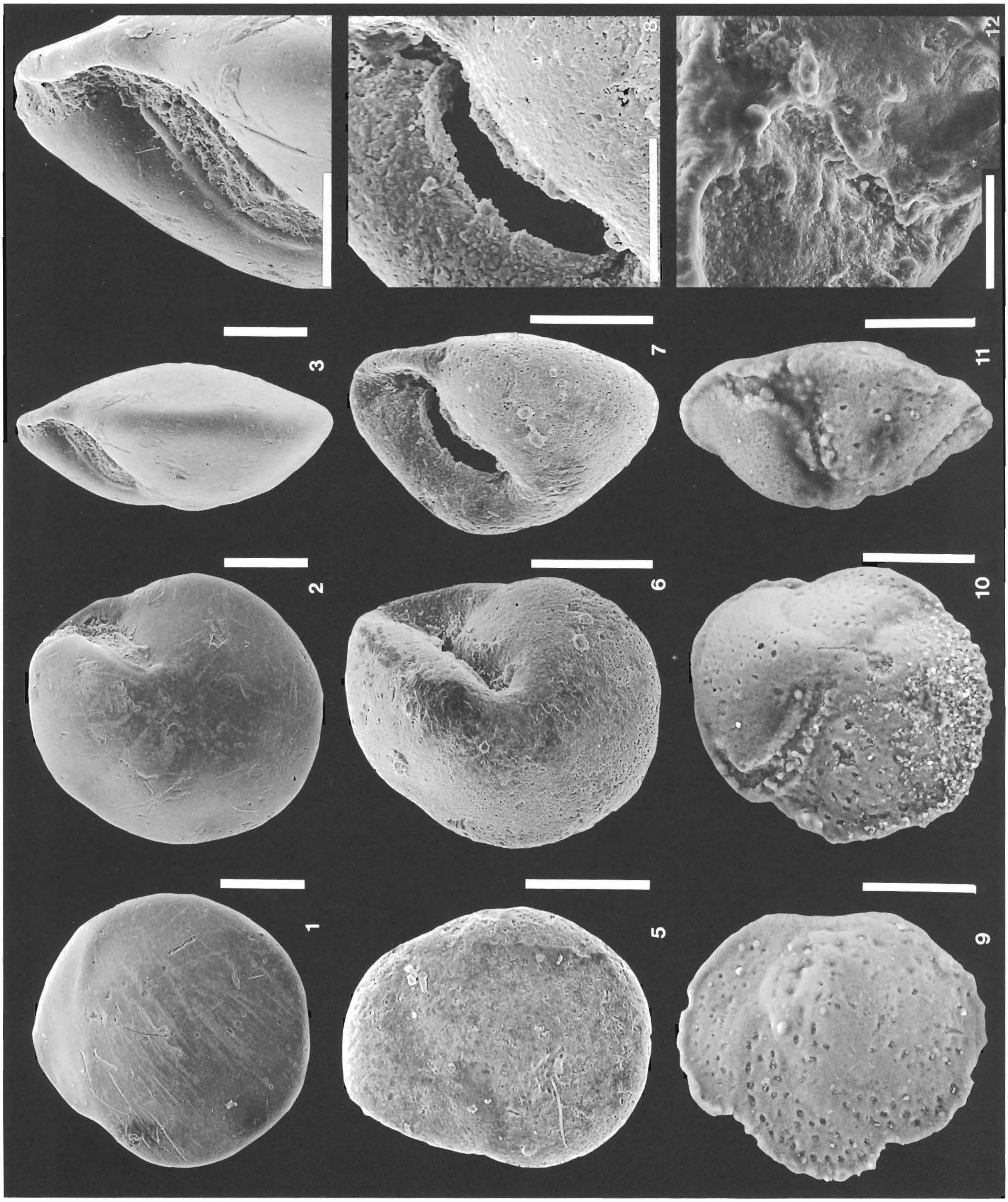

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 5

Cribroparrella regadana ten Dam, 1948. Ain Regadana, West Algeria; Upper Miocene. CC57994.
1 Spiral side (250 μm).
2 Umbilical side (250 μm).
3 Side view (250 μm).
4 Close-up of the aperture (100 μm).

Cribroparrella bengalensis (Schwager, 1866). Kar Nicobar; Upper Miocene. BMNH P48592.
5 Spiral side (250 μm).
6 Close-up of the aperture (100 μm).
7 Section through the last few chambers (250 μm).
8 Oblique view of the umbilical region in a section (100 μm).

Conorotalites aptiensis Bettenstaedt, 1952. Georgsdorf Well 81, -564 m, Lingen, Germany; lowermost Aptian. SMF XXVII 3968, paratype.
9 Spiral side (100 μm).
10 Umbilical side (100 μm).
11 Side view (100 μm).
12 Close-up of a foramen (100 μm).

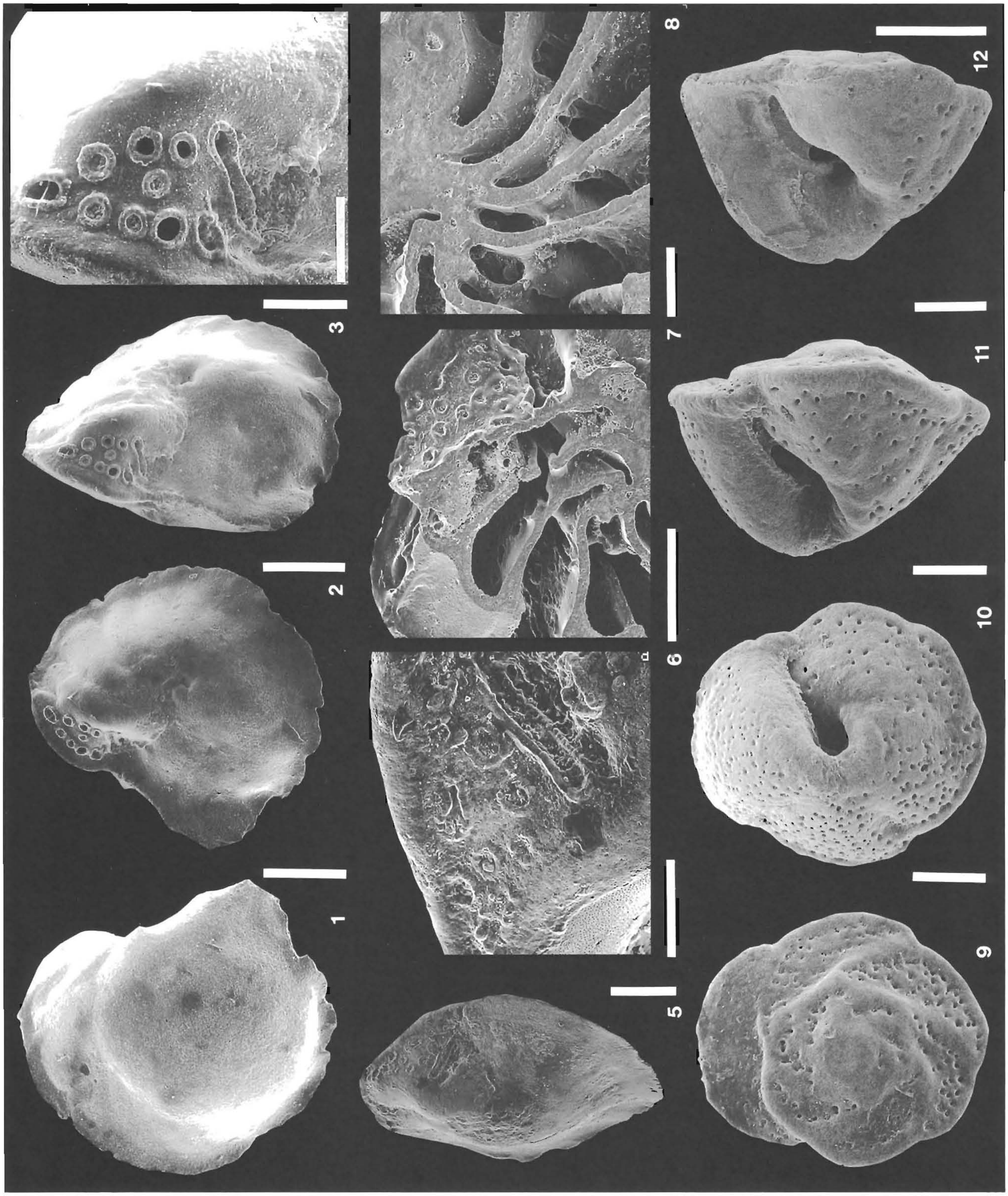

1
2
3
5
6
7
8
9
10
11
12

PLATE 6

Goupillaudina daguini Marie, 1958. Pyrenees, Spain; Campanian. BMNH FP53092.
1 Spiral side (250 μm).
2 Umbilical side (250 μm).
3 Side view (250 μm).
4 Close-up of a foramen (100 μm).

Oridorsalis westi Andersen, 1961. Mississippi Mudlumps, Mississippi Delta, USA; Recent. BMNH ZF5060.
5 Spiral side (100 μm).
6 Umbilical side (100 μm).
7 Side view (100 μm).
8 Close-up of the aperture (50 μm).

Osangularia lens Brotzen, 1940. Kjølby Gård, Denmark; Maastrichtian
9 Spiral side (125 μm), BMNH FP53093.
10 Umbilical side (125 μm).
11 Side view (125 μm).
12 Side view of a broken specimen, with the foramen clearly visible (125 μm), BMNH FP53094.

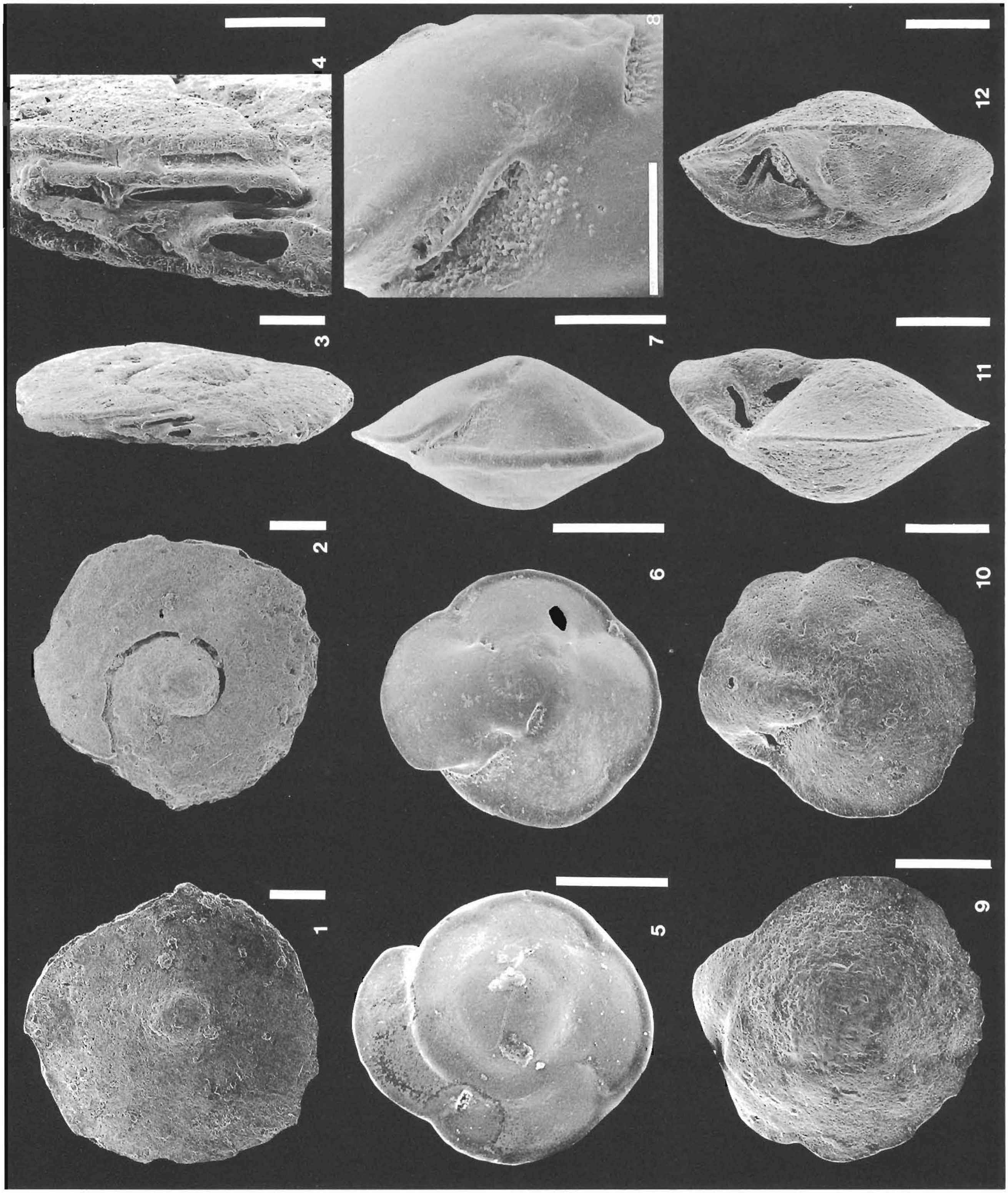

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 7

Gavelinella pertusa (Marsson, 1878). Rügen, Germany; Maastrichtian. USNM, lectotype.
1 Spiral side (200 μm).
2 Umbilical side (200 μm).
3 Side view (200 μm).
4 Close-up of a foramen (50 μm).

Gavelinella lorneiana (d'Orbigny, 1840). Gravesend, England; Campanian. CC6981.
5 Spiral side (200 μm).
6 Umbilical side (200 μm).
7 Side view (200 μm).
8 Close-up of a foramen (50 μm).

Angulogavelinella gracilis (Marsson, 1878). Rügen, Germany; Maastrichtian. USNM, lectotype.
9 Spiral side (200 μm).
10 Umbilical side (200 μm).
11 Side view (200 μm).
12 Close-up of the aperture (50 μm).

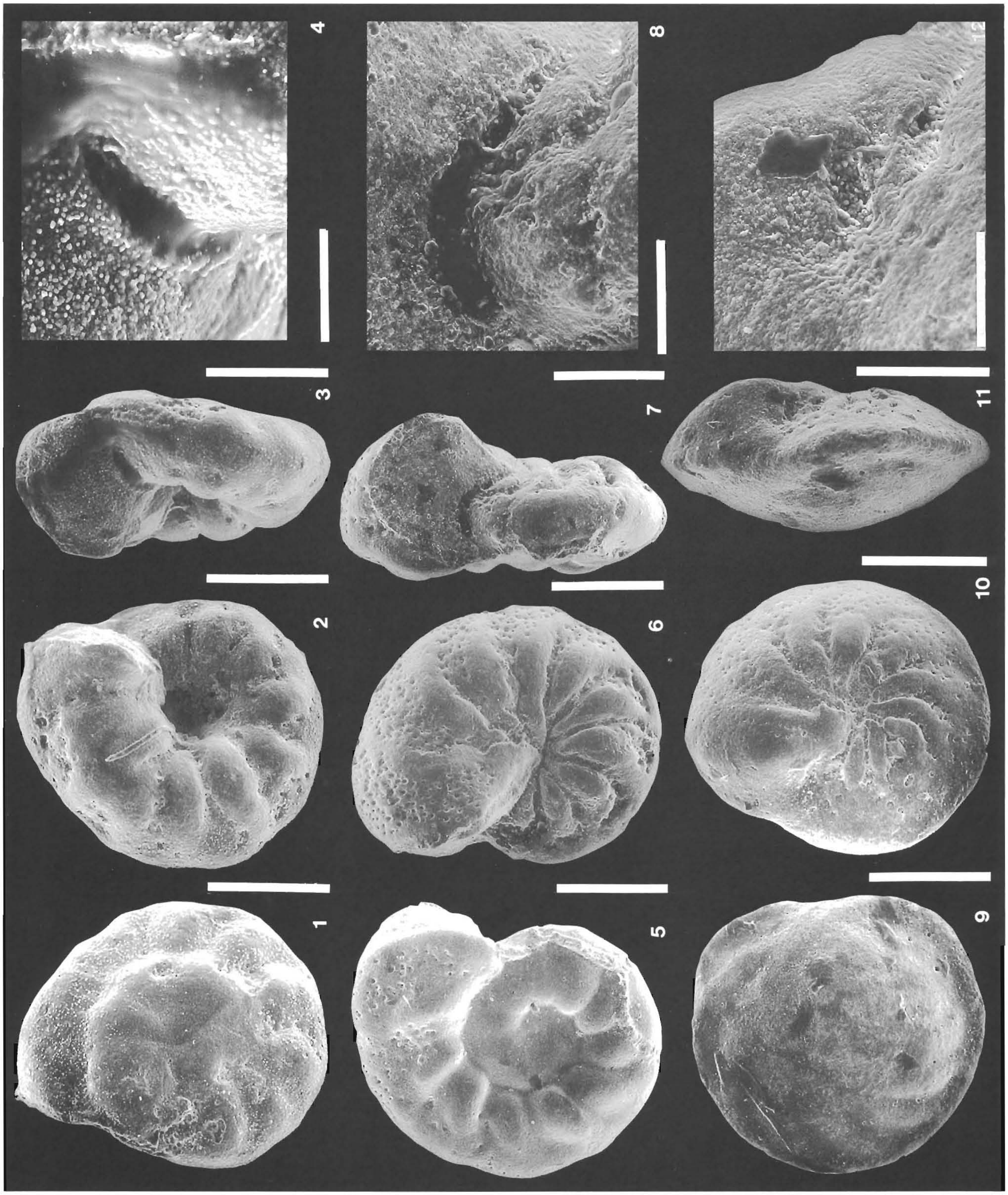

1
2
3
4
5
6
7
8
9
10
11

PLATE 8

Berthelina intermedia (Berthelin, 1880). Fresnoy-le-Château, Aube, France; Middle Albian. BMNH FP53095.
1 Spiral side (150 μm).
2 Umbilical side (150 μm).
3 Side view (150 μm).
4 Close-up of the aperture (50 μm).

Boldia lobata (Terquem, 1882). Septeuil, Paris, France; Calcaire Grossier, Middle Eocene. USNM 433604.
5 Spiral side (100 μm).
6 Umbilical side (100 μm).
7 Side view (100 μm).
8 Close-up of the aperture (50 μm).

Cocoarota cocoaensis (Cushman, 1928). Cocoa Post Office, Alabama, USA; Upper Eocene.
9 Spiral side (200 μm), CC10410, holotype.
10 Umbilical side (200 μm).
11 Side view (200 μm).
12 Section from the umbilical side (150 μm), topotype.

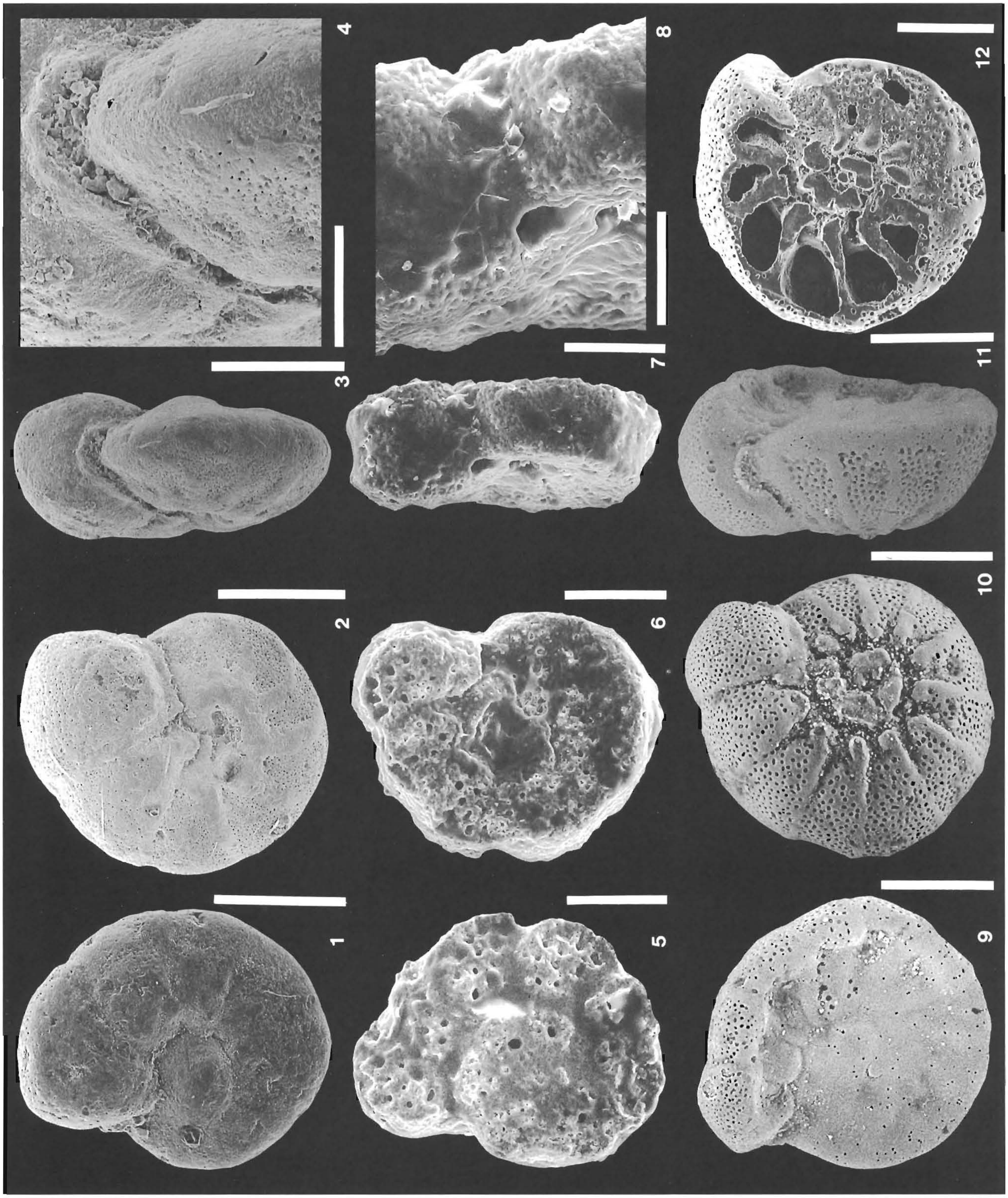
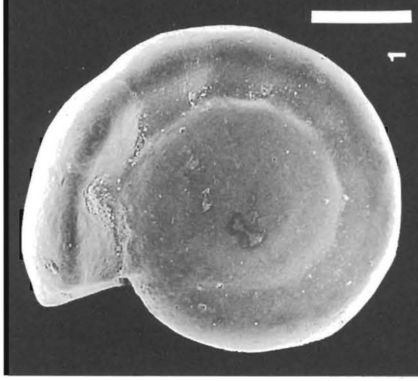

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 9

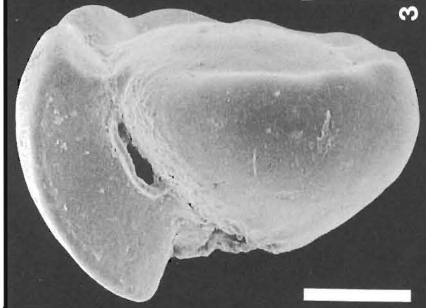
Hansenisca soldanii (d'Orbigny, 1826). Rimini, Adriatic Sea, Italy; Recent. BMNH ZF 5061.
1 Spiral side (100 μm).
2 Umbilical side (100 μm).
3 Side view (100 μm).
4 Close-up of the central umbilicus (33 μm).

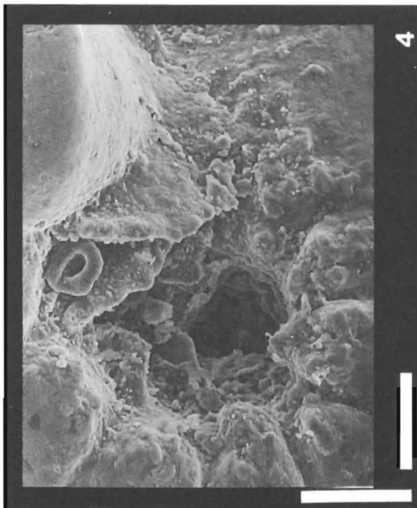
Lingulogavelinella albiensis Malapris, 1965. Villemoyenne, Aube, France; Lower Albian. BMNH FP 53096.
5 Spiral side (100 μm).
6 Umbilical side (100 μm).
7 Side view (100 μm).
8 Close-up of the aperture (25 μm).

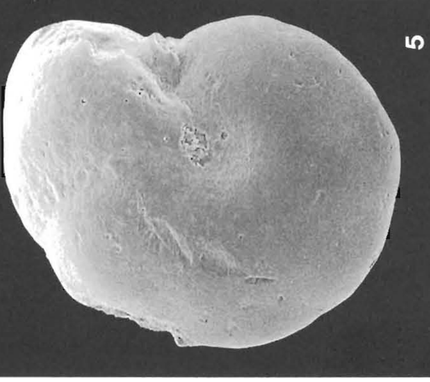
Pseudogavelinella clementiana (d'Orbigny, 1840). Pinswanger Graben, Neubeuern, Bavaria, Germany; Campanian. USNM.
9 Spiral side (200 μm).
10 Umbilical side (200 μm).
11 Side view (200 μm).
12 Close-up of the aperture (50 μm).

1


2

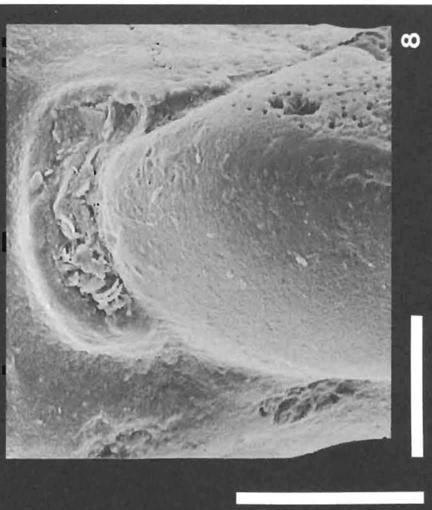

3


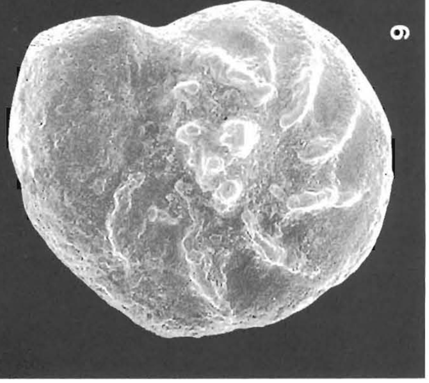
4


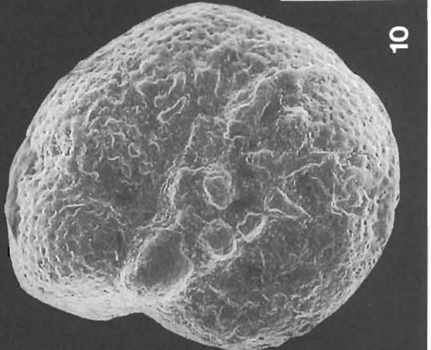
5


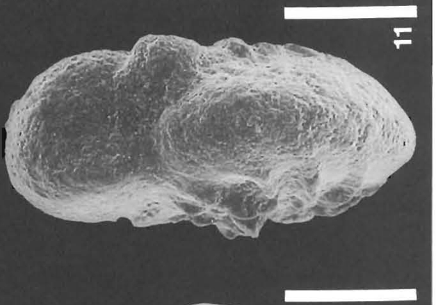
6


7


8


9


10


11


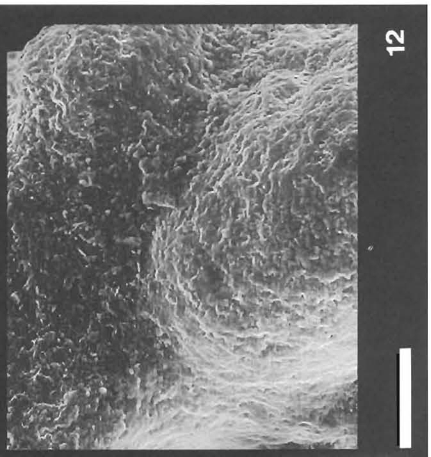
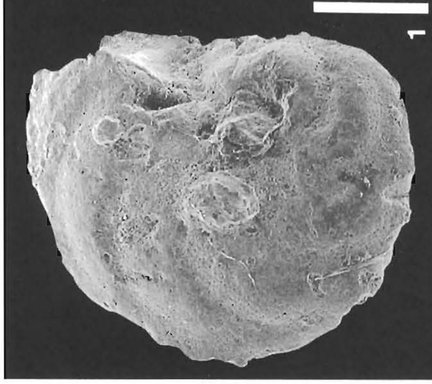
12


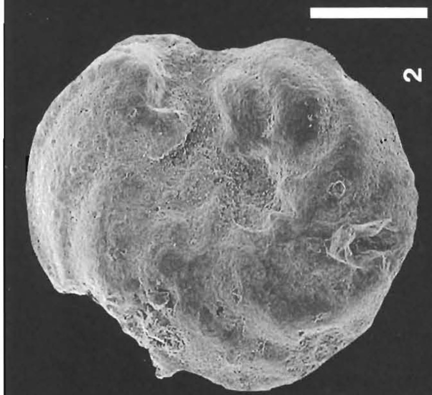
PLATE 10

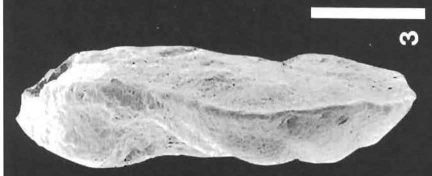
Notoplanulina rakauroana (Finlay, 1939). Mid Waipara, North Canterbury, New Zealand; Piripauan Beds, Campanian. NZGS.
1 Spiral side (250 μm).
2 Umbilical side (250 μm).
3 Side view (250 μm).
4 Close-up of the central umbilical region (100 μm).

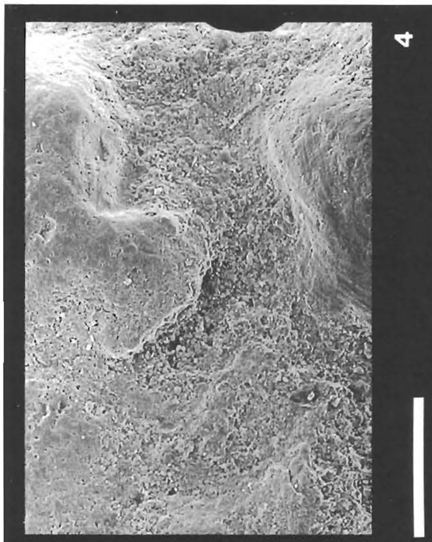
Cancris auriculus (von Fichtel & von Moll, 1798). Nußdorff, Vienna, Austria; Tortonian. BMNH FP 53097.
5 Spiral side (250 μm).
6 Umbilical side (250 μm).
7 Side view (250 μm).
8 Close-up of the aperture (100 μm).

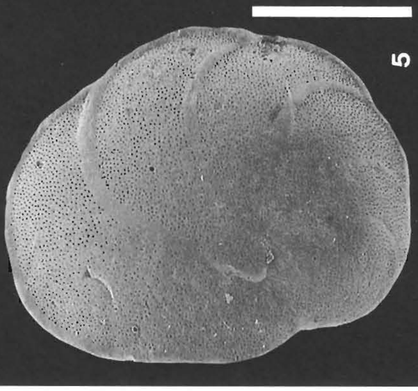
Cibicorbis herricki Hadley, 1934. Yumuri River Gorge, Matanzas, Dominican Republic; Upper Oligocene. USNM P3315, paratype.
9 Spiral side (200 μm).
10 Umbilical side (200 μm).
11 Side view (200 μm).
12 Close-up of the aperture (50 μm).

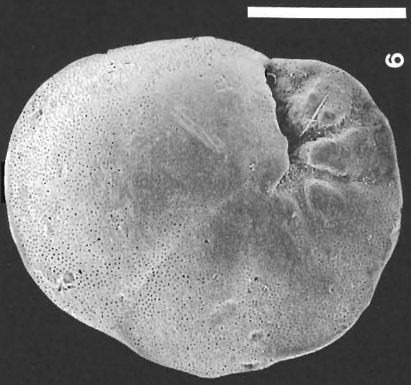

1

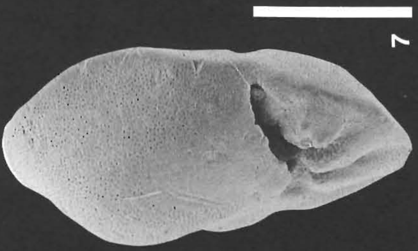

2

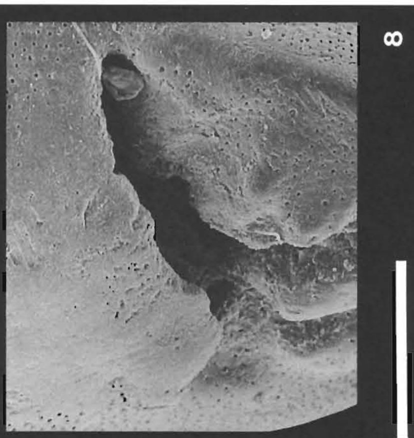

3

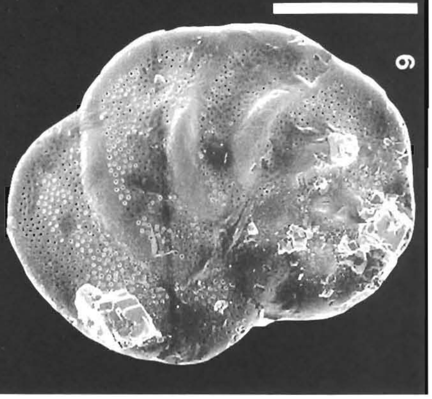

4

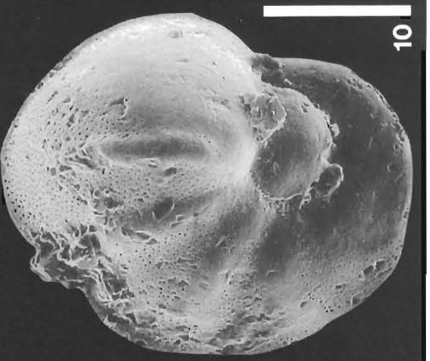

5

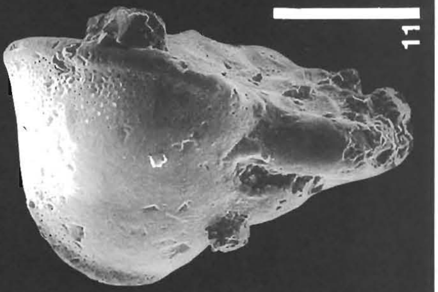

6


7


8


9


10


11

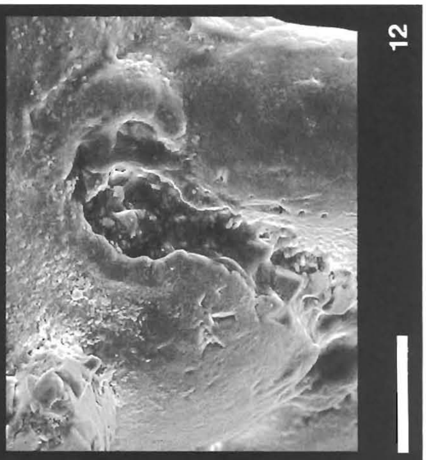

12

PLATE 11

Brotzenella monterelensis (Marie, 1941). Le Caillaud, Talmont, France; Campanian. BMNH FP53098.
1 Spiral side (100 μm).
2 Umbilical side (100 μm).
3 Side view (100 μm).
4 Close-up of the aperture (50 μm).

Gyroidinoides nitidus (Reuss, 1844). Kystra, Ohre, Czech Republic; Middle Turonian. BMNH FP53099.
5 Spiral side (100 μm).
6 Umbilical side (100 μm).
7 Side view (100 μm).
8 Close-up of the aperture (50 μm).

Gyroidinoides lenticulus (Reuss, 1845). Kystra, Ohre, Czech Republic; Middle Turonian. BMNH FP53100.
9 Spiral side (100 μm).
10 Umbilical side (100 μm).
11 Side view (100 μm).
12 Close-up of the central umbilical region (25 μm).

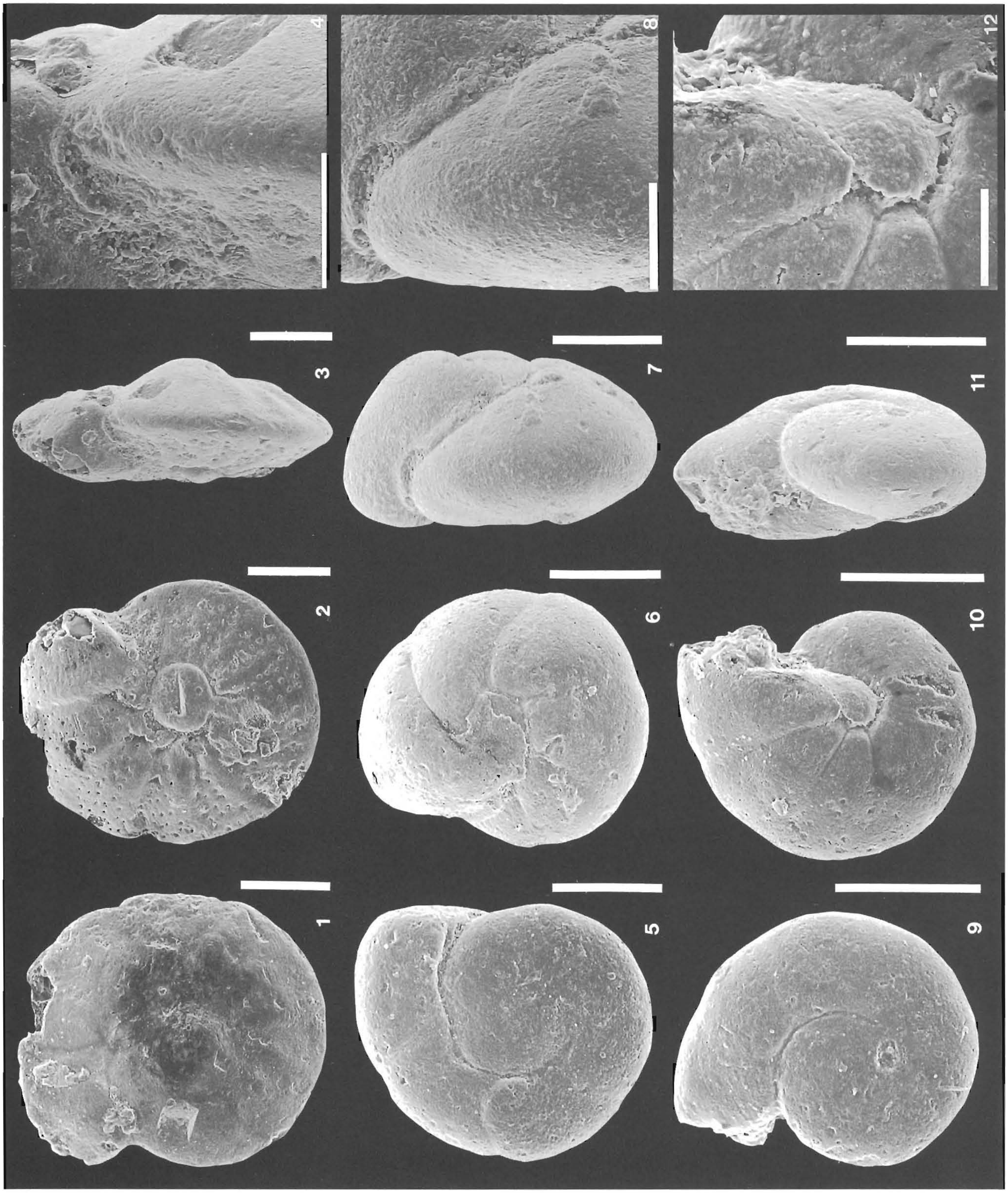
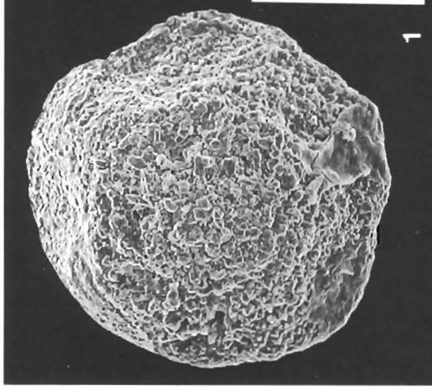

1
2
3
4
5
6
7
8
9
10
11
12

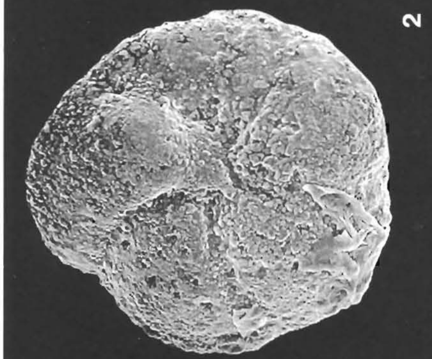
PLATE 12

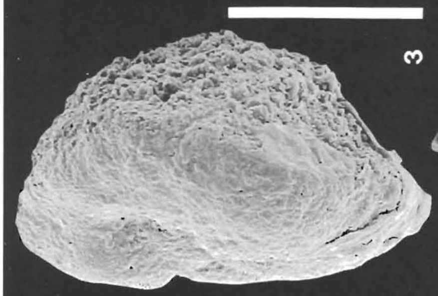
Scheibnerova protindica Quilty, 1984. Exmouth Plateau, ODP766, Australia; Lower Cenomanian. BMNH FP53101.
1 Spiral side (100 μm).
2 Umbilical side (100 μm).
3 Side view (100 μm).
4 Close-up of the central umbilical region (50 μm).

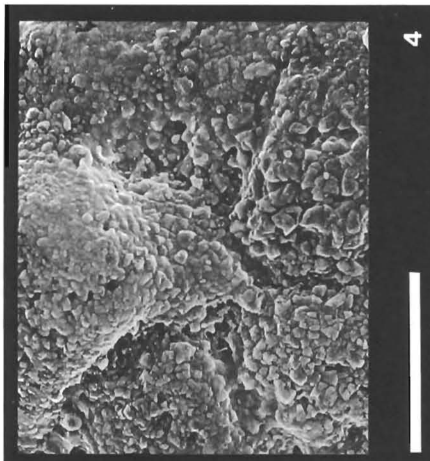
Stensioeina exsculpta (Reuss, 1860). Mersch bei Hamm, Westphalia, Germany; Campanian. CC35142.
5 Spiral side (100 μm).
6 Umbilical side (100 μm).
7 Side view (100 μm).
8 Close-up of the aperture (40 μm).

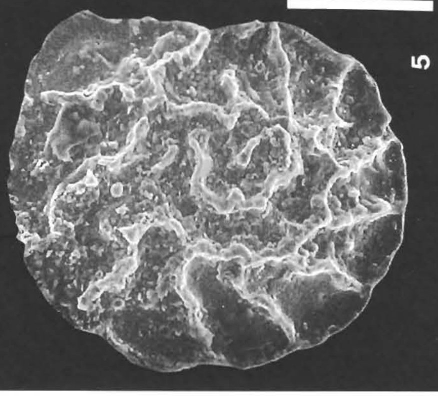
Valvulineria californica Cushman, 1926. San Luis Obispo County, California, USA; Monterey Formation, Miocene. CC5798, holotype.
9 Spiral side (200 μm).
10 Umbilical side (200 μm).
11 Side view (200 μm).


1

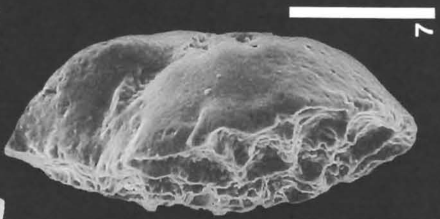

2

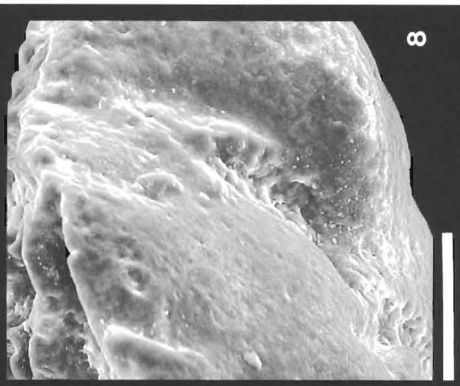

3

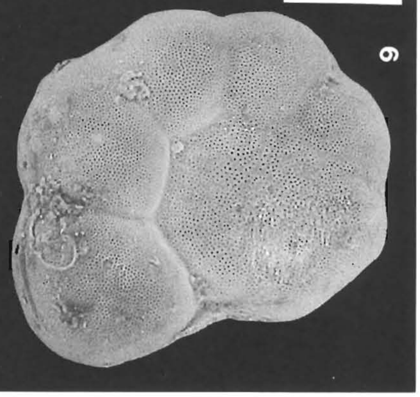

4

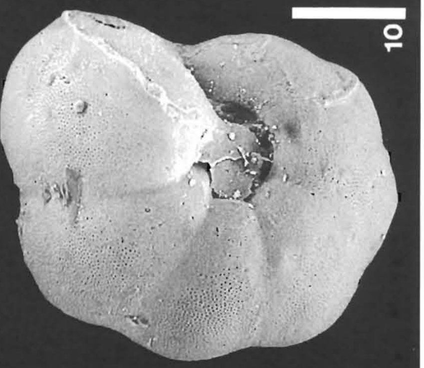

5


6


7


8


9


10


11

PLATE 13

Globorotalites multiseptus (Brotzen, 1936). Eriksdal, Sweden; Maastrichtian.
1 Spiral side (150 μm), NRS 58, holotype.
2 Umbilical side (150 μm).
3 Side view (150 μm).
4 Close-up of a foramen with the bipartitor (50 μm), topotype.

Gyroidina orbicularis Parker, Jones & Brady, 1865. Rimini, Adriatic Sea, Italy; Recent. BMNH ZF5062.
5 Spiral side (150 μm).
6 Umbilical side (150 μm).
7 Side view (150 μm).
8 Close-up of a foramen with the bipartitor (50 μm).

Gyroidina orbicella Bandy, 1951. Letterbox Canyon, Carlsbad, San Diego County, California, USA; Panoche Group, Campanian. USNM231417, holotype.
9 Spiral side (50 μm).
10 Umbilical side (50 μm).
11 Side view (50 μm).
12 Close-up of a foramen with the bipartitor (40 μm).

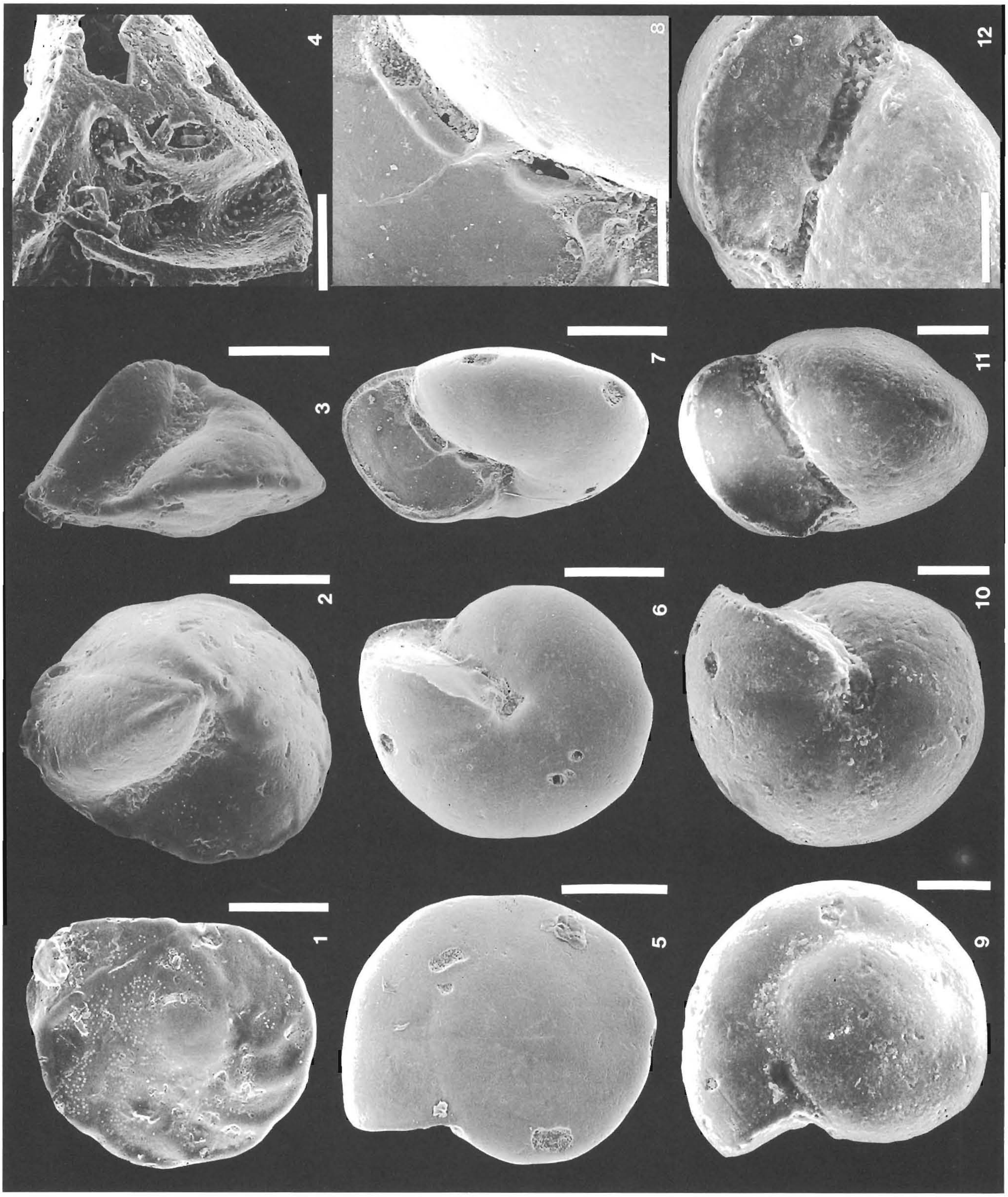
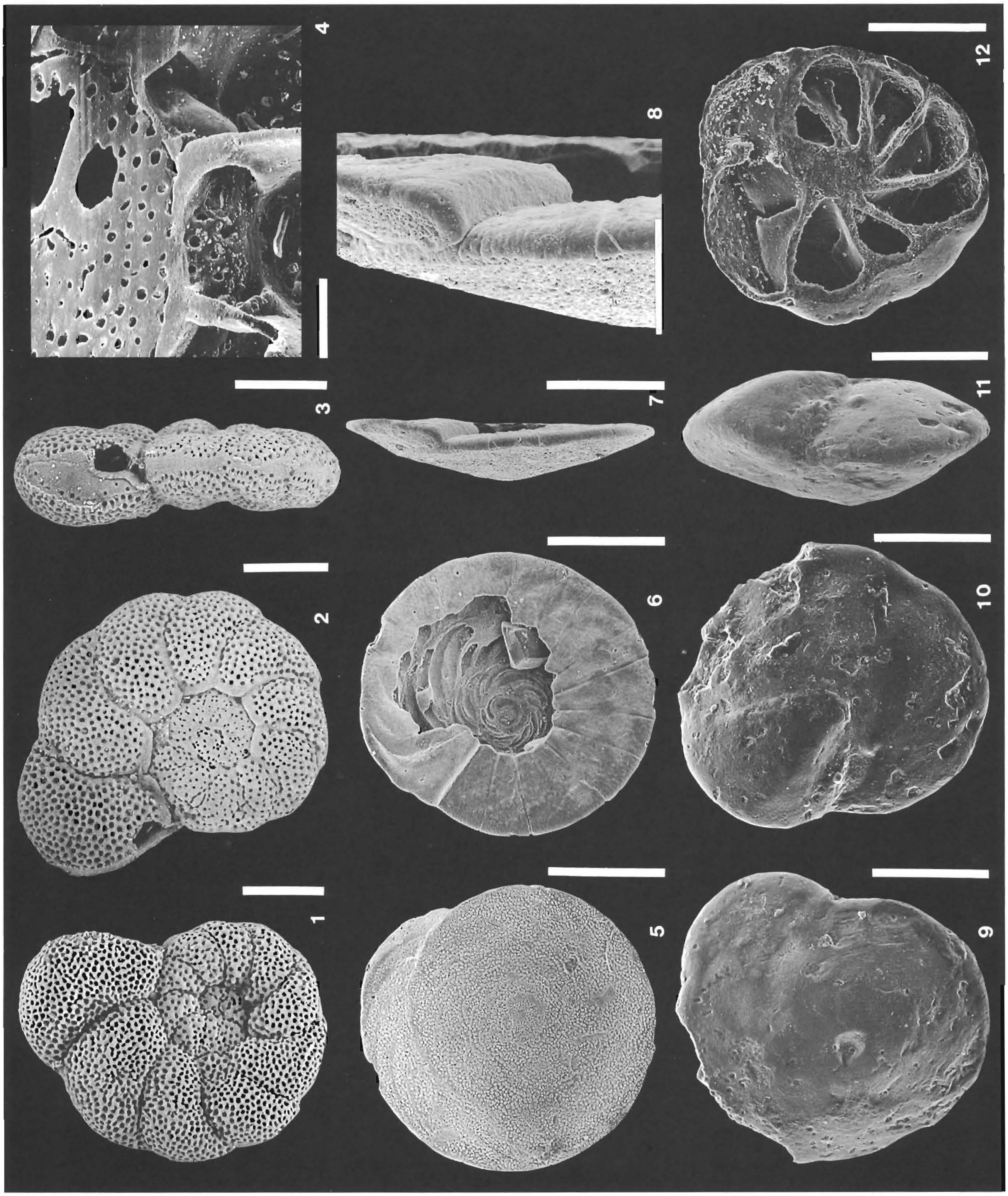

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 14

Holmanella valmonteensis (Kleinpell, 1938). Woodring, Bramlette, California, USA; Valmonte Diatomite, Upper Miocene.
1 Spiral side (200 μm), USNM497214, holotype.
2 Umbilical side (200 μm).
3 Side view (200 μm).
4 Close-up of a section from the umbilical side (50 μm), CC42316.

Nummodiscorbis novozealandica Hornibrook, 1961. Weka Pass Stream, North Canterbury, New Zealand; Altonian, Lower Miocene. NZGS, paratype.
5 Spiral side (150 μm).
6 Umbilical side (150 μm).
7 Side view (150 μm).
8 Close-up of the apertural region (50 μm).

Hollandina pegwellensis Haynes, 1956. Pegwell Bay, Kent, England; Thanet Formation, Thanetian. BMNH P42607.
9 Spiral side (100 μm).
10 Umbilical side (100 μm).
11 Side view (100 μm).
12 Section from the umbilical side, showing the simple foramina (100 μm).


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