Early to middle Miocene foraminifera from the deep-sea Congo Fan, offshore Angola

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ABSTRACT: Analysis of a 630m section of an exploration well penetrating the distal part of the Congo Fan (~2000m water depth) yielded high abundance and diversity assemblages of agglutinated and calcareous benthic foraminifera. Planktonic foraminifera constrain the age to Early – Middle Miocene, and $\delta^{18}O$ records reveal the Mi1 (~16.3 Ma) isotopic shift. Relatively few taxonomic studies of deep-water calcareous and agglutinated benthic foraminifera exist from this time period in this locality. All species encountered are therefore taxonomically described and documented using SEM photography (over 170 species), along with 27 species of planktonic foraminifera. Faunas show close affinities to those of the eastern Venezuela Basin, Gulf of Mexico and Central Paratethys.

Seven assemblages are defined and analysed using morphogroup analysis and Correspondence Analysis, documenting the response of benthic foraminifera to three primary environmental-forcing factors; energy levels in the benthic boundary layer, oxygen levels relating to changing surface water productivity, and fluctuations in the level of the CCD. Near the top and bottom of the studied section both foraminiferal abundance and diversity decrease, corresponding with increased sand content implying greater energy levels and environmental disturbance. The majority of the section consists of shales with very low percentage sand, high foraminiferal abundance and diversity, and high sedimentation rates of ~10cm/kyr. Morphogroup analysis reveals a major switch in the fauna at around oxygen isotope event Mi1, with the transition from an epifaunal-dominated *Cibicidoides* assemblage to shallow infaunal-dominated *Bulimina* assemblage. We regard this as likely due to expansion of the oxygen minimum zone (paleobathymetric estimates are ~1000m) related to increased surface-water productivity and global cooling. Shifts in calcareous foraminiferal percentage over the studied interval overprint these signals and are believed to be related to a shoaling CCD, linked to reduced oceanic acidity and global atmospheric CO_2 levels during the early Middle Miocene Monterey Carbon Isotope Excursion.

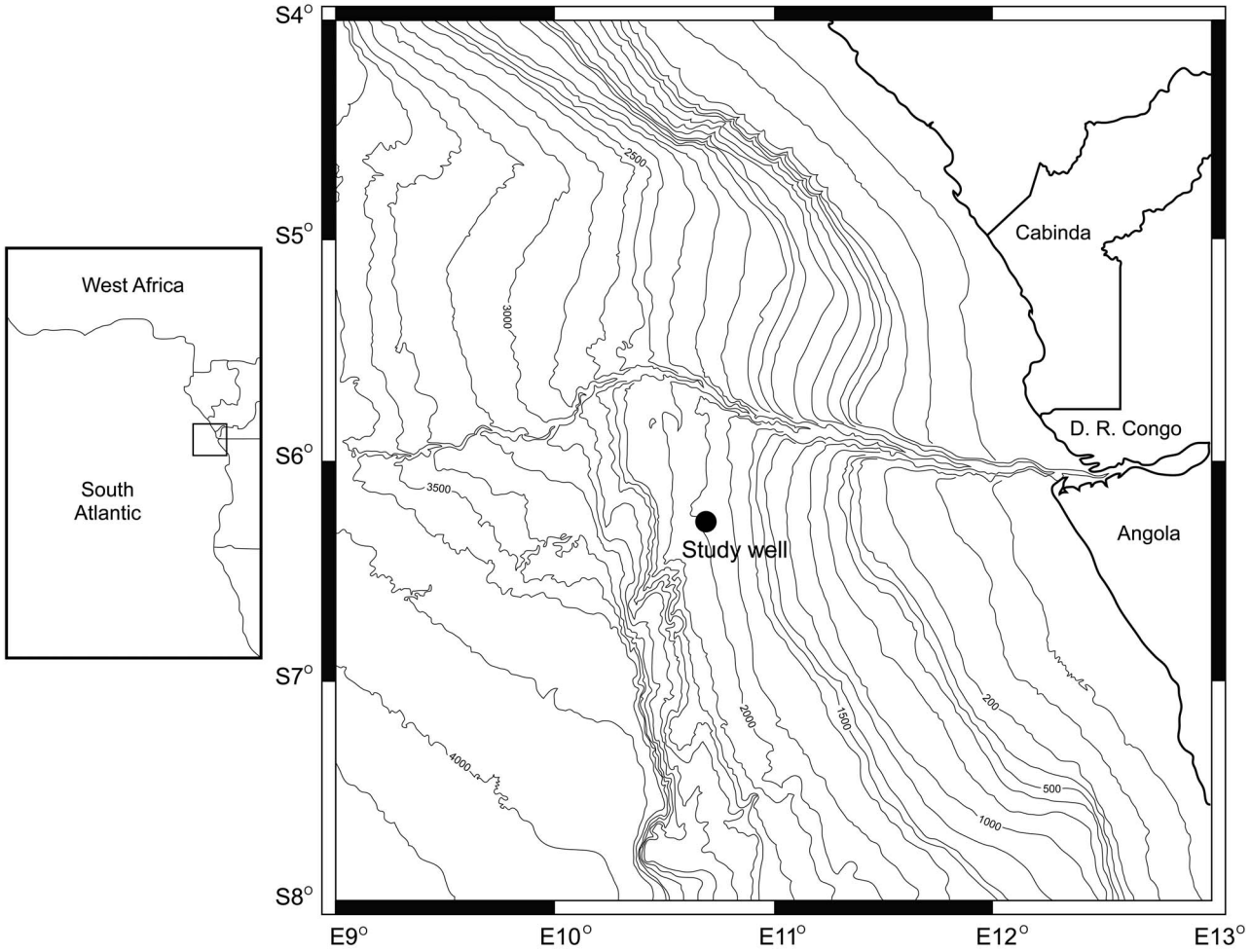
INTRODUCTION

The Congo Fan has been the subject of an increasing number of earth science studies in recent literature, not least due to the increase in hydrocarbon interest in the region over the last few years (Evans 2002). Although this has lead to the publication of many geological studies (Anderson et al. 2000; Lavier et al. 2001; Anka and Séranne 2004; Broucke et al. 2004; Giresse 2005), architectural studies (Savoye et al. 2000; Babonneau et al. 2002; Sultan et al. 2004), geochemical studies (Bentahila et al. 2006) and seismic studies (Uenzelmann-Neben et al. 1997; Uenzelmann-Neben 1998), relatively little has been published on the micropaleontology of the Congo Fan. A series of foraminiferal studies from West Africa focussed on Cretaceous and also Cenozoic outcrops in which many species were described (Chenouard et al. 1960; de Klasz et al. 1960; de Klasz and Rérat 1962a, 1962b; de Klasz et al. 1963; Graham et al. 1965; Le Calvez et al. 1971; Volat et al. 1996). Cameron (1978) studied Neogene benthic foraminifera from DSDP Sites 360 and 362 offshore Angola, basing their taxonomic work largely on comparisons from New Zealand. Seiglie and Baker (1983) described several new Cenozoic species of complex-walled agglutinated foraminifera from West Africa. Preece (1999) and Preece et al. (1999; 2000) studied Miocene benthic foraminifera from exploration wells offshore Cabinda, describing new species and paleoenvironmental implications. The present authors published a taxonomic and paleoenvironmental study of the Oligocene section of the well in this study (Kender et al. 2006; Kender et al. 2008) which contained almost exclusively agglutinated foraminifera. This study aims to provide a complete taxonomic and paleoenvironmental analysis of the benthic foraminifera from a 630m section of Lower-Middle Miocene shales from the distal section of the Congo Fan (text-fig. 1), with over 200 species of agglutinated, calcareous and planktonic foraminifera photographed and described.

GEOLOGY AND SEDIMENTOLOGY

The Congo Fan is the second largest delta system in the world (3.7×10^6 km^2), draining most of central Africa through the Congo River and its associated tributaries. A general lithologic column is given in text-figure 2. The Congo Fan is a terrigenous wedge largely built of Oligocene and Miocene sands and shales organised into thick sedimentary packages containing paleocanyons, paleochannels, and overbank deposits (Anderson et al. 2000; Lavier et al. 2001; Anka and Séranne 2004; Broucke et al. 2004; Giresse 2005). The unique meandering paleochannels contain sands that have proved high quality traps for migrating hydrocarbons (Evans 2002). In this study we analyse the foraminiferal microfauna from the Miocene section of a well drilled in the distal part of the Congo Fan (text-fig. 1).

The West African margin has been depositionally active since initial rifting took place in the Early Cretaceous (Jansen et al. 1984; Nürnberg and Müller 1991), resulting in three sub-basins developing along the West African passive margin, including the Lower Congo basin (Broucke et al. 2004). The earliest marine sediments consist of Aptian evaporites (<1000m thick) which overlie lacustrine deposits and form the complex of diapirs seen throughout the overlying strata.



TEXT-FIGURE 1
Bathymetric map of the Congo Fan, showing the location of the well analysed in this study, Block 31, water depth ~2000m.

From the Late Cretaceous to Early Oligocene, aggradational carbonate/siliciclastic ramp sediments formed ~200m of deposits, which form the principal source rock for the overlying hydrocarbon-bearing sands. These are directly overlain by a significant Oligocene unconformity of several million years, followed by prograding terrigenous turbidite deposits that continue through the Neogene forming up to 3000m of sediment. These consist of shale and sand overbank, levee and channel deposits, containing foraminifera in varying abundances.

The well in this study largely spans the Oligocene to Middle Miocene distal section of the turbiditic fan. It has been sampled at 10m intervals from about 4270-2760m depth, has a water depth of ~2000m, and is located ~170km offshore Angola (Block 31). The Upper Oligocene section (4270-3710m), analysed by Kender et al. (2008), consists of predominantly black muds and silts with interbedded sandy horizons, which continues into the Lower Miocene with little sedimentological change until reaching a large sand/silt body interpreted as a submarine paleochannel. The foraminifera are almost entirely agglutinated, and are present in most samples at medium to low abundances (average 150 specimens per 100g). Typical cosmopolitan Paleogene forms can be identified (*Nothia robusta*, *Ammodiscus latus*, *Reticulophragmium amplectens*), along with several dominating high productivity forms (e.g. *Portatrochammina profunda* and *Scherochorella congoensis*). The diversity ranges from medium to low (average 24, maximum 40 species per 100g) with significant faunal variation possibly related to productivity fluctuations.

The overlying sand horizon (3700-3420m) becomes barren after foraminiferal diversity and abundance drops away leaving only rare specimens of *Nothia* spp. and *Ammodiscus* spp. Above this, the sand abruptly gives way to the Lower and Middle Miocene silts and muds analysed in this report (3410-2760m), containing gradually more calcareous and planktonic foraminifera as well as persistent agglutinated forms. The diversity and abundance is high, and shows significant variation in calcareous content which could be related to fluctuations in the CCD during the Middle Miocene. Sedimentation rates over this interval are in the order of 10cm/kyr. Faunas become more diverse and reveal typical Middle Miocene calcareous and agglutinated foraminifera, along with some persisting typical Paleogene forms (see Taxonomy).

EARLY-MIDDLE MIOCENE PALEOCEANOGRAPHY

The Early-Middle Miocene represents an important time in Earth's history as it was a transitional phase between the Paleogene climatic high and the 'icehouse' climate of the Neogene. The Early Miocene witnessed a series of fluctuating Antarctic glacial and interglacial episodes which culminated in the warmest period of the Neogene around the early/middle Miocene boundary, before a significant cooling phase and the final transition into the cold icehouse world at around 14 Ma (Miller et al. 1987, 1991; Flower and Kennett 1994, 1995; Flower et al. 1997; Holbourn et al. 2005).

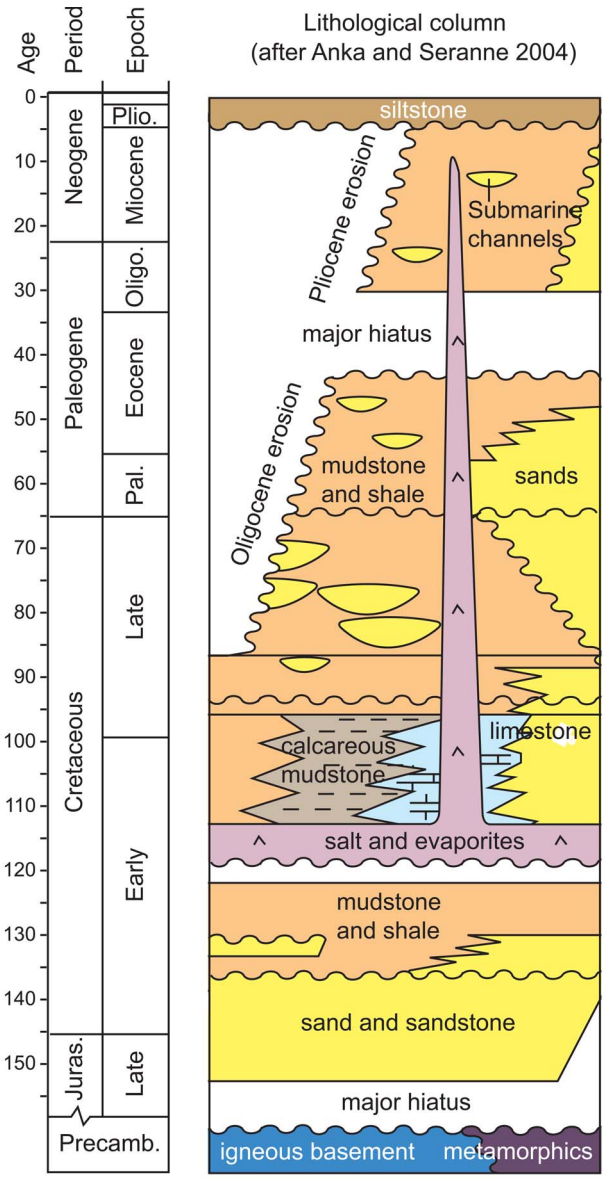
Early Miocene oceanic circulation is relatively poorly understood due in part to widespread unconformities in ocean sediments at this interval (Keller and Barron 1983; Wright et al. 1992). Barron and Keller (1982) record a widespread deep-sea hiatus at around 15–16 Ma which they related to increased bottom current strength associated with polar cooling. Carbon isotope signals are however thought to indicate that there was only a small contribution of Northern Component Water (NCW) to the South Atlantic at this time (Wright et al. 1992). The formation of warm saline deep water in the Indian Ocean has been suggested by several authors (Woodruff and Savin 1989; Flower and Kennett 1994, 1995), and may have contributed a significant component of Atlantic waters through the open Tethys Ocean at this time. Around the early/middle Miocene boundary a major reorganisation of global circulation occurred that resulted in the well-documented 'silica switch', representing a change in the locus of biosilica production from the North Atlantic to the Indo-Pacific Oceans (Barron and Baldauf 1990). This coincided with the intermittent closure of Tethys (Jones 2006) and the emergence of the Iceland Plateau (Schnitker 1980; Flower et al. 1997). The final transition to icehouse world at around 14 Ma has been found to be coincident with a period of prolonged Antarctic low summer insolation creating the boundary conditions needed for large-scale cooling (Holbourn et al. 2005).

MATERIALS AND METHODS

Sample Processing

Ditch cutting samples were collected at 10m intervals from a near-vertical exploration well in Block 31, offshore Angola, at a water depth of ~2000m (text-fig. 1). Samples of approximately 100g were weighed, washed over a 63µm sieve to remove silt content, dried in an oven, and weighed again. All foraminifera > 125µm were picked from each sample, or fraction of sample if abundances were significantly higher than 300, sorted into species, glued onto cardboard reference slides and counted (Appendix 1). Smaller fractions were not included in the analysis as the fossilisation potential of small specimens is even lower than larger ones, thus introducing an even greater element of bias into results. Photographic images were taken using JEOL JSM-648OLV SEM at University College London, after coating specimens in gold. Image brightness and contrast were adjusted using Adobe Photoshop©.

Due to the scarcity of benthic foraminifera in some samples oxygen isotopes were obtained from *Cibicidoides* spp. (*C. mundulus* and *C. pachyderma* were preferentially used where available), 2-5 specimens >250µm taken where possible. Crushed specimens were then immersed in 3% hydrogen peroxide for 30min, ultrasonicated in methanol for 15s, excess residue and liquid removed, and dried at 45ºC. Stable isotope analysis was conducted using a ThermoFinnigan MAT 252 and

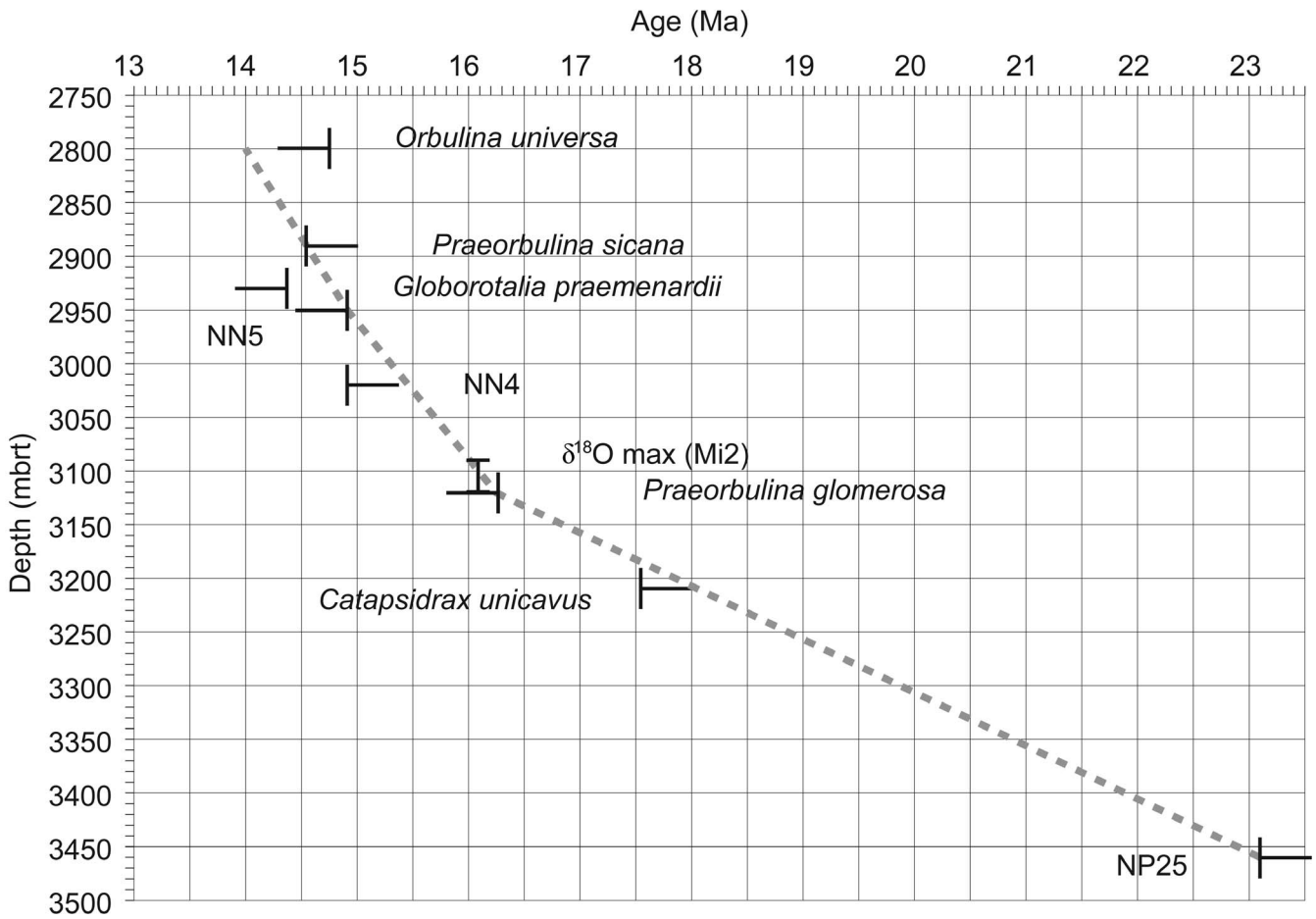


TEXT-FIGURE 2
Generalised geological column for the Lower Congo basin, West African passive margin. The Congo Fan has been depositionally active since the mid-Oligocene and makes up the majority of sediment in this region.

coupled carbonate preparation device at Cardiff University, with an external reproducibility of =0.08‰ for $\delta^{18}O$ and reported on the VPDB scale. Values of $\delta^{18}O$ recorded from *Cibicidoides* spp. have been adjusted by +0.64‰ to align them with equilibrium calcification at given temperature and $\delta^{18}O_{sw}$ (Shackleton 1974).

Data Analysis and Statistics

Sand percentage was obtained by subtracting the weight of the sample containing least sand (practically none) from all samples, giving the remaining weight as a percentage of the total unwashed sample. Absolute abundance was calculated by dividing the number of foraminifera picked from each sample by the fraction picked, and then dividing by the number of grams originally sampled (around 100g for each sample) to obtain speci-



TEXT-FIGURE 3
Age / depth model for the well in this study (Block 31, offshore Angola). Age diagnostic planktonic foraminifera are rare in most samples.

mens per gram. Diversity is given both as number of species encountered per sample, and as Fisher's alpha (α) in order to normalise for the differing number of specimens picked per sample (Fisher et al. 1943). The quantity α is found using the following equation (calculated by PAST of Hammer et al. 2005):

$$\frac{N}{S} = \frac{(e^{S\alpha} - 1)}{S / \alpha}$$

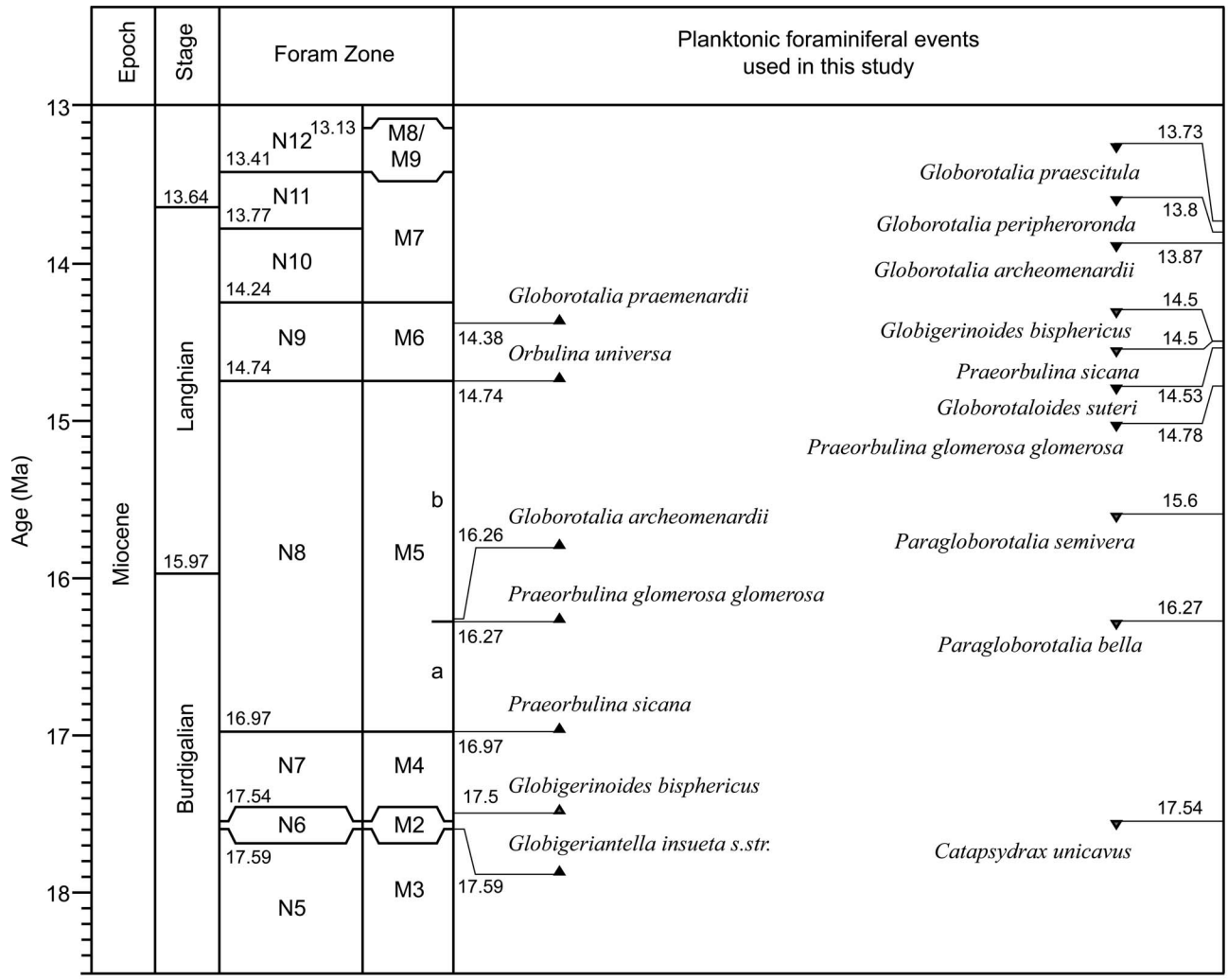
Where N is the number of specimens and S is the number of species per sample. The total value α is given for each sample, and this is interpreted as the number of species in each population that are represented by just one specimen (Hayek and Buzas 1997), and is independent of sample size (N). Fisher's α has been used successfully by many authors (e.g. Kuhnt et al. 2002; Gooday and Hughes 2002; Murray and Pudsey 2004) due to its ease of use and results as reliable as any other method (Hayek and Buzas 1997).

Correspondence Analysis (CA) results have been obtained using PAST (Hammer et al. 2005), using the entire dataset (Appendix 1) unaltered. CA is similar to Principal Components Analysis in that it attempts to show multidimensional data in fewer dimensions (Teil 1975; Greenacre 1984), and has been used by many authors to characterise biological gradients from taxonomic counts (Hammer and Harper 2006; Kuhnt et al. 2002). Rather than finding the principal component along which greatest variance is apparent, CA places both species and samples in the same space, samples and species that are clustered together sharing similar assemblages or distributions. Values for samples and species are found using a reciprocal averaging algorithm that averages abundances and species values by abundances, and vice-versa with sample values, continuously until minimal change is obtained through successive iterations (Benzecri 1992). The first axis has been found to represent primary ecological gradients (Hammer and Harper 2006), and in our results may represent oxygen concentration, although we generally use the technique to gain evidence for deriving assemblages.

RESULTS

Biostratigraphy and Age / Depth Model

The age model for the study well (text-fig. 3) has been constructed using planktonic foraminiferal events, an oxygen isotope event (Mi2) and nannofossil events, with a linear sedimentation rate inferred between tie-points. All events are



TEXT-FIGURE 4
Absolute ages for planktonic foraminifera encountered in this study against the timescale of Lourens et al. (2004). Events compiled from Ogg and Lugowski (2007); Berggren et al. (1995); Bolli and Saunders (1995); and Kennett and Srinivasan (1983).

fitted to the Lourens et al. (2004) timescale. The age ranges used for all planktonic foraminifera found in this study are given in text-figure 4, based on the works of Ogg and Lugowski (2007); Berggren et al. (1995); Bolli and Saunders (1985); Kennett and Srinivasan (1983), and a brief discussion of each species is presented in the taxonomic part of this paper. As the recovery of planktonic foraminifera was relatively low (see Appendix 1), first and last occurrences are not a useful indication of age and so in most cases we have used these only as a guide.

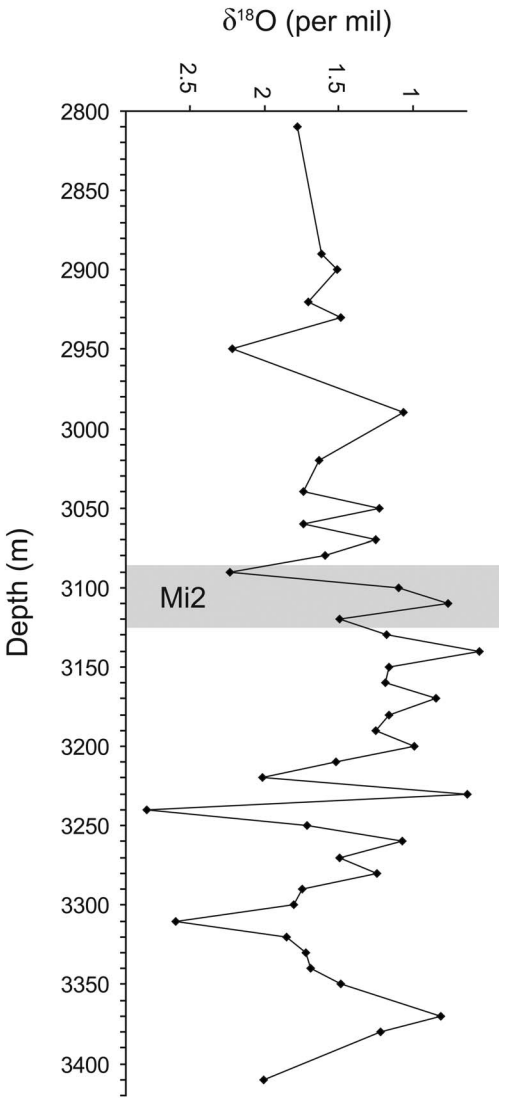
The upper section of the well (2760-2890m) is constrained to Middle Miocene (Langhian, zone N9) by the occurrence of *Orbulina universa*, and *Praeorbulina sicana*, whose ranges overlap in this interval. The occurrence of *Globorotalia praemenardii* at 2930m suggests an earlier age but may be caved as the older form *P. sicana* occurs significantly higher in the section.

The occurrence of *Praeorbulina glomerosa glomerosa* at 3120m suggests an age of no older than about 16.3 Ma (Berggren et al. 1995), and this depth also coincides with oxygen isotope event Mi2 (Miller et al 1991) at 16.1 Ma seen in the isotope record from this study (text-fig. 5) as the beginning of global cooling ($\delta^{18}O$ increase). The $\delta^{13}C$ record also fits the global trend at this location (unpublished data). Nannofossil dating (unpublished BP data, text-fig. 3) supports these ages.

The appearance of *Catapsydrax unicavus* at depth 3210m suggests that the samples below this point are older than the top of zone N6 (Kennett and Srinivasan 1983) at 17.5 Ma. Samples below this depth are more impoverished in planktonic foraminifera and dating is more difficult. Nannofossil dating (unpublished BP data) places the Oligo-Miocene boundary at approximately 3475m. The presence of *Paragloborotalia mayeri* sensu Bolli and Saunders (1985) in sidewall core sample 3521m suggests that this level is no older than Chattian.

Benthic Foraminiferal Assemblages

Benthic foraminiferal results reveal a taxonomically diverse fauna with over 200 species identified (Appendix 1). Abundance and diversity vary up the section (text-fig. 6), along with



TEXT-FIGURE 5
Oxygen isotope results for the well in this study (Block 31, offshore Angola). The oxygen isotope event Mi2 (Miller at al. 1991) is given (shaded area).

abundances of each species (text-fig. 7). The ranges of some of the more abundant species are shown in text-figure 8. Seven assemblages have been identified based on species abundance fluctuations, Correspondence Analysis, and morphogroup analysis and are listed below:

(1) Low diversity agglutinated Assemblage 7 (depths 3390-3240m) is characterised by almost exclusively agglutinated foraminifera and low diversity (around 20 species per sample, Fisher's α = 10). Absolute abundance is also low. The most commonly occurring species in this assemblage are *Rhabdammina cylindrica*, *Nothia excelsa*, *Nothia* spp., *Rhizammina* spp., *Glomospira gordialis*, *Glomospira irregularis*, *Saccammina sphaerica* and *Reticulophragmium* spp. This assemblage also contains a slightly higher proportion of sand than assemblage 2 (around 5%).

(2) High diversity *Cibicidoides* Assemblage 6 (depths 3230-3050m) is characterised by high diversity (around 50 species per sample, Fisher's α = 20) of both agglutinated and calcareous foraminifera, and higher abundances (20 to 40 specimens per sample) of planktonic foraminifera. Absolute abundance is also high (200 to 700 specimens per 100 g). The most commonly occurring species are *Cibicidoides crebbsi*, *Oridorsalis umbonatus*, *Hanzawaia mantaensis*, *Uvigerina mantaensis*, *Bolivina tenuisstriata*, and *Paratrochamminoides* spp. Sand percentage is low.

(3) Agglutinated Assemblage 5 (depths 3040m and 3030m) is characterised by a high diversity fauna (around 40 species per sample, Fisher's α = 15) of almost entirely agglutinated foraminifera. Absolute abundance is high (around 500 specimens per 100g). The most commonly occurring species are *Glomospira gordialis*, *Paratrochamminoides* spp., *Cyclammina* spp., *Reticulophragmium* spp., *Bathysiphon* spp. Sand percentage is low.

(4) *Bulimina* Assemblage 4 (depths 3020-2930m) is characterised by a largely calcareous fauna of low diversity (around 20 species per sample, Fisher's α = 8) and widely fluctuating absolute abundances (from 100 to 6800 specimens per 100 g). The most commonly occurring species are *Bulimina elongata*, *Brizalina* cf. *barbata*, *Uvigerina* aff. *carapitana*, *Brizalina alazanensis* and *Bulimina marginata*. Sand content is relatively low (maximum 5%).

(5) *Valvulineria pseudotumeyensis* Assemblage 3 (depths 2920-2890m) is characterised by low diversity (around 20 species per sample, Fisher's α = 8) and high relative abundance (up to 2272 specimens per 100 g), and is dominated by the species *Valvulineria pseudotumeyensis*. The assemblage is largely calcareous. *Bulimina falconensis* and *Brizalina alazanensis* are also common. Sand content is relatively low (maximum 5%).

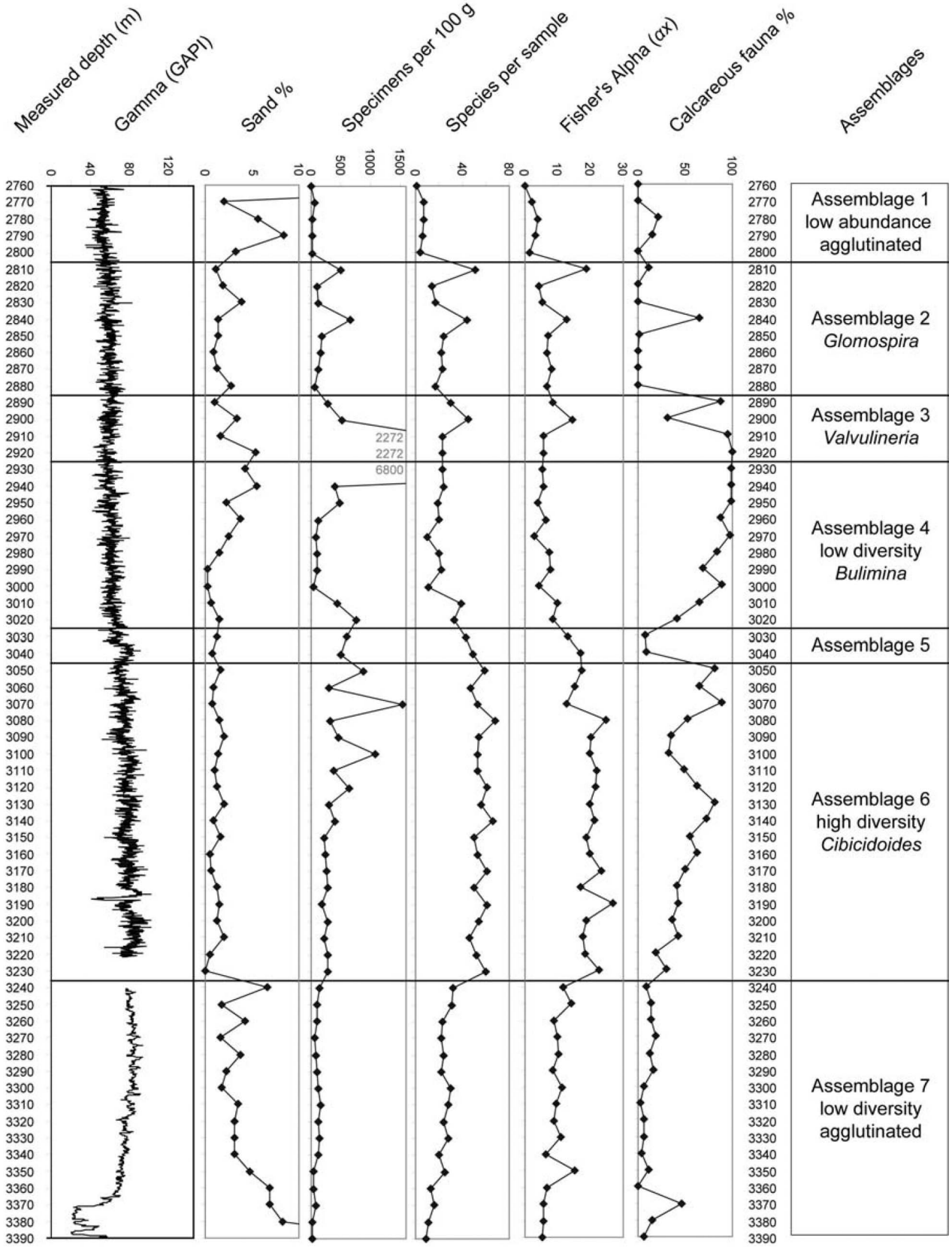
(6) Agglutinated *Glomospira* Assemblage 2 (depths 2880-2810m) is characterised by a medium diversity fauna (around 20 to 40 species per sample, Fisher's α = 10) of almost entirely agglutinated foraminifera. Absolute abundance is low (around 200 specimens per 100 g). The most commonly occurring species are *Glomospira gordialis*, *Bathysiphon* spp., *Rhizammina* spp., *Rhabdammina cylindrica* and *Saccammina* cf. *sphaerica*. Sand percentage is low.

(7) Low abundance Assemblage 1 (depths 2800-2760m) is characterised by a low abundance fauna (less than 50 specimens per 100g), largely agglutinated in nature, and low in diversity (less than 7 species per sample, Fisher's α= 4). Common species are *Glomospira gordialis*, *Rhabdammina* spp. and *Bathysiphon* spp. Sand percentage is relatively high (around 5%).

Correspondence Analysis Results

The results from Correspondence Analysis reveal the clustering of samples from each assemblage (text-fig. 9b), adding statistical evidence for assemblages designated in this study. Also shown are the species that characterize each assemblage (text-fig. 9a). This independent analysis helps prove the validity of assemblages designated above using species abundance and diversity changes, and also supports morphogroup results (below).

The species *V. pseudotumeyensis* (text-fig. 9) has low axis 1 values and the highest axis 2 values, corresponding well with



TEXT-FIGURE 6
Graphs showing gamma ray log (sandy horizons indicated by lower values), percentage sand (measured for each sample), absolute abundance, species counted per sample, Fisher's Alpha diversity, percentage calcareous specimens and assemblages, against depth.

TABLE 1
List of species placed within the agglutinated morphogroups followed in this study using morphogroup categories of Van den Akker et al. (2000).

Erect epifauna M1

Bathysiphon sp.
Hyperammina elongata
Hyperammina sp.
Kalamopsis sp.
Nothia excelsa
Nothia latissima
Nothia robusta
Nothia sp.
Rhabdammina cylindrica
Rhabdammina linearis
Rhabdammina sp.
Rhabdammina sp.1
Rhizammina sp.
Tolypammina sp.

Shallow infauna globular M2a

Praesphaerammina sp.
Praesphaerammina sp.1
Psammosphaera sp.
Psammosphaera sp.1
Psammosphaera cf. *fusca*
Saccammina cf. *sphaerica*
Saccammina sp.
Saccammina sp.1

Surficial epifauna trochospiral M2b

Conglophragmium irregularis
Cribrostomoides sp.
Cribrostomoides sp.1
Cribrostomoides subglobosus
Glomospira charoides
Lituotuba lituiformis
Paratrochamminoides challengeri
Paratrochamminoides deflexiformis
Paratrochamminoides gorayskiformis
Paratrochamminoides heteromorphus
Paratrochamminoides mitratus
Paratrochamminoides olszewskii
Paratrochamminoides sp.
Paratrochamminoides sp.1
Portatrochammina profunda
Recurvoides azuaensis
Recurvoides sp.
Recurvoides sp.1
Trochammina sp.
Trochammina sp.1
Trochammina sp.2
Trochammina sp.3
Trochammina sp.4
Trochamminoides folius
Trochamminoides sp.
Trochamminoides subcoronatus

Surficial epifauna keeled M2c

Gaudryina atlantica
Vulvulina miocenica

Surficial epifauna flattened M3a

Ammodiscus aff. *peruvianus*
Ammodiscus cretaceus
Ammodiscus glabratus
Ammodiscus latus
Ammodiscus sp.
Ammodiscus sp.3
Ammosphaeroidina pseudopauciloculata
Ammosphaeroidina sp.
Glomospira aff. *serpens*
Glomospira glomerata
Glomospira gordialis
Glomospira irregularis
Glomospira sp.
Glomospira sp.1
Glomospira sp.2
Spiropsammina primula

Surficial epifauna irregular M3b

Ammolagena clavata
Discamminoides sp.1

Shallow infauna planispiral M4a

Budashevaella multicamerata
Bulbobaculites sp.1
Cyclammina cancellata
Cyclammina cancellata ssp.1
Cyclammina sp.
Cyclammina sp.1
Cyclammina sp.2
Glaphyrammina americana
Haplophragmoides carinatus
Haplophragmoides cf. *bradyi*
Haplophragmoides horridus
Haplophragmoides nauticus
Haplophragmoides sp.
Haplophragmoides sp.1
Reticulophragmium acutidorsatum
Reticulophragmium acutidorsatum ssp.1
Reticulophragmium aff. *orbicularis*
Reticulophragmium amplectens
Reticulophragmium amplectens ssp.1
Reticulophragmium gasparensis
Reticulophragmium rotundidorsatum
Reticulophragmium sp.
Reticulophragmium sp.1

Deep infauna M4b

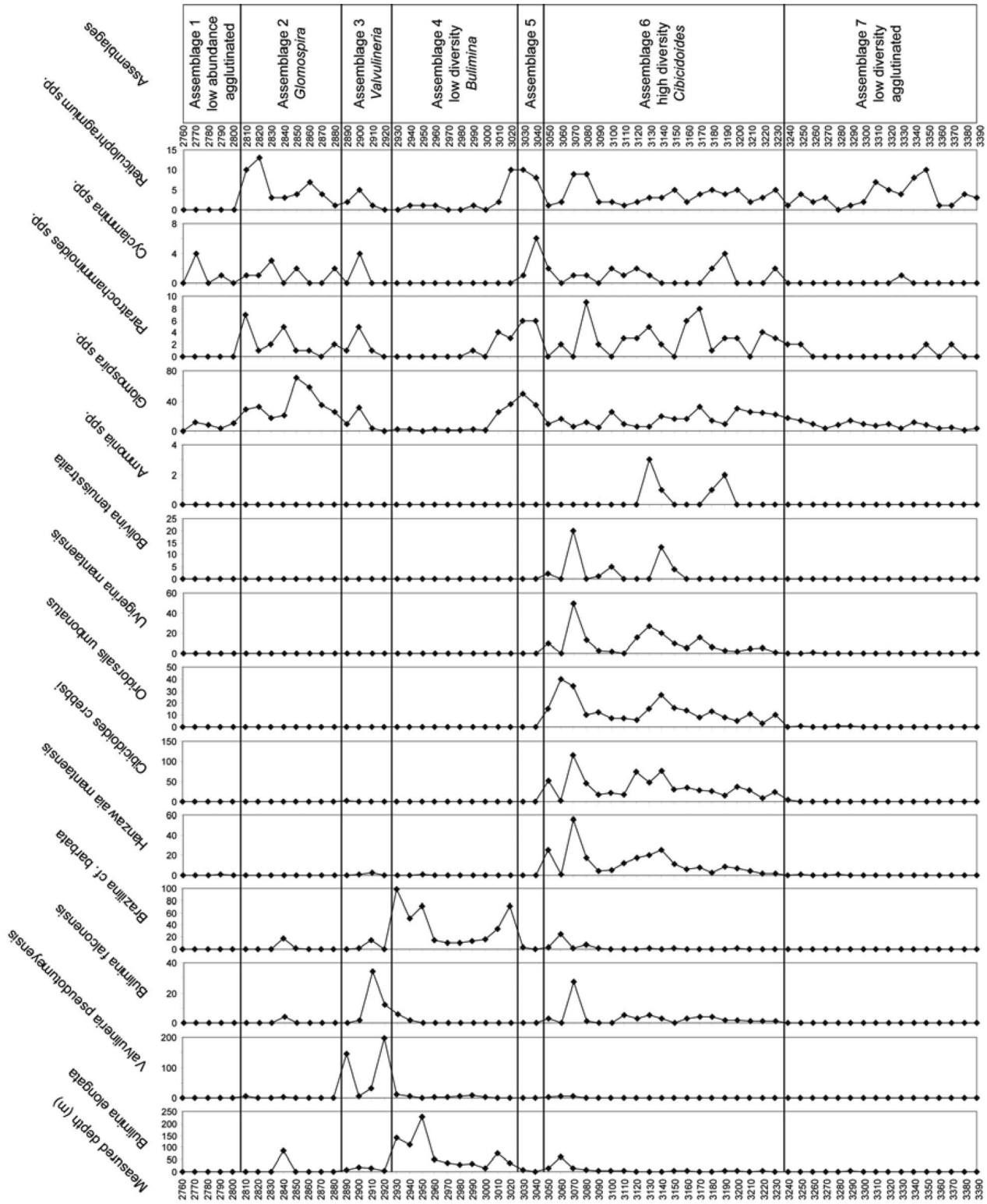
Aschemocella grandis
Bigenerina sp.
Eggerelloides sp.1
Hormosina glabra
Hormosina globulifera
Hormosinella carpenteri
Hormosinelloides guttifer
Karreriella aff. *bradyi*
Karreriella sp.1
Karrerulina apicularis
Karrerulina sp.
Martinotiella aff. *communis*
Martinotiella sp.
Pseudonodosinella nodulosa
Reophanus berggreni
Reophax pilulifer
Reophax sp.
Subreophax scalaris
Subreophax sp.1
Textularia earlandi
Valvulina flexilis

depths from *Valvulineria pseudotumeyensis* Assemblage 3. Low axis 1 and axis 2 values are dominated by the species *B. elongata*, *B.* cf. *barbata*, *B. marginata* and *U.* aff. *carapitana*, corresponding well with the *Bulimina* Assemblage 4. High axis 1 and axis 2 values are found in the species *Cibicidoides* sp., *C. crebbsi*, *H. mantaensis* and *U. mantaensis*, with good correlation to the High diversity *Cibicidoides* Assemblage 6. High axis 1 and low axis 2 values are associated with the species *G. gordialis*, *Bathysiphon* sp. and *N. excelsa*, corresponding well with samples of Agglutinated Assemblages 2 and 5. Clustering of species around the origin indicates those species showing no overall clustering around a narrow depth range. Clustering of samples from the Low abundance Assemblage 1 and Low diversity agglutinated Assemblage 7 near the origin indicates a similarity on the basis of their species distributions. Clustering towards one end of axis 1, known as compression (Hammer and Harper 2006), is expected and not thought to be obviously meaningful. It is noticeable that most species showing constrained ranges about particular depths (high or low axis values) are calcareous in nature. Agglutinated foraminifera, taken separately, vary little up the section, providing a more-or-less single assemblage overprinted on the more variable calcareous foraminifera.

Morphogroup Results

Morphogroup analysis for agglutinated foraminifera (text-fig. 10) follows the groups of Van den Akker et al. (2000) which were modified from Nagy (1992) and Nagy et al. (1995). The species assigned to each group are given in Table 1. Limitations in morphogroup analysis are derived from the excessive lumping of morphotypes into ecological categories, which must be acknowledged as an oversimplification as shape is not the only foraminiferal response to environmental change (e.g. Smart 2002). Broad changes in distributions can however give interesting results, but must be analysed with caution. In general, morphogroup depth-designations relate to position within the sediment during 'normal' conditions, and are probably driven largely by oxygen level as the primary ecological variable in these environments (e.g. Jorissen et al. 1995; Gooday and Rathburn 1999). As species migrate with oxygen concentration (Alve and Bernhard 1995), it is the oxygen fluctuations that are assumed to be recorded with changing morphogroup proportions.

In general, morphogroup M1 dominates with frequently 50-70% of the assemblage, the largest proportions at the base of the section (3390-3240m). Morphogroup M2b is at highest pro-



TEXT-FIGURE 7
Abundance of selected species per sample against depth and assemblages. Values are from raw data and not adjusted for sediment weight.

TABLE 2
List of species placed within the calcareous morphogroups followed in this study, using categories of Corliss (1991).

Epifaunal (0 to 1 cm)

Cibicidoides crebbsi
Cibicidoides dohmi
Cibicidoides grimsdalei
Cibicidoides guazumalensis
Cibicidoides havanaensis
Cibicidoides mundulus
Cibicidoides pachyderma
Cibicidoides sp.
Cibicidoides sp.1
Globocassidulina subglobosa
Gyroidina orbicularis
Gyroidinoides altiformis
Gyroidinoides altispira
Gyroidinoides soldanii
Gyroidinoides sp.1
Hanzawaia mantaensis
Hanzawaia sp.
Hanzawaia sp.1
Hoeglundina elegans
Neoeponides campester
Oridorsalis ex gr. *umbonatus*
Oridorsalis sp.
Oridorsalis umbonatus
Planulina renzi
Pyrgo magnacaudata
Pyrgo sp.
Quinqueloculina triangularis
Quinqueloculina triloculiniforma
Valvulineria pseudotumeyensis

Shallow infaunal (0 to 2 cm)

Bolivina multicostata
Bolivina sp.
Bolivina tenuisstraita
Brazilina cf. *barbata*
Brizalina aff. *inflata*
Brizalina alazanensis
Bulimina buchiana
Bulimina elongata
Bulimina falconensis
Bulimina macilenta
Bulimina marginata
Bulimina mexicana
Bulimina sculptilis
Bulimina sp.
Buliminella sp.1
Cassidulina sp.
Cassidulinella pliocenica
Globocassidulina aff. *punctata*
Lenticulina aff. *multinodosa*
Lenticulina americana
Lenticulina formosa
Lenticulina sp.
Sphaeroidina bulloides
Uvigerina hispida
Uvigerina aff. *mediterranea*
Uvigerina carapitana
Uvigerina macrocarinata
Uvigerina mantaensis
Uvigerina proboscidea
Uvigerina sp.
Uvigerina spinulosa

Intermediate infaunal (1 to 4 cm)

Gyroidina umbonata
Melonis pompilioides
Pullenia bulloides

Deep infaunal (>4 cm)

Amphimorphina stainforthi
Nonion sp.1
Praeglobobulimina aff. *socialis*
Praeglobobulimina ovata

portions between depths 3170-3030m (High diversity *Cibicidoides* Assemblage), and reduces rapidly in place of M3a between depths 2880-2780m (Agglutinated Assemblage 2). Morphogroups M2c, M4a and M4b remain low and relatively stable throughout.

Morphogroup analysis for calcareous benthic foraminifera is shown in text-fig. 10. The morphogroup analysis followed here (after Corliss 1991) utilises four depth-groups distinguished from live benthic foraminifera from depths 200-3000m in the Nova Scotian continental margin and Gulf of Maine (northwest Atlantic). As the majority of species encountered are different from those used by Corliss (1991), we have assigned species to groups based on their morphological similarities to those forms (Table 2).

The percentage change in calcareous morphogroups can be seen to vary up the section, with Epifaunal and Shallow Infaunal morphogroups making up the majority of species present. In general, the Epifaunal morphogroup dominates samples 3390-3040m by around 60–70%, with the Shallow Infauna morphogroup making up about 30% and the Intermediate and Deep Infauna groups less than 10%. Between 3030-2840m a switch occurs and the Shallow Infaunal group dominates with between 75–100% of the assemblage. Epifaunal group makes up the remainder, with other groups hardly occurring at all. The assemblages (above) can be seen to coincide with this large shift in morphogroups between 3040-3030m.

DISCUSSION

Caving and Reworking

The samples in this study have been collected as rock cuttings (ditch cuttings) and are therefore susceptible to down-hole contamination (caving). Although some specimens have been found to be caved (e.g. 1 specimen of *G. praemenardii* in sample 2930m – see Biostratigraphy and Age / Depth Model above) and this phenomenon must be a component, we observe no large-scale caving and therefore regard the overall trends in species abundances to be real.

Reworking in our samples is regarded as low. Evidence of shallow water species transported down-slope (e.g. *Ammonia* spp. in samples 3130-3190m) is sparse, and we therefore regard reworking an insignificant component (see Paleobathymetry below).

Paleobathymetry

Analysis of bathymetric ranges of commonly occurring species in this study (text-fig. 11) reveals a palaeobathymetric depth of at least middle – lower bathyal (~1000m) during the Early – Middle Miocene. Two common species with lower depth ranges of middle bathyal in the Gulf of Mexico are *C. crebbsi* (Picou et al. 1999, although Van Morkhoven et al. 1986 record upper bathyal) and *S. bulloides* (Van Morkhoven et al. 1986). The species *L. calcar* and *C. pachyderma* are both upper bathyal forms (Van Morkhoven et al. 1986), but occur in low numbers and may have been transported down-slope or occur at differing ranges in this location. The species *A. clavata* has been reported as a middle bathyal form in the Gulf of Mexico, but ranging shallower elsewhere (Kaminski and Gradstein 2005). Both *G. soldanii* (Jones 1994 – North Atlantic) and *P. renzi* (Van Morkhoven et al. 1986 – Gulf of Mexico) are middle bathyal to abyssal species. The species *C. havanensis* persistently occurs through the section, and has an upper depth limit of lower bathyal in the Gulf of Mexico (Van Morkhoven et al. 1986). The species *R. orbicularis* is a modern form recorded at abyssal depths in the South Pacific (Jones 1994). However the extinct

TABLE 3
Summary of paleoenvironmental interpretation for the assemblages identified in this study. See text for details.

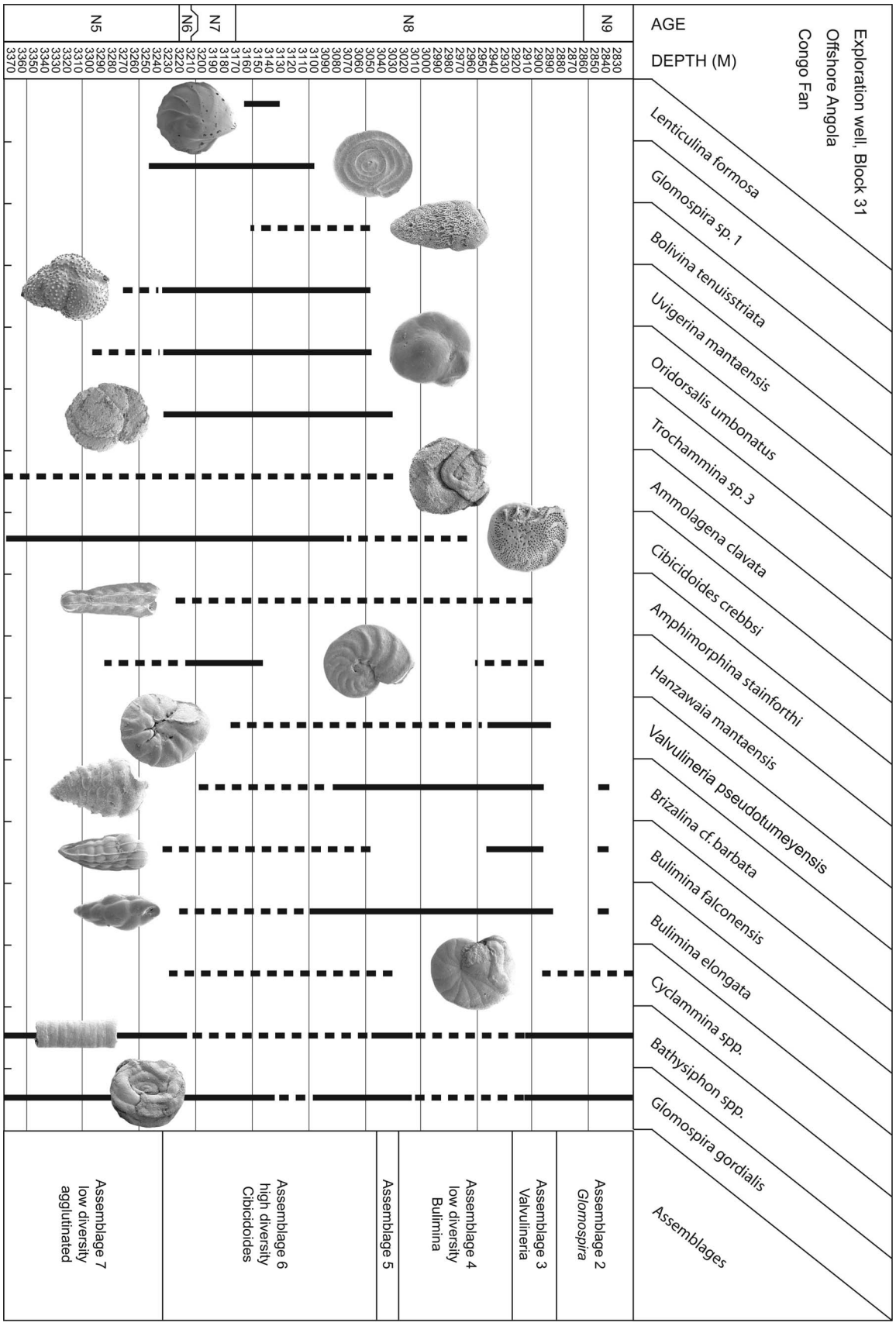
Assemblage	*Dominant / important species*	*Paleoenvironmental interpretation*
1. Low abundance agglutinated	*Glomospira gordialis* *Rhabdammina* spp. *Bathysiphon* spp.	Increased sand content and low abundance / diversity indicates higher energy levels in sedimentary deposition.
2. *Glomospira*	*Glomospira* spp. *Saccammina* cf. *sphaerica* *Bathysiphon* spp. *Rhizammina* spp.	Reduced diversity indicates stressed environment. Dominating species *Glomospira* suggests increased organic carbon flux and expanded OMZ. Decreased calcareous content may be associated with regional decrease in bottom water calcite saturation.
3. *Valvulineria*	*Valvulineria pseudotumeyensis* *Brizalina alazanensis* *Bathysiphon* spp.	Reduced diversity indicates stressed environment. Oxygen levels may well be low due to an expanded OMZ.
4. Low diversity *Bulimina*	*Bulimina elongata* *Bulimina marginata* *Uvigerina* aff. *carapitana* *Brizalina* cf. *barbata*	Reduced diversity indicates stressed environment, with infaunal morphogroup indicating low oxygen conditions. This is likely associated with OMZ expansion.
5. Agglutinated	*Trochammina* sp. 3 *Glomospira gordialis* *Saccammina* cf. *sphaerica* *Bathysiphon* spp.	Temporary removal of calcareous content may be associated with regional decrease in bottom water calcite saturation.
6. High diversity *Cibicidoides*	*Cibicidoides* spp. *Hanzawaia mantaensis* *Oridorsalis umbonatus* *Glomospira* spp. *Rhabdammina* spp. *Tolypammina* spp. *Psammosphaera* spp.	High diversity suggests a stable, well oxygenated, low energy environment with good supply of organic carbon. Increased calcareous content may be associated with regional increase in bottom water calcite saturation.
7. Low diversity agglutinated	*Nothia* spp. *Rhabdammina* spp. *Rhizammina* spp. *Glomospira gordialis*	Increased sand content and low abundance / diversity indicates higher energy levels in sedimentary deposition.

species *R. rotundidorsatum*, believed to be an evolutionary ancestor of *R. orbicularis*, is strictly bathyal (Kaminski and Gradstein 2005). It is therefore postulated that the early form of *R. orbicularis* had a shallower depth range in the Early – Middle Miocene. The primary control on foraminiferal bathymetric preference has been found by Altenbach et al. (1999) to be levels of organic carbon flux, which reduce with depth. As the flux is likely to have been greater in this location than in the Gulf of Mexico during this time period, bathymetric ranges of equivalent species are likely to be greater off West Africa. This leads us to conclude that paleobathymetry was likely greater than 1000m (lower bathyal).

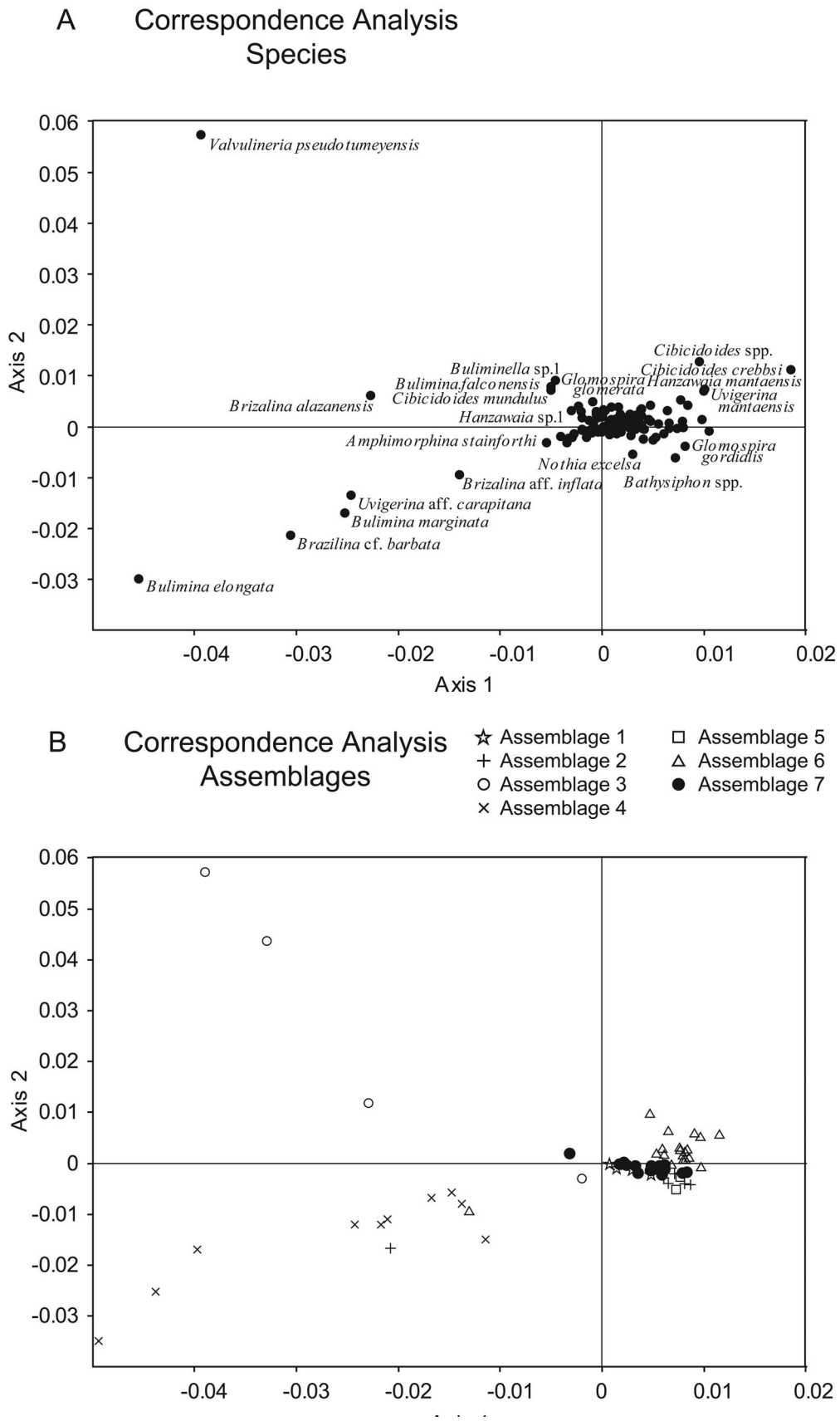
Morphogroup analysis of agglutinated foraminifera (text-fig. 10) shows the tubular group M1 making up about 50% of assemblages. According to Jones and Charnock (1985), basing their morphogroup analysis on numerous sites from the northeast Atlantic, the tubular suspension-feeding group only start to dominate by 'middle bathyal, 1000-1650m' where they make up 50% of the agglutinated fauna. In addition, their morphogroups B (surface-dwellers) and C (infauna) make up the majority of the remaining assemblage, which is in agreement with our equivalent groups M2a, M2b, M3a and M4b. It remains a strong possibility however that these morphogroups (especially M1) are not depth-dependent but rather responding to changes in the substrate.

Paleoecology and Paleoceanography

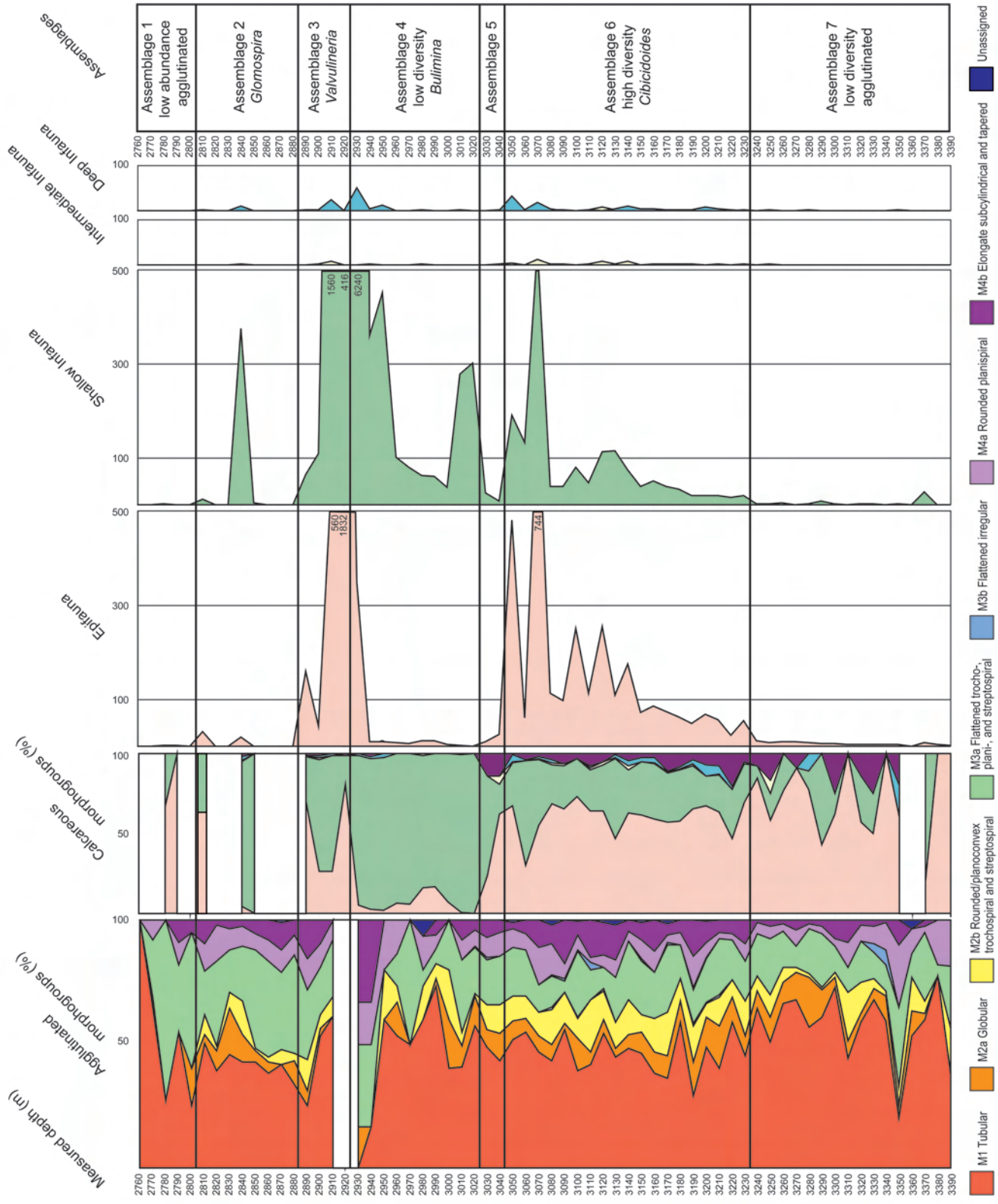
Paleoenvironments appear to have been largely conducive for foraminiferal growth as evidenced by the wide diversity and abundances observed in most samples, a phenomenon also recorded in many other comparable turbiditic fan environments (e.g. Brouwer 1965 – Europe; Jones 1999 – North Sea; Fontanier et al. 2005 – Bay of Biscay). In deep-sea environments, factors affecting foraminiferal populations include organic matter input and dissolved oxygen in pore waters (Jorissen et al. 1995; Altenbach et al. 1999; Preece et al. 1999; Van der Zwaan et al. 1999; Gooday et al. 2000), level of the Calcite Compensation Depth (CCD) and energy levels in the benthic boundary layer (Kaminski 1985; Schmiedl et al. 1997).



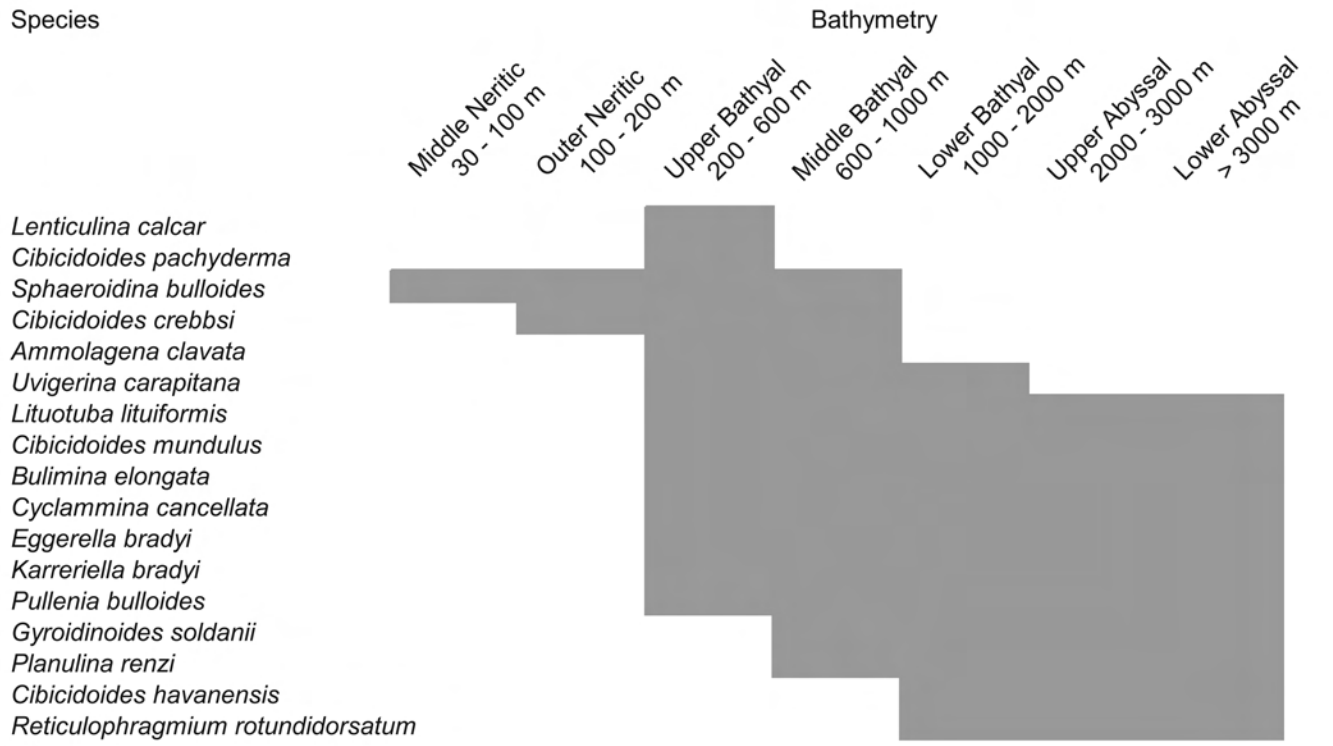
TEXT-FIGURE 8
Ranges of selected commonly occurring foraminifera against depth and assemblages. Dashed lines indicate sporadic occurrence.



TEXT-FIGURE 9
Results of Correspondence Analysis for all species and samples in this study. Samples are shown by symbol, relating to the assemblage they belong to. Results reveal the clustering of samples from each assemblage, adding statistical evidence for assemblages designated in this study.



TEXT-FIGURE 10
Results of morphogroups as percentage of total fauna for agglutinated and calcareous foraminifera. Absolute abundances of calcareous morphogroups also given. The significant switch from epifaunal-dominated assemblages to shallow infaunal-dominated assemblages at 3030m is interpreted as OMZ expansion.



TEXT-FIGURE 11
Palaeobathymetric ranges of important species from the Miocene section of the study well. Species such as *C. crebbsi* and *C. havanensis* are persistent throughout most of the section, suggesting palaeobathymetry did not change significantly over this interval. Ranges compiled from Van Morkhoven et al. (1986), Picou et al. (1999), Kaminski and Gradstein (2005) and Jones (1994).

Altenbach et al. (1999) and Licari and Mackensen (2005) recorded productivity variations, and their associated changes to levels of organic matter and oxygen at the sea-floor, as the only significant environmental variable at all latitudes in the Atlantic and offshore West Africa today. Larger studies of Recent benthic foraminifera from the southeastern Atlantic (Schmiedl et al. 1997) reveal organic carbon / oxygen levels, carbonate corrosiveness, and energy levels to be the principle factors affecting deep-sea communities. Preece et al. (1999) found variations in TOC (Total Organic Carbon) through a Miocene section of the Congo Fan to be the major factor explaining faunal fluctuations through time, this phenomenon ultimately related to benthic oxygen levels. Jones (2006) summarised foraminiferal distributions within deep-sea fan environments as commonly composed of autochthonous agglutinated '*Rhabdammina* faunas' and transported allochthonous shelfal faunas, relating to hemipelagic-dominated and turbidite-dominated sedimentation respectively. The low sedimentation rate hemipelagic horizons, also referred to as condensed sections, can act as mudstone cap-rocks. A significant intra-Aquitanian cap-rock has been identified from many sections offshore West Africa (Jones 2006), and may coincide with the base of the studied section, and the poorly age-constrained massive short-term progradation/retrogradation event reported by Anka and Seranne (2004). The foraminiferal faunas described in this study are believed to be largely *in situ* due to the nature of the foraminifera (see Paleobathymetry), an interpretation also supported by the fine grain size of the sediment.

We observe, in both the Low Diversity Agglutinated Assemblage 7 (3390-3240m) and the Low Abundance Assemblage 1 (2800-2760m, text-fig. 6), a reduction in abundance and diversity at levels of increased sand content, and propose that the associated increased energy levels caused environmental deterioration (Table 3). A significant reduction in sand content from depths 3230m up-section corresponds with a significant increase in diversity and appears to be a sedimentological change perhaps relating to a shift from higher energy (largely silt-loaded) turbidites to lower energy turbidites. The following High Diversity *Cibicidoides* Assemblage 6 (3230-3050m) probably represents a period of relatively stable, well-oxygenated, low-energy conditions associated with a good supply of organic matter, as high diversity and morphogroup distributions suggest. Morphogroup results from this section (text-fig. 10) show a dominance of the calcareous Epifaunal morphogroup which lends evidence for well-oxygenated bottom waters. Abundance generally increases towards the top of this interval (3120-3050m), which may be the result of condensed sections as Haq et al. (1987) records major sea-level fluctuations at the beginning of the Early Miocene (around 15 and 16 Ma). Increased abundance levels can also be the result of decreased predation caused by reduced oxygen levels. We regard this as unlikely due

to the epifaunal nature of the assemblages. Agglutinated Assemblage 5 (3040-3030m) shows a reduction in diversity due to the removal of the calcareous foraminifera (agglutinated diversity remains high), and may be caused by a locally reduced CCD rather than reduced oxygen.

The following *Bulimina* Assemblage 4 (3020-2930m) coincides with much-reduced diversity and is therefore the result of a more stressed ecological environment. Morphogroup analysis shows the calcareous Shallow Infauna dominates, suggesting lower oxygen. This may be the result of productivity changes and / or sluggish bottom-water circulation. We regard the former to be more likely as this interval also coincides with global cooling (text-fig. 5), a phenomenon known to increase upwelling in the southeastern Atlantic during glacial periods due to an increase in Trade Wind strength (e.g. Stuut et al. 2002). The following *Valvulineria pseudotumeyensis* Assemblage 3 (2920-2890m) shows continuing low diversity and a resurgence of the Epifaunal morphogroup largely due to the dominance of the species *V. pseudotumeyensis*. Low diversity and faunal dominance is characteristic of stressed environments and suggests a continuation of low oxygen conditions.

Glomospira Assemblage 2 (2880-2810m) shows continuing low diversity, partly caused by the removal of the calcareous assemblage. Agglutinated morphogroups show a reduced domination of tubular suspension-feeders (M1), and also an increase in the flattened surficial epifaunal group (M3a) mainly the result of increased *G. charoides*, *G. gordialis* and *G. irregularis*. The species *G. charoides* has been found to respond positively to high organic matter flux from levels termed the '*Glomospira* facies' (also including the species *G. gordialis* and *G. irregularis*) in the North Atlantic, Mediterranean and Alpine-Carpathian Flysch in the Early Eocene (see Kaminski and Gradstein 2005). Conversely, this species has been recorded at oligotrophic levels of reduced organic matter flux in the Mediterranean (De Rijk et al. 2000). Kaminski (1988) also found *G. charoides* in high abundance close to natural hydrocarbon seeps in the Gulf of Mexico, and Jonasson et al. (1995) recorded high levels of *G. gordialis* near a hydrothermal venting site in the northeast Pacific. In this setting, coupled with low diversity, we regard an increase in these species to indicate continuing low oxygen and high organic carbon flux conditions.

The fluctuating content of calcareous versus agglutinated foraminifera within samples is not easily explained by the discussed environmental changes to productivity, oxygen levels and organic carbon, and may well be the result of changing bottom-water chemistry affecting and changing the local CCD. We would not necessarily expect the Early-Middle Miocene CCD to be around 1000m (today's depth is 4-5km in the Atlantic), but it has been observed that, in high-sedimentation rate fan environments, agglutinated faunas often dominate (e.g. Kaminski et al. 1988; Jones 1999; Kender et al. 2005; Jones 2006). These environments exhibit high sedimentation rates and large quantities of terrestrially-derived organic carbon, the rapid burial and oxygenation of which is proposed by Jones (1999) to release acids incompatible with calcite preservation. Certainly this environment would be more inhospitable for the generally more specifically adapted calcareous foraminifera. Within this context, a slight reduction of acidity to bottom-waters could cause increased calcite preservation. Indeed better preservation of calcite tests worldwide at this time is observed, and postulated to be the result of lowering ocean acidity related to increased carbon burial (Woodruff and Savin 1991; Pagani et al. 1999) during the Monterey Carbon Isotope Excursion (Vincent and Berger 1985).

CONCLUSIONS

The 630m section analysed in this study has been found to range from Early Miocene (Zone N5, Aquitanian / Burdigalian) to Middle Miocene (N9, Langhian) by the occurrence of planktonic foraminifera *O. universa*, *G. bisphericus*, and *P. mayeri*, spanning the oxygen isotope event Mi2 (Miller et al 1991) at 16.3 Ma identified from the $\delta^{18}O$ record. Benthic foraminifera reveal taxonomically diverse open-ocean assemblages showing strong affinities with faunas from the Gulf of Mexico and Central Paratethys.

Benthic foraminiferal assemblages, defined with the help of morphogroup analysis and Correspondence Analysis, reveal a changing fauna affected by three tiers of forcing parameters: sedimentology and energy levels in the benthic boundary layer; oxygen fluctuations and changes to surface water productivity; ocean chemistry and shifts in CCD through time. The majority of the section contains shales representing a relatively stable environment with turbiditic sedimentation rates in the order of 10 cm/kyr. Within this interval a dramatic shift from epifaunal-dominated to shallow infaunal-dominated benthic foraminifera, at approximately 15.5 Ma, probably represents an expansion of the oxygen minimum zone related to global cooling and increased wind-strength and the associated increased upwelling in this region. Paleobathymetric estimates reveal a paleodepth of around 1000m (middle to lower bathyal) at this time.

Changes in the percentage of calcareous benthic foraminifera over the section are thought to relate to changing ocean water chemistry affecting CCD levels, caused by the documented reduction in CO_2 over this period (Woodruff and Savin 1991; Pagani et al. 1999), coinciding with the Monterey Carbon Isotope Excursion, and reducing ocean water acidity.

ACKNOWLEDGMENTS

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TAXONOMY

The following species of benthic foraminifera have been arranged in taxonomic order using the suprageneric classifications of Loeblich and Tappan (1987) for calcareous-walled taxa, and Kaminski (2004) for agglutinated. Species identifications have been based in large part on the taxonomic works of Kohl (1985), Papp and Schmid (1985), Van Morkhoven et al. (1986), Boersma (1984), Kaminski and Geroch (1993) and Kaminski and Gradstein (2005). Planktonic foraminifera are arranged in alphabetical order by genus. Species identifications have been based largely on the taxonomic works of Kennett and Srinivasan (1983), Bolli and Saunders (1985) and Spezzaferri (1994).

Family RHABDAMMINIDAE Brady 1884
Subfamily RHABDAMMINININAE Brady 1884
Genus *Rhabdammina* M. Sars in Carpenter 1869

Rhabdammina cylindrica Glaessner 1937
Plate 1, fig. 1

Rhabdammina cylindrica GLAESSNER 1937, p. 354, pl. 1, fig. 1.
Rhabdammina cylindrica Glaessner. – KUHNT and PLETSCH 2001, p. 306, pl. 1, figs 2-3, pl. 2, figs 1-4, pl. 3, figs1-4.

Occurrence: 262 specimens from 41 samples.

Description: Test tubular, medium to large in size, circular in cross section, wall thick, composed of several layers of coarse to very coarse angular sand grains, surface rough, aperture a simple terminal opening.

Remarks: Originally described from the Tertiary of the Caucasus, this species occurs with high abundance in the studied samples, but is always broken into small lengths approximately three times as long as wide.

Rhabdammina linearis Brady 1879
Plate 1, fig. 2

Rhabdammina linearis BRADY 1879, p. 37, pl. 3, figs 10-11. – KAMINSKI and GRADSTEIN 2005, p. 124, pl. 7, figs 1a-8.

Occurrence: 6 specimens from 3 samples.

Description: Test tubular, with inflated portion forming a bulge midway, medium to large in size, circular in cross section, wall thick, composed of several layers of coarse to very coarse angular sand grains, surface rough, aperture a simple terminal opening.

Remarks: Originally described from the Recent of the South Atlantic, it is a cosmopolitan form that ranges from the Cretaceous to Recent. Specimens of this species are always broken into small lengths approximately three times as long as wide.

***Rhabdammina* sp. 1**
Plate 1, fig. 3

Occurrence: 162 specimens from 23 samples.

Description: Test tubular, medium to large in size, circular in cross section, invariably flattened, wall medium thickness, composed of several layers of coarse to very coarse angular sand grains, surface rough, aperture a simple terminal opening.

Remarks: We have placed in this category all the described forms, which are invariably broken into small lengths of varying sizes.

***Rhabdammina* spp.**
Occurrence: 368 specimens from 38 samples.

Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test tubular, wall thick to medium, size small to large, grainsize fine to coarse, occasionally branching.

Remarks: Specimens in this category are always broken and fragmentary.

Subfamily BATHYSIPHONINAE Avnimelech 1952
Genus *Bathysiphon* Sars 1872

***Bathysiphon* spp.**
Plate 1, fig. 4

Occurrence: 635 specimens from 37 samples.

Description: Included in this group are all forms displaying the following characteristics: test tubular, wall thick to medium, size small to large, grainsize fine, wall smooth, slight regular constrictions present, non-branching, aperture a simple terminal opening.

Remarks: Specimens in this category are always broken and fragmentary.

Subfamily BATHYSIPHONINAE Avnimelech 1952
Genus *Nothia* Pflaumann 1964

Nothia excelsa (Grzybowski 1898)
Plate 1, fig. 5

Dendrophrya excelsa GRZYBOWSKI, p. 272, pl. 10, figs 2-4.
Nothia excelsa (Grzybowski). – GEROCH and KAMINSKI 1992, p. 255, pl. 1, figs 1-4, pl. 2, figs 1-11. – KAMINSKI and GRADSTEIN 2005, p. 106, pl. 2A, figs 1-9, pl. 2B, figs 1-11.

Occurrence: 306 specimens from 23 samples.

Description: Test tubular, medium size, rarely branching, usually straight to slightly curved, flattened, wall thin, coarse, moderately rough finish, aperture a simple terminal opening.

Remarks: Originally reported from the Eocene of the Polish Carpathians, this species has been recorded from many Paleogene localities containing tubiditic deep-sea sediments.

Nothia latissima (Grzybowski 1898)
Plate 1, fig. 6

Dendrophrya latissima GRZYBOWSKI, p. 273, pl. 10, fig. 8.
Nothia latissima (Grzybowski). – KAMINSKI and GEROCH 1993, p. 245, pl. 1, figs. 1a-c, 14a,b. – KAMINSKI and GRADSTEIN 2005, p. 113, pl. 3, figs 1-4b.

Occurrence: 28 specimens from 4 samples.

Description: Test tubular, medium size, rarely branching, usually straight to slightly curved, flattened, wall thin, medium sized grains, finish moderately rough, aperture a simple terminal opening.

Remarks: Originally reported from the Paleogene of the Polish Carpathians, this species has been recorded from many Cretaceous to Paleogene localities containing tubiditic deep-sea sediments.

Nothia robusta (Grzybowski 1898)
Plate 1, fig. 7

Dendrophrya robusta GRZYBOWSKI, p. 273, pl. 10, fig. 7.
Nothia robusta (Grzybowski). – GEROCH and KAMINSKI 1992, pl. 1, figs. 1-4, pl. 2, figs. 1-11. – KAMINSKI and GRADSTEIN 2005, p. 116, pl. 4, figs 1-8.

Occurrence: 24 specimens from 8 samples.

Description: Test very large, robust, tubular, rarely branching, no constrictions or inflations, usually straight to slightly curved,

usually flattened with a median furrow, wall thick, medium sized grains, finish usually smooth, wall sometimes contains randomly oriented sponge spicules, aperture a simple terminal opening.

Remarks: Originally described from the Eocene of the Polish Carpathians, this species is very common in deep sea turbiditic sediments, is cosmopolitan in distribution, and has been reported from sediments ranging from the Late Cretaceous to Lower Miocene in age.

***Nothia* spp.**
Occurrence: 504 specimens from 41 samples.

Description: Included in this group are all forms displaying the following characteristics: test tubular, small to large in size, fragmented, with a thin and therefore much flattened wall, grain size fine to coarse, finish usually rough.

Family RHIZAMMINIDAE Brady 1879
Genus *Rhizammina* Brady 1879

***Rhizammina* spp.**
Plate 1, fig. 8

Occurrence: 437 specimens from 38 samples.

Description: Included in this group are all forms displaying the following characteristics: test tubular, small in size, fragmented, with a very thin and delicate wall and irregular outline, grain size medium to coarse, finish usually rough.

Family SACCAMMINIDAE Brady 1884
Subfamily SACCAMMININAE Brady 1884
Genus *Saccammina* Carpenter 1869

Saccammina* cf. *sphaerica Sars 1872
Plate 1, fig. 9

Saccammina sphaerica SARS 1872, p. 250. – BRADY 1884, p. 253, pl. 18, figs 11-15. – CHARNOCK and JONES 1990, pl. 1, fig. 3.
Saccammina cf. *sphaerica* Sars. – KAMINSKI et al. 2005, p. 392.

Occurrence: 258 specimens from 42 samples.

Description: Test medium size, single chamber, inflated, globular, spherical, wall thin and composed of several layers of quartz grains, test flattened and depressed, grainsize medium, surface texture rough, aperture a small opening on a raised neck.

Remarks: Originally described from the Recent of Norway, this species is a cosmopolitan form that has been reported from the Miocene. Our specimens differ form the original *description* by having a generally smaller grain size.

***Saccammina* sp. 1**
Plate 1, fig. 10

Occurrence: 52 specimens from 19 samples.

Description: Test medium to large in size, single chamber, inflated, globular, spherical, wall thick and composed of several layers of quartz grains, test flattened and depressed, grainsize medium, surface texture relatively smooth, aperture a small opening on a raised neck.

Remarks: Differs from *S. sphaerica* by having a much thicker wall.

***Saccammina* spp.**

Occurrence: 4 specimens from 2 samples.

Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test single chambered, sphaerical, small to large in size, fine to medium grained.

Family PSAMMOSPHAERIDAE Haeckel 1894
Subfamily PSAMMOSPHAERINAE Haeckel 1894
Genus *Psammosphaera* Schulze 1875

***Psammosphaera* sp. 2**
Plate 1, figs 12,13

Occurrence: 149 specimens from 32 samples.

Description: Test small to medium in size, single chamber, inflated, globular, spherical, wall thin, composed of several layers of quartz grains, test flattened and depressed, grainsize medium to coarse, surface texture rough, aperture small openings in between sand grains.

***Psammosphaera* sp. 1**

Occurrence: 1 specimens from 1 samples.

Description: Test small to medium in size, single chamber, inflated, globular, spherical, wall thick, composed of several layers of quartz grains, test flattened and depressed, grainsize medium, surface texture smooth, aperture small openings in between sand grains.

Remarks: Differs from *Psammosphaera* sp. 2 in having a much thicker wall.

***Psammosphaera* spp.**

Occurrence: 4 specimens from 3 samples.

Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test single chambered, small to large, coarse grained.

Family HIPPOCREPINIDAE Rhumbler 1895
Subfamily HIPPOCREPININAE Rhumbler 1895
Genus *Jaculella* Brady 1879

***Jaculella* sp. 1**
Plate 1, fig. 14

Occurrence: 1 specimen from 1 sample.

Description: Test tubular, tapering, conical, wall of medium thickness, comprising several layers of medium sized quartz grains, surface with a rough finish.

Family HYPERAMMINIDAE Eimer and Fickert 1899
Subfamily HYPERAMMININAE Eimer and Fickert 1899
Genus *Hyperammina* Brady 1878

Hyperammina elongata Brady 1878
Plate 1, fig. 15

Hyperammina elongata BRADY 1878, p. 433, pl. 1, figs 16,18,19. – JONES 1994, p. 33, pl. 23, fig. 8. – KAMINSKI et al. 2005, p. 386, pl. 1, figs 16,18,19.

Occurrence: 17 specimens from 5 samples.

Description: Test medium to large in size, single inflated proloculus followed by a single tube, somewhat irregular in appearance, wall of medium thickness and composed of several layers of quartz grains, test usually flattened and depressed, grainsize coarse, surface texture rough, aperture a simple opening at the end of the tubular section.

Remarks: Originally described from the Recent of the Arctic Ocean, this species has also been recorded from Miocene sediments of the Greenland Sea.

***Hyperammina* spp.**

Occurrence: 6 specimens from 6 samples.
Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test elongate, single inflated proloculus followed by a single tube, test usually flattened and depressed, grainsize fine to coarse, aperture a simple opening at the end of the tubular section.

Family AMMODISCIDAE Reuss 1862
Subfamily AMMODISCINAE Reuss 1862
Genus *Ammodiscus* Reuss 1862

Ammodiscus cretaceus (Reuss 1845)
Plate 1, fig. 16, Plate 2, fig. 5

Operculina cretacea REUSS 1845, p. 35, pl. 13, figs 64-65.
Ammodiscus cretaceus (Reuss). – CUSHMAN 1934, p. 45. – KAMINSKI and GRADSTEIN 2005, p. 147, pl. 14, figs 1a-10.

Occurrence: 17 specimens from 9 samples.

Description: Test medium to large in size, planispiral, evolute, single chamber increasing in size gradually as grown, eight to eleven coils in the adult form, chamber somewhat inflated, sutures distinct, slightly depressed, surface smooth, with radial growth lines visible, wall thick, aperture a simple terminal opening.

Remarks: Originally described from the Late Cretaceous of the Czech Republic, this species has been reported from Cretaceous to Eocene deep-water turbidite deposits from many localities.

Ammodiscus glabratus Cushman and Jarvis 1928
Plate 2, fig. 5

Ammodiscus glabratus CUSHMAN and JARVIS 1928, p. 87, pl. 12, fig. 6. – KAMINSKI and GRADSTEIN 2005, p. 148, pl. 15, figs 1-6.

Occurrence: 1 specimen from 1 sample.

Description: Test medium to large in size, planispiral, biconcave, evolute, single chamber increasing in size gradually as grown, chamber inflated, increasing in thickness rapidly as grown, sutures slightly depressed, surface smooth, wall thick, aperture a simple terminal opening.

Remarks: Originally described from the Paleogene of Trinidad, this species has been described from many localities ranging from Maastrichtian to Eocene in age.

Ammodiscus latus Grzybowski 1898
Plate 1, fig. 17

Ammodiscus latus GRZYBOWSKI 1898, p. 282, pl. 10, figs 27-28. – KAMINSKI and GRADSTEIN 2005, p. 152, pl. 16a, figs 1-8, p. 153, pl. 16b, figs 1-6.

Occurrence: 100 specimens from 26 samples.

Description: Test medium to large in size, planispiral, evolute, single chamber increasing in size gradually as grown, few coils, three to five in adult, chamber much inflated, large, sutures depressed, surface with a rough texture, wall medium thickness, aperture a simple terminal opening.

Remarks: Originally described from the Eocene of the Polish Carpathians, this species has been recorded from the Eocene to Oligocene of the Tethys, and up to the Middle Miocene of the Arctic.

Ammodiscus* aff. *peruvianus
Plate 2, figs 1,2

Ammodiscus peruvianus BERRY 1928, p. 342, fig. 27. – KENDER et al. 2005, p. 261, pl. 10, fig. I. – KAMINSKI and GRADSTEIN 2005, p. 157, pl. 18, figs 1-6.

Occurrence: 8 specimens from 4 samples.

Description: Test of medium size, planispiral, evolute, elongated along the long axis, biconcave, single chamber increasing in size gradually as grown, few coils, chamber much inflated, large, sutures depressed, surface with a smooth texture, wall medium thickness, aperture a simple terminal opening.

Remarks: Originally described from the Eocene of Peru, this is a cosmopolitan species recorded from many localities of Cretaceous to Eocene age. Our specimens differ from the original *description* in having a slightly larger and more inflated chamber.

***Ammodiscus* sp. 3**
Occurrence: 2 specimens from 1 sample.

Description: Test small in size, planispiral, evolute, single chamber increasing in size gradually as grown, chamber thin, sutures slightly depressed, surface with a rough texture, wall thin, aperture a simple terminal opening.

Remarks: This species is characterized by it's very small size and thin wall.

***Ammodiscus* spp.**
Occurrence: 6 specimens from 5 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test planispiral, generally round in outline, evolute, one chamber increasing in size as grown, aperture a terminal opening.

Subfamily TOLYPAMMININAE Cushman 1928
Genus *Ammolagena* Eimer and Fickert 1899

Ammolagena clavata (Jones and Parker 1860)
Plate 2, figs 4-6, Plate 12, fig. 9

Trochammina irregularis (d'Orbigny) var. *clavata* JONES and PARKER 1860, p. 304.
Ammolagena clavata (Jones and Parker). – KAMINSKI and GRADSTEIN 2005, p. 165, pl. 21, figs 1-6.

Occurrence: 24 specimens from 12 samples.

Description: Test attached, medium to large in size, initial proloculus ovoid, followed by an undivided elongate irregular meandering tube-like chamber, inflated, not increasing in size, wall smooth, thin so that it is usually depressed, growth lines can sometimes be seenm, two apertures, one at the terminus of the initial proloculus as a simple opening surrounded by a lip, one at the termination of the tube extension, simple opening.

Remarks: Originally recorded from the Recent of the Mediterranean, this species has a long range from the Early Cretaceous and is common in deep sea environments from both the Pacific and the Atlantic.

Genus *Tolypammina* Rhumbler 1895

***Tolypammina* spp.**
Plate 2, figs 7,8

Occurrence: 241 specimens from 32 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test unilocular, undivided elongate tube, small, very irregular meandering, wall thin, fine grained, aperture a simple terminal opening.

Subfamily USBEKISTANIINAE Vyalov 1977
Genus *Glomospira* Rzehak 1885

Glomospira charoides (Jones and Parker 1860)
Plate 2, fig. 9

Trochammina squamata Jones and Parker var. *charoides* JONES and PARKER 1860, p. 304.
Glomospira charoides (Jones and Parker). – BERGGREN and KAMINSKI 1990, pl. 1, fig. 2. – KAMINSKI and GRADSTEIN 2005, p. 173, pl. 22, figs 1-16.

Occurrence: 244 specimens from 50 samples.

Description: Test rounded in outline, initial proloculus followed by a single undivided chamber, trochospirally enrolled about the axis, about three layers of enrolment, last whorl occasionally deviates from the general coiling, wall smooth, aperture simple opening at the terminus of the tube.

Remarks: This species is a cosmopolitan form described from many localities of Jurassic to Recent age.

Glomospira glomerata (Grzybowski 1898)
Plate 2, fig. 10

Ammodiscus glomeratus GRZYBOWSKI 1898, p. 285, pl. 11, fig. 4.
"Glomospira" glomerata (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 179, pl. 24, figs 1-6.

Occurrence: 24 specimens from 7 samples.

Description: Test irregular in shape, comprised of a single undivided chamber, coiled in a repeated open S-shape, or irregularly, not enrolled, wall coarse, thick, surface with a rough finish, aperture a terminal opening.

Remarks: Originally described from the Eocene of the Polish Carpathians, this species is a cosmopolitan deep-water form recorded from Late Cretaceous to Oligocene sediments.

Glomospira gordialis (Jones and Parker 1860)
Plate 2, fig. 11

Trochammina squamata Jones and Parker var. *gordialis* JONES and PARKER 1860, p. 304.
Glomospira gordialis (Jones and Parker). – BERGGREN and KAMINSKI 1990, pl. 1, fig. 1.
– KAMINSKI and GRADSTEIN 2005, p. 184, pl. 25, figs 1-8.

Occurrence: 512 specimens from 53 samples.

Description: Test rounded in outline, compressed, with initial hidden small proloculus followed by a single undivided chamber trochospirally enrolled for one layer, then glomospirally coiled along a general plane, last whorl occasionally deviates from the general coiling, wall smooth, aperture simple opening at the terminus of the tube.

Remarks: Originally described from the Recent of the Indian Ocean and Arctic Sea, this species is a cosmopolitan deep-water form recorded from Late Cretaceous to Recent sediments.

Glomospira irregularis (Grzybowski 1898)
Plate 2, fig. 12

Ammodiscus irregularis GRZYBOWSKI 1898, p. 285, pl. 11, figs 2, 3.
Glomospira irregularis (Grzybowski). – KAMINSKI and GEROCH 1993, p. 256, pl. 6, fig. 6-8b. – KAMINSKI and GRADSTEIN 2005, p. 187, pl. 26, figs 1a-7.

Occurrence: 184 specimens from 41 samples.

Description: Test irregular in outline, consisting a single undivided chamber, streptospirally enrolled, somewhat irregular in appearance, wall rough, aperture simple opening at the terminus of the tube.

Remarks: Originally described from the Eocene of the Polish Carpathians, this species is a cosmopolitan deep-water form recorded from Jurassic to Recent sediments.

Glomospira* aff. *serpens (Grzybowski 1898)
Plate 2, fig. 13

Ammodiscus serpens GRZYBOWSKI 1898, p. 285, pl. 10, fig. 31.
Glomospira serpens (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 187, pl. 26, figs 1a-7.

Occurrence: 2 specimens from 2 samples.

Description: Test flattened ovate in outline, consisting a single undivided chamber elliptically enrolled, milioline-like, arranged around a central axis at 60 degree angles to the preceeding whorls, chamber inflated, wall smooth, of medium thickness, aperture simple opening at the terminus of the tube.

Remarks: Differs from the original *description* by having wider chamber with thinner wall. *G. serpens* was originally described from the Eocene of the Polish Carpathians. This species is a cosmopolitan deep-water form recorded from Cretaceous to Eocene sediments.

***Glomospira* sp. 1**
Plate 2, fig. 14

Glomospirella sp. SCHRÖDER et al. 1988, p. 32, pl. 4, fig. 15.
Glomospira charoides ssp. 1 BENDER 1995, p. 45, pl. 3, fig. 3.

Occurrence: 22 specimens from 11 samples.

Description: Test rounded in outline, compressed, with initial hidden small proloculus followed by a single undivided chamber trochospirally enrolled for only the first whorl, then glomospirally coiled along a general plane almost planispiral,

last whorl deviates slightly from the general coiling, chamber thin, wall smooth, aperture simple opening at the terminus of the tube.

Remarks: Differs from *G. gordialis* in having a much smaller initial trochospiral part. Described from offshore Ivory Coast and Ghana, and the south Pacific.

***Glomospira* sp. 2**
Plate 2, fig. 15

Occurrence: 2 specimens from 2 samples.

Description: Test large, rounded in outline, compressed, with initial proloculus followed by a single undivided chamber trochospirally enrolled for only the first whorl, then glomospirally coiled along a general plane almost planispiral, chamber thick, wall rough, grainsize coarse, aperture simple opening at the terminus of the tube.

Remarks: Differs from Glomospira sp. 1 in having a much coarser wall and thicker chamber.

***Glomospira* spp.**
Occurrence: 5 specimens from 4 samples.

Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test single undivided chamber, not increasing rapidly in size, coiled trochospiral or irregular.

Family HORMOSINELLIDAE Rauser and Reitlinger 1986
Genus *Hormosinella* Shchedrina 1969

Hormosinella carpenteri (Brady 1884)
Plate 2, fig. 16

Trochammina (Hormosina) carpenteri BRADY 1881, p. 51 [no figure given].
Hormosina carpenteri BRADY 1884, pl. 31, figs 16-22 [earliest figure].
Hormosinella carpenteri (Brady). – JONES 1994, p. 44, pl. 39, figs 14-18.

Occurrence: 1 specimen from 1 sample.

Description: Test large, uniserial, elongate chambers, tapering towards the terminal end, wall coarse, with a rough texture, aperture a terminal simple opening.

Remarks: Originally described from the Recent of the Atlantic.

Genus *Reophanus* Saidova 1970

Reophanus* aff. *berggreni Gradstein and Kaminski 1997
Plate 3, figs 1,2

Reophanus berggreni GRADSTEIN and KAMINSKI 1997, p. 220, textfig. 4, fig. 5 1-7b. – KAMINSKI and GRADSTEIN 2005, p. 265, pl. 50, figs 1-7.

Occurrence: 4 specimens from 3 samples.

Description: Test very large, uniserial, chambers rounded to oval in outline, wall coarse, with a rough texture, aperture a terminal simple opening.

Remarks: Originally described from the Oligocene of the North Sea, this species occurs only as large fragments. Also described from the Miocene of the Fram Strait, Greenland Sea. Our specimens differ from the original in having a coarser grainsize.

Family HORMOSINELLIDAE Rauser and Reitlinger 1986
Genus *Subreophax* Saidova 1975

Subreophax scalaris (Grzybowski 1896)
Plate 3, figs 3,4

Reophax guttifera Brady var. *scalaria* GRZYBOWSKI 1896, p. 277, pl. 8, fig. 26.
Subreophax scalaris (Grzybowski). – KAMINSKI, GRADSTEIN, BERGGREN, GEROCH and BECKMANN 1988, p. 187, pl. 2, figs 16-17.
Reophax scalaris (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 279, pl. 55, figs 1-7.

Occurrence: 110 specimens from 35 samples.

Description: Test small, uniserial, elongate rectilinear or sinuous, chambers increasing in size only slowly, rounded globular, collapsed, sutures depressed, wall thin, rough texture, aperture a simple terminal opening.

Remarks: Originally described from the Late Cretaceous of the Polish Carpathians, this species has been also been recorded from many Cretaceous to Oligocene localities including Trinidad and the Labrador Sea.

***Subreophax* sp. 1**
Plate 3, fig. 6

Occurrence: 1 specimen from 1 sample.

Description: Test uniserial, elongate rectilinear, chambers increasing in size only slowly, slightly globular, sutures slightly depressed, chamebrs collepsed, wall thin, rough taxture, aperture a simple terminal opening.

Family ASCHEMOCELLIDAE Vyalov 1966
Genus *Aschemocella* Vyalov 1966

Aschemocella grandis (Grzybowski 1898)
Plate 3, fig. 5

Reophax grandis GRZYBOWSKI 1898, p. 277, pl. 10, figs 13-15.
Aschemocella grandis (Grzybowski). – KAMINSKI and GEROCH 1993, p. 249, pl. 2, figs 8-10. – KAMINSKI and GRADSTEIN 2005, p. 229, pl. 39, figs 1-8b.

Occurrence: 60 specimens from 16 samples.

Description: Test large, uniserial, chambers not increasing in size as added, rounded globular, collapsed, sutures much depressed, wall thin, rough texture, aperture a small simple terminal opening on a slight neck.

Remarks: Usually recovered as single chambers, this species has a propensity to break along the sutures. It was originally described from the Paleocene of the Polish Carpathians, as is known also from Trinidad, the North Sea, Labrador Sea and Morocco. Ranges from the Campanian to Lower Miocene.

Genus *Kalamopsis* de Folin 1883

***Kalamopsis* spp.**
Plate 3, fig. 7

Occurrence: 4 specimens from 2 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test

elongate rectilinear, of medium size, chambers tubular, sutures slightly depressed, wall thick, surface usually smooth.

Family REOPHACIDAE Cushman 1927
Genus *Hormosinelloides* Saidova 1975

Hormosinelloides guttifer (Brady 1884)
Plate 3, fig. 8

Reophax guttifer BRADY 1881, p. 49 [no figure given].
Reophax guttifer BRADY 1884, pl. 31, figs 10-15 [earliest figure].
Hormosinelloides guttifer (Brady). – ZHENG and FU 2001.
Occurrence: 1 specimen from 1 sample.

Description: Test medium size, uniserial, chambers pyriform, collapsed, attached by a short stolon, sutures depressed, wall thin, rough texture, aperture a small simple terminal opening on a slight neck.

Remarks: Originally described from the Recent of the South Atlantic, this is a cosmopolitan species recorded from Late Cretaceous to Recent deep-sea sediments.

Genus *Reophax* de Montfort 1808

Reophax pilulifer (Brady 1884)
Plate 3, fig. 9

Reophax pilulifer BRADY 1884, p. 292, pl. 30, figs 18-20. – KAMINSKI and GRADSTEIN 2005, p. 273, pl. 53, figs 1a-9.

Occurrence: 10 specimens from 6 samples.

Description: Test medium to large in size, uniserial, straight to arcuate, up to five chambers in adult, chambers rounded globular, increasing in size rapidly as added, collapsed, sutures depressed, wall coarse grained, single-layered, rough texture, aperture a small simple terminal opening on a slight shoulder.

Remarks: Originally described from the Recent of the North Atlantic, this is a long ranging cosmopolitan species recorded from all the major oceans.

***Reophax* spp.**
Occurrence: 2 specimens from 1 sample.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test uniserial, elongate, multilocular.

Family HORMOSINIDAE Haeckel 1894
Subfamily HORMOSININAE Haeckel 1894
Genus *Hormosina* Brady 1879

Hormosina glabra Cushman and Stainforth 1945
Plate 3, fig. 10

Hormosina glabra CUSHMAN and STAINFORTH 1945, p. 14, pl. 1, fig. 9.

Occurrence: 20 specimens from 12 samples.

Description: Test medium to large in size, uniserial, rectilinear, chambers numerous, pyriform globular, increasing in size gradually as added, collapsed, sutures slightly depressed, wall thick, fine grained, smooth texture, aperture a small simple terminal opening on a slight shoulder.

Remarks: Originally described from the Middle Miocene of Trinidad.

Hormosina globulifera Brady 1879
Plate 3, fig. 11

Hormosina globulifera BRADY 1879, p. 60, pl. 4, figs 4-5. – CHARNOCK and JONES 1990, p. 162, pl. 4, figs 2,3, pl. 15, fig. 3. – JONES 1994, p. 44, pl. 39, figs 1-4, 6.

Occurrence: 36 specimens from 28 samples.

Description: Test medium to large in size, uniserial, straight to arcuate, up to five chambers in adult, chambers rounded globular, increasing in size sometimes rapidly, collapsed, sutures depressed, wall thick, multi-layered, medium grained, smooth texture, aperture a small simple terminal opening on a raised shoulder.

Remarks: Differs from *Reophax pilulifer* in having a multi-layered wall and finer grains. Originally described from the Recent of the North Atlantic, has also been recorded from the Paleogene of the North Sea.

Genus *Pseudonodosinella* Saidova 1970

Pseudonodosinella nodulosa
Plate 3, fig. 12

Reophax nodulosa BRADY 1879, p. 52, pl. 4, figs 7,8.
Pseudonodosinella nodulosa (Brady). – LOEBLICH and TAPPAN 1987, p. 61, pl. 46, figs 5,6. – KAMINSKI and GRADSTEIN 2005, p. 259, pl. 49, figs 1-9.

Occurrence: 1 specimen from 1 sample.

Description: Test uniserial, elongate rectilinear, chambers increasing in size only slowly, strongly embracing, subglobular, sutures depressed, wall thick, smooth texture, aperture a simple terminal opening.

Remarks: Originally described from the Recent of the South Atlantic, this species has been been recorded from Eocene to Recent sediments.

Family LITUOTUBIDAE Loeblich and Tappan 1984
Genus *Lituotuba* Rhumbler 1895

Lituotuba lituiformis (Brady 1879)
Plate 3, figs 13-15

Trochammina lituiformis BRADY 1879, p. 59, pl. 5, fig. 16.
Lituotuba lituiformis (Brady). – KAMINSKI and GRADSTEIN 2005, p. 287, pl. 58, figs 1-8.

Occurrence: 8 specimens from 5 samples.

Description: Test medium to large in size, sometimes uncoiling irregular straptospiral, chambers elongate of varying length, subglobular, sutures depressed, wall thin, smooth texture, aperture a simple terminal opening.

Remarks: Originally described from the Recent of the West Indies, this species has been been recorded from Cretaceous to Recent sediments from localities including the Pacific and South China Sea.

Genus *Paratrochamminoides* Soliman 1972

Paratrochamminoides challengeri (Rögl 1995)
Plate 3, fig. 16

Trochammina proteus (Karrer). – BRADY 1884, p. 341, pl. 40, figs 1,2 (not 3). – CUSHMAN 1910, p. 98, figs 142-144; (non Karrer).
Trochamminoides challengeri RÖGL 1995, p. 256.
Paratrochamminoides challengeri (Rögl). – KAMINSKI and KUHNT 2004, p. 280.

Occurrence: 7 specimens from 6 samples.

Description: Test medium to large in size, initially irregular streptospiral, becoming planispiral, chambers elongate of fixed length, globular, sutures depressed, wall thin, smooth texture, aperture a simple terminal opening.

Remarks: Originally described from the Recent of the West Atlantic, this species was re-described by Rögl from Brady's original figures. It has also been recorded from the Recent of the Pacific.

Paratrochamminoides deflexiformis (Noth 1912)
Plate 3, fig. 17

Trochammina deflexiformis NOTH 1912, p. 26, figs 10a-b.
Paratrochamminoides deflexiformis (Noth). – KENDER, KAMINSKI and CIESZKOWSKI 2005, p. 263, fig. 11, K1,2. – KAMINSKI and GRADSTEIN 2005, p. 293, pl. 60, figs 1-4.

Occurrence: 12 specimens from 8 samples.

Description: Test medium to large in size, oval in outline, irregular streptospiral, chambers numerous, eight to ten in the final whorl, bead-like, globular, sutures depressed, wall thin, smooth texture, aperture a simple terminal opening.

Remarks: Originally described from the Eocene of the Polish Carpathians, this species has also been recorded from the Paleogene of Morocco and Trinidad, and the Maastrichtian of the Polish Carpathians.

Paratrochamminoides gorayskiformis Kender, Kaminski and Jones 2006
Plate 3, fig. 18

Paratrochamminoides gorayskiformis KENDER, KAMINSKI and JONES 2006, p. 467, pl. 1, figs 7-10.

Occurrence: 3 specimens from 3 samples.

Description: Test oval in outline, coiling triloculine, coiled in three planes about the long axis, chambers of varying length, from elongate to distinctly bead-like, approximately five in the last whorl, wall finely agglutinated, finish smooth, wall thin, aperture at the open end of the tube.

Remarks: Originally described from the Oligocene section of the well studied in this paper.

Paratrochamminoides heteromorphus (Grzybowski 1898)
Plate 4, fig. 1

Trochammina heteromorpha GRZYBOWSKI 1898, p. 286, pl. 11, fig. 16.
Paratrochamminoides heteromorphus (Grzybowski). – KAMINSKI and GEROCH 1993, p. 258, pl. 7, figs 3-5. – KAMINSKI and GRADSTEIN 2005, p. 298, pl. 301, figs 1-10.

Occurrence: 2 specimens from 2 samples.

Description: Test large, coiling glomospiral to trochospiral, in two planes, uncoiling in later stage, chambers subglobular, bead-like, inflated, approximately six in the last whorl, wall finely agglutinated, finish relatively smooth, wall thin, aperture a simple terminal opening.

Remarks: Originally described from the Eocene of the Polish Carpathians, this species has been recorded from the Maastrichtian and Paleogene of Trinidad and Morocco.

Paratrochamminoides mitratus (Grzybowski 1901)
Plate 4, fig. 2

Trochammina mitrata GRZYBOWSKI 1901, p. 280, pl. 8, fig. 3.
Paratrochamminoides mitratus (Grzybowski). – KAMINSKI and GEROCH 1993, p. 278, pl. 16, figs 4,6. – KAMINSKI and GRADSTEIN 2005, p. 302, pl. 304, figs 1-7.
Occurrence: 1 specimen from 1 sample.

Description: Test large, coiling streptospiral to triloculine, changing direction abruptly between whorls, compact, chambers globular, bead-like, inflated, approximately six in the last whorl, wall finely agglutinated, finish relatively smooth, wall thin, aperture a simple terminal opening.

Remarks: Originally described from the Paleogene of the Polish Carpathians, this species has also been recorded from the North Sea, Trinidad and Morocco.

Paratrochamminoides olszewskii (Grzybowski 1898)
Plate 4, fig. 3

Trochammina olszewskii GRZYBOWSKI 1898, p. 298, pl. 11, fig. 6.
Paratrochamminoides olszewskii (Grzybowski). – KAMINSKI and GEROCH 1993, p. 257, pl. 7, figs 1a-2b. – KAMINSKI and GRADSTEIN 2005, p. 307, pl. 64, figs 1a-7.

Occurrence: 4 specimens from 3 samples.

Description: Test small, oval in outline, coiling glomospiral, chambers globular, elongate of varying length, three to five in the last whorl, wall finely agglutinated, finish smooth, wall thin, aperture a simple terminal opening.

Remarks: Originally described from the Paleogene of the Polish Carpathians, this species is cosmopolitan and known from Cretaceous to Eocene sediments.

***Paratrochamminoides* sp. 1**
Plate 4, figs 4-9, Plate 5, figs 1,2

Occurrence: 11 specimens from 6 samples.

Description: Test large, oval to round in outline, coiling streptospiral, umbilicus open, chambers globular, large and rectangular in shape, usually slightly longer than wide, sometimes square, about four in the last whorl, sutures distinct, depressed, wall finely agglutinated, finish medium coarse or smooth, wall thin, aperture a simple terminal opening, specimens invariably collapsed and compressed in any plane.

Remarks: A similar but much smaller form was described as *Trochamminoides pseudointermedius* Săndulescu (1972) from the Late Cretaceous of the Eastern Carpathians, Romania. As the morphology of this form is rather non-descript, the size small (and therefore may be a juvenile of another species), the age Cretaceous (and we observe none of these species in the Oligocene section of the well), we regard the specimens in this report most likely to be of another species.

***Paratrochamminoides* spp.**
Occurrence: 35 specimens from 18 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test streptospirally enrolled, numerous ovate to globular chambers, wall thin.

Genus *Conglophragmium* Bermúdez and Rivero 1963

Conglophragmium irregularis (White 1928)
Plate 5, fig. 3

Trochamminoides irregularis WHITE 1928, p. 307, pl. 42, fig. 1.
Conglophragmium irregularis (White). – KAMINSKI and GRADSTEIN 2005, p. 286, pl. 57, figs 1-6.

Occurrence: 15 specimens from 11 samples.

Description: Test streptospiral, chambers few in number, globular, large, spherical, wall finely agglutinated, finish smooth, wall thin, aperture a long interiomarginal arch.

Remarks: Originally described from the Paleocene of Mexico, this species is cosmopolitan and known from Late Cretaceous to Oligocene sediments.

Family TROCHAMMINOIDAE Haynes and Nwabufo-Ene 1998
Genus *Trochamminoides* Cushman 1910

Trochamminoides folius (Grzybowski 1898)
Plate 5, fig. 4

Trochammina folium GRZYBOWSKI 1898, p. 288, pl. 11, figs 7-9.
Trochamminoides folius (Grzybowski). – KAMINSKI and GEROCH 1993, p. 306, pl. 9, figs 1a-4b.

Occurrence: 2 specimens from 2 samples.

Description: Test oval in outline, coiling irregular becoming planispiral, uncoiling, chambers globular, elongate tube-like, wall finely agglutinated, finish smooth, wall thick, aperture a simple terminal opening.

Remarks: Originally described from the Paleogene of the Polish Carpathians.

Trochamminoides subcoronatus (Grzybowski 1896)
Plate 5, figs 5,6

Trochammina subcoronata GRZYBOWSKI 1896, p. 283 - 284, pl. 9, fig. 3a-c.
Trochamminoides subcoronatus (Grzybowski). – KAMINSKI, GRADSTEIN, BERGGREN, GEROCH and BECKMANN 1988, p. 192, pl. 4, fig. 19. – KAMINSKI and GRADSTEIN 2005, p. 319, pl. 67, figs 1a-6.

Occurrence: 18 specimens from 10 samples.

Description: Test planispiral, chambers globular, spherical, about six in the final whorl, wall finely agglutinated, finish smooth, wall thin, aperture a simple terminal opening.

Remarks: Originally described from the Paleocene of the Polish Carpathians, this species is cosmopolitan and known from Late Cretaceous to Eocene sediments.

***Trochamminoides* spp.**
Occurrence: 3 specimens from 3 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test irregularly coiled becoming planispiral, numerous ovate to globular chambers, wall thin.

Family HAPLOPHRAGMOIDIDAE Maync 1952
Genus *Haplophragmoides* Cushman 1910

Haplophragmoides* cf. *bradyi (Robertson 1891)
Plate 5, fig. 7

Trochammina bradyi ROBERTSON 1891, p. 388.
Haplophragmoides bradyi (Robertson). – PARKER 1954, pl. 1, fig. 16. – SCHRÖDER 1986, p. 637, pl. 3, fig. 4.
Haplophragmoides cf. *bradyi* (Robertson). – GREEN et al. 2004, p. 124, pl. 1, figs 5-7. – KAMINSKI et al. 2005, p. 384.

Occurrence: 57 specimens from 16 samples.

Description: Test small, involute planispiral, round in outline, periphery rounded, chambers slightly inflated, four and a half in the final whorl, sutures depressed, straight, radial, wall finely agglutinated, finish smooth, wall thin, aperture a slit at the base of the apertural face.

Remarks: Originally described as *Trochammina robertsoni* by Brady (1887) from the Recent of the British Isles, our specimens have less variability in chamber number and more closely resemble those reported from the Miocene of the Gulf of Mexico and the Fram Strait.

Haplophragmoides horridus (Grzybowski 1901)
Plate 5, fig. 8

Haplophragmium horridum GRZYBOWSKI 1901, p. 270, pl. 7, fig. 12.
Haplophragmoides horridus (Grzybowski). – KAMINSKI and GEROCH 1993, p. 318, pl. 15, figs 6-8. – KAMINSKI and GRADSTEIN 2005, p. 349, pl. 77, figs 1a-6.

Occurrence: 36 specimens from 13 samples.

Description: Test large, involute planispiral, round in outline, periphery rounded, chambers inflated, four and a half in the final whorl, last chamber greatly enlarged, sutures depressed, straight, radial, wall finely agglutinated, finish rough, wall thin, aperture a slit at the base of the apertural face.

Remarks: Originally described from the Paleogene of the Polish Carpathians.

Haplophragmoides nauticus Kender, Kaminski and Jones 2006
Plate 5, figs 10-12

Haplophragmoides nauticus KENDER, KAMINSKI and JONES 2006, p. 469, pl. 2, figs 1-3.

Occurrence: 23 specimens from 8 samples.

Description: Test planispiral, circular in outline, acute periphery, coiling evolute, nine chambers in the final whorl, chambers truncated triangular (trapezoidal) in shape, increasing in size rapidly as added, sutures straight to sigmoidal, slightly depressed, wall simple, thin, finely agglutinated, smooth finish, aperture slit-like, located at the base of the final chamber.

Remarks: Originally described from the Oligocene section of the well studied in this paper.

Haplophragmoides walteri (Grzybowski 1898)
Plate 5, fig. 9

Trochammina walteri GRZYBOWSKI 1898, p. 290, pl. 11, fig. 31.

Haplophragmoides walteri (Grzybowski). – CHARNOCK and JONES 1990, p. 171, pl. 6, figs 3,4, pl. 17, fig. 2. – KAMINSKI and GEROCH 1993, p. 263, pl. 10, fig. 3a-7c. – KAMINSKI and GRADSTEIN 2005, p. 365, pl. 83, figs 1-6.

Occurrence: 25 specimens from 17 samples.

Description: Test involute planispiral, round in outline, periphery acute, not carinate, umbilicus slightly depressed, chambers increasing in size gradually as added, about ten in the final whorl, sutures slightly depressed, straight, radial, wall finely agglutinated, finish smooth, wall thin, aperture a slit at the base of the apertural face.

Remarks: Originally described from the Paleogene of the Polish Carpathians, is a true cosmopolitan species recorded from the Late Cretaceous to Middle Miocene.

***Haplophragmoides* sp. 1**
Plate 6, fig. 1

Occurrence: 4 specimens from 2 samples.

Description: Test large, involute planispiral, round in outline, periphery rounded, umbilicus depressed, chambers distinctly globular, five in the final whorl, sutures depressed, straight, radial, wall coarsely agglutinated, finish rough, wall thick, aperture a slit at the base of the apertural face.

***Haplophragmoides* spp.**
Plate 6, fig. 2

Occurrence: 35 specimens from 21 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test planispiral, wall agglutinated, chambers increasing in size as added.

Family DICAMMINIDAE Loeblich and Tappan 1984
Genus *Glaphyrammina* Cushman 1910

Glaphyrammina americana (Cushman 1910)
Plate 6, figs 3,4

Ammobaculites americanus CUSHMAN 1910, p. 117, figs 1-4.
Glaphyrammina americana (Cushman). – LOEBLICH and TAPPAN 1987, p. 68, pl. 51, figs 7-10. – JONES 1994, p. 40, pl. 34, figs 1-4.

Occurrence: 1 specimen from 1 sample.

Description: Test evolute planispiral, becoming uncoiled, oval in outline, periphery rounded, umbilicus depressed, chambers increasing in size rapidly as added, becoming elongate, seven to ten in the final whorl, sutures depressed, straight, slightly oblique, wall coarsely agglutinated, with a rough finish, wall thin.

Remarks: Originally described from the Recent of the North Pacific, this species has also been recorded by Brady (1884) from the Recent of the South Atlantic.

Family SPHAERAMMINIDAE Cushman 1933
Subfamily PRAESPHAERAMMININAE Kaminski and Mikhalevich 2004
Genus *Praesphaerammina* Kaminski and Filipescu 2000

***Praesphaerammina* sp. 1**
Plate 6, fig. 5

Occurrence: 1 specimen from 1 sample.

Description: Test very large in size, planispiral, three to four strongly overlapping chambers, final chamber is so large it makes up the majority of test, wall very thick, coarse, with a rough texture.

***Praesphaerammina* spp.**
Occurrence: 5 specimens from 2 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test large, planispirally enrolled, involute, with about four strongly overlapping chambers per whorl, final chamber embracing and overlapping more than half of test, wall fine, with a rough to smooth finish.

Remarks: Usually occurs as fragments of very large specimens.

Family LITUOLIDAE de Blainville 1827
Genus *Discamminoides* Bronnimann 1951

***Discamminoides* sp. 1**
Plate 6, fig. 6

Occurrence: 1 specimen from 1 sample.

Description: Test large, involute, planispiral becoming uniserial, flattened, four to five chambers in last coil, up to five chambers in uniserial part, increasing in size steadily, as added, initial coiled part either large or small depending on micro- or megalo- spheric generation, periphery acute, sutures straight, seen as slight depression or undulation of test surface, or only visible as internal layer, aperture a terminal slit, wall bilamellar, internal layer thicker at peripheral part, coarse and sometimes speculated, with thin tubular alveoles, outer layer medium to coarse grained and thin.

Remarks: This species occurs in high abundance in the Oligocene section of the well.

Family AMMOSPHAEROIDINIDAE Cushman 1927
Subfamily AMMOSPHAEROIDININAE Cushman 1927
Genus *Ammosphaeroidina* Cushman 1910

Ammosphaeroidina pseudopauciloculata (Mjatliuk 1966)
Plate 6, fig. 7

Cystamminella pseudopauciloculata MJATLIUK 1966, p. 246, pl. 1, figs 5-7, pl. 2, fig. 6, pl. 3, fig. 3.
Ammosphaeroidina pseudopauciloculata (Mjatliuk). – MJATLIUK 1970, p. 104, pl. 15, fig. 6, pl. 30, figs 10-14. – KAMINSKI, GRADSTEIN, BERGGREN, GEROCH and BECKMANN 1988, p. 193, pl. 8, figs 3-5. – GREEN et al. 2004, p. 125, pl. 5, fig. 3.

Occurrence: 42 specimens from 14 samples.

Description: Test streptospirally enrolled, rounded in outline, chambers globular, increasing rapidly in size as added, embracing so that only four are visible in the final whorl, sutures depressed, straight, wall fine grained, surface smoothly finished, aperture a low interiomarginal arch.

Remarks: Also described from the Paleogene of Trinidad and Miocene of the Gulf of Mexico.

***Ammosphaeroidina* spp.**
Plate 8, fig. 2

Occurrence: 30 specimens from 7 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test streptospirally enrolled, rounded in outline, chambers globular, increasing rapidly in size as added, embracing, sutures depressed, straight, wall fine grained.

Subfamily RECURVOIDINAE Alekseychik-Mitskevich1973
Genus *Budashevaella* Loeblich and Tappen 1964

Budashevaella multicamerata (Voloshinova and Budasheva 1961)
Plate 6, fig. 8

Circus multicamerata VOLOSHINOVA 1961, p. 201, pl. 7, figs 6a-c, pl. 8, 1a-c.
Budashevaella multicamerata Voloshinova. – KAMINSKI and GRADSTEIN 2005, p. 388, pl. 90, figs 1a-6b.

Occurrence: 7 specimens from 7 samples.

Description: Test medium to large in size, evolute, becoming planispiral, round in outline, periphery subrounded, umbilicus depressed, chambers numerous, about ten in the final whorl, increasing in size as added, sutures depressed, straight, wall coarsely agglutinated, with a rough finish, wall thick, aperture an indistinct slit at the base of the apertural face.

Remarks: Originally described from the Oligocene - Miocene of the Kamchatka Peninsula, this species is cosmopolitan and has been recorded from the Pacific and Atlantic Oceans.

Genus *Cribrostomoides* Cushman 1910

Cribrostomoides subglobosus (Cushman 1910)
Plate 6, fig. 9

Lituola subglobosa CUSHMAN 1910, p. 253.
Cribrostomoides subglobosus (Cushman). – JONES, BENDER, CHARNOCK, KAMINSKI and WHITTAKER 1993, pl. 1, figs 1-5.
Cribrostomoides subglobosus subglobosus (Cushman). – KAMINSKI and GRADSTEIN 2005, p. 391, pl. 92, figs 1-3.

Occurrence: 19 specimens from 13 samples.

Description: Test medium to large in size, involute, trochospiral becoming planispiral, round in outline, periphery rounded, umbilicus depressed, chambers inflated, about six in the final whorl, increasing in size rapidly as added, sutures slightly depressed or flush with surface, straight, wall coarsely agglutinated, with a rough finish, wall thick, aperture a slit at the base of the apertural face, slightly raised to an areal position, bordered by a distinct lip.

Remarks: Originally described from the Recent of the North Pacific, this species has also been recorded by Brady (1884) from the Recent of the all the major oceans. It is also been recorded from many localities from the Cretaceous to Recent.

***Cribrostomoides* sp. 1**
Plate 6, fig. 10

Occurrence: 4 specimens from 4 samples.

Description: Test very large in size, involute, nearly planispiral, round in outline, periphery rounded, umbilicus depressed, chambers inflated, about five in the final whorl, increasing in size rapidly as added, sutures slightly depressed or flush with surface, straight, wall coarsely agglutinated, with a rough finish, wall thick, aperture indistinct.

Remarks: This species differs from *C. subglobosus* in having a much larger test and more depressed sutures.

***Cribrostomoides* spp.**

Occurrence: 30 specimens from 7 samples.
Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test involute, nearly planispiral, round in outline, periphery rounded, umbilicus depressed, chambers inflated, increasing in size rapidly as added, sutures slightly depressed or flush with surface, straight, wall coarsely agglutinated, with a rough finish, wall thick, aperture indistinct.

Genus *Recurvoides* Earland 1934

Recurvoides azuaensis Bermúdez 1949
Plate 7, figs 1,4

Recurvoides azuaensis BERMÚDEZ 1949, pl. 1, figs 35-37.
Recurvoides azuaensis Bermúdez. – GREEN 2004, p. 126, pl. 3, fig. 6.

Occurrence: 39 specimens from 17 samples.

Description: Test medium to large in size, streptospiral, involute, tightly coiled, round to oval in outline, periphery rounded, chambers increasing in size rapidly as added, about five in the final whorl, sutures slightly depressed or flush with surface, straight, wall coarsely agglutinated, with a rough finish, wall relatively thin so that specimens are flattened, aperture a narrow areal slit near the base of the final chamber.

Remarks: Originally described from the Oligocene of the Dominican Republic, this species has also been recorded from the Miocene of the Gulf of Mexico.

***Recurvoides* sp. 1**
Plate 7, fig. 3

Occurrence: 39 specimens from 17 samples.

Description: Test small, consisting of five to seven elongated chambers tightly enrolled to form spherical test, coiling streptospiral becoming just off planispiral, sutures slightly depressed, wall coarse, with a rough finish, aperture an areal slit.

***Recurvoides* spp.**
Occurrence: 32 specimens from 19 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test subglobular, streptospirally enrolled, generally few chambers per whorl, generally trochospiral to planispiral or may show an abrupt change in plane of coiling, wall coarsely agglutinated, medium to thick, surface usually roughly finished, aperture areal.

Family AMMOBACULINIDAE Saidova 1981
Subfamily AMMOBACULININAE Saidova 1981
Genus *Bulbobaculites* Maync 1952

***Bulbobaculites* sp. 1**
Plate 7, fig. 5

Occurrence: 1 specimen from 1 sample.

Description: Test of medium size, elongate, early stage with streptospirally enrolled globular and inflated chambers, later chambers uncoiled and rectilinear, sutures distinct, depressed and horizontal, wall coarsely finished and simple, aperture terminal, a single small rounded opening.

Family SPIROPLECTAMMINIDAE Cushman 1927
Subfamily VULVULININAE Saidova 1981
Genus *Vulvulina* d'Orbigny 1826

Vulvulina miocenica Cushman 1932
Plate 7, fig. 6

Vulvulina spinosa Cushman var. *miocenica* CUSHMAN 1932, p. 80, pl. 10, fig. 10.
Vulvulina spinosa Cushman var. *miocenica* Cushman. – CUSHMAN and TODD 1945, p. 4, pl. 1, fig. 10. – CUSHMAN and RENZ 1947, p. 5, pl. 1, fig. 10. – Renz 1948, p. 179, pl. 2, fig. 1.
Vulvulina miocenica Cushman. – KOHL 1985, p. 322, pl. 1, fig. 6.

Occurrence: 4 specimens from 4 samples.

Description: Test large in size, wide, elongate, laterally compressed, initially planispiral, becoming biserial and then uniserial, chambers elongate, increasing in size very rapidly, curved, downward pointing spine at the periphery, sutures limbate, raised, wall coarse, surface rough, aperture a terminal elongate slit.

Remarks: This species has been recorded from the Oligocene to Pliocene of many localities in and around the Gulf of Mexico.

Family PAVONTINIDAE Loeblich and Tappan 1961
Subfamily SPIROPSAMMININAE Seiglie and Baker 1984
Genus *Spiropsammina* Seiglie and Baker 1984

Spiropsammina primula Seiglie and Baker 1983
Plate 7, fig. 7

Figure 1. Transmitted light photograph of *Spiropsammina primula* (width 473 ìm).
Spiropsammina primula SEIGLIE and BAKER 1983, pl. 2, figs 7-9.

Occurrence: 4 specimens from 4 samples.

Description: Test rounded in outline, greatly compressed, evolute planispiral, about three coils in total, chambers elongate, increasing in size rapidly as added, curved, containing several alveoles in a fan-like arrangement, wall thin, coarse, surface rough.

Remarks: Originally described from the Middle Miocene offshore Cabinda, this species has been recorded from many localities offshore West Africa ranging from the Upper Oligocene to Middle Miocene.

Family TROCHAMMINIDAE Schwager 1877
Subamily TROCHAMMININAE Schwager 1877
Genus *Portatrochammina* Echols 1971

Portatrochammina profunda Kender, Kaminski and Jones 2006
Plate 7, figs 8-10

Portatrochammina profunda KENDER, KAMINSKI and JONES 2006, p. 469, pl. 2, figs 3-8.

Occurrence: 23 specimens from 8 samples.

Description: Test low trochospiral, rounded in outline, three to four whorls in adult, four to four and a half chambers in each whorl, chambers inflated, increase in size rapidly so that the final whorl makes up majority of the test, sutures depressed, wall thin, surface rough with predominantly medium grains containing occasional coarse inclusions.

Remarks: Originally described from the Oligocene section of the well studied in this paper.

Genus *Trochammina* Parker and Jones 1859

***Trochammina* sp. 1**
Plate 7, fig. 13

Occurrence: 79 specimens from 23 samples.

Description: Test of medium size, consisting of five to six globular chambers trochospirally enrolled and increasing in size gradually, sutures radial, wall thin, coarse, with a rough texture, aperture interiomarginal opening resting on the first chamber of the final whorl.

***Trochammina* sp. 2**
Plate 7, figs 11,12

Occurrence: 2 specimens from 2 samples.

Description: Test high trochospiral, elongate, rounded in section, greatly compressed, about five whorls, three to four chambers in each whorl, chambers inflated, increase in size rapidly, sutures depressed, wall thin, surface rough, aperture an interiomarginal opening.

Remarks: This species differs from *Trochammina altiformis* Cushman and Renz (1946), described from the Upper Cretaceous of the West Indies, in having many more whorls and a higher spire.

***Trochammina* sp. 3**
Occurrence: 151 specimens from 18 samples.

Description: Test very small, trochospiral, chambers increasing gradually in size, sutures radial, periphery rounded, aperture generally unseen, wall fine grained, thin.

Remarks: Differs from *Trochammina* spp. in having a much smaller size and thinner wall.

***Trochammina* sp. 4**
Plate 8, fig. 1

Occurrence: 1 specimen from 1 sample.

Description: Test low trochospiral, rounded in outline, globular, four chambers in the final whorl, chambers inflated, increase in size rapidly, sutures depressed, wall thick, surface rough, aperture an interiomarginal opening with a raised lip.

***Trochammina* spp.**
Occurrence: 32 specimens from 11 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test small to large, trochospiral, chambers increasing gradually in size, sutures radial, periphery rounded, wall coarse to fine, thin to thick.

Family PROLIXOPLECTIDAE Loeblich and Tappan 1985
Genus *Eggerelloides* Haynes 1973

***Eggerelloides* sp. 1**
Plate 8, figs 3,4

Occurrence: 4 specimens from 4 samples.

Description: Test large in size, subfusiform, early stage of growth trochospiral, later triserial, aperture a high interiomarginal arch in the centre of the apertural face, with a broad lip, wall simple, thick, coarse, with a rough texture.

Genus *Karrerulina* Finlay 1940

Karrerulina apicularis (Cushman 1911)
Plate 8, figs 5-7

Gaudryina apicularis CUSHMAN 1911, p. 69, textfig. 110.
Karrerulina apicularis (Cushman). – LOEBLICH and TAPPAN 1987, p. 130, pl. 139, figs 7-13. – MURRAY and ALVE 1994, pl. 1, fig. 13.

Occurrence: 47 specimens from 23 samples

Description: Test elongate and slender, initially trochospiral, later triserial becoming biserial, chambers slightly inflated, sutures distinct, wall coarse grained, finish rough, aperture terminal, at the end of a projected neck.

Remarks: Originally described from the Recent of the North Pacific, this species is also recorded from the North Atlantic and the Miocene of West Africa.

***Karrerulina* sp.**
Occurrence: 1 specimen from 1 sample.

Description: Test elongate, slender, trochospirally coiled in the initial part and reduced in the latter stages.

Family REOPHACELLIDAE Mikhalevich and Kaminski 2004
SubfamilyVERNEUILININAE Cushman 1927
Genus Gaudryina d'Orbigny 1839

Gaudryina atlantica (Bailey 1851)
Plate 8, fig. 8

Textularia atlantica BAILEY 1851, p. 12, text-figs 38-43.
Gaudryina atlantica (Bailey). – CUSHMAN 1922, p. 70, pl. 13, figs 1-3. – BERMÚDEZ 1949, p. 74, pl. 3, figs 63,64. – KOHL 1985, p. 33, pl. 3, fig. 7.

Occurrence: 2 specimens from 2 samples

Description: Test large, elongate, triangular in section, initially triserial, later becoming biserial, increasing in size steadily as added, chambers triangular, sutures depressed, wall coarse grained, finish rough, aperture a short slit at the base of the final chamber in the umbilical region.

Remarks: Originally described from the Recent of the Atlantic, this species is also recorded from the Miocene of Puerto Rico and Jamaica.

Family CYCLAMMINIDAE Marie 1941
Subfamily ALVEOLOPHRAGMIINAE Saidova 1981
Genus *Reticulophragmium* Maync 1955

Reticulophragmium acutidorsatum (Hantken 1868)
Plate 8, fig. 9

Haplophragmium acutidorsatum HANTKEN 1868, p. 82, pl. 1, fig. 1.
Reticulophragmium acutidorsatum (Hantken). – KAMINSKI and GRADSTEIN 2005, p. 490, pl. 122, figs 1-7.

Occurrence: 64 specimens from 29 samples

Description: Test large, circular to oval in outline, compressed, planispiral, involute, slightly depressed umbilicus, eight to ten chambers in the final whorl, sutures radial, straight to slightly sigmoidal, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth, apertural face contains coarser grains, aperture a long interiomarginal slit, no supplementary areal apertures.

Remarks: Originally described from the Oligocene of Hungary, this species is also recorded in Oligocene to Miocene sediments from the Atlantic, North Sea and Celebes Sea.

***Reticulophragmium acutidorsatum* ssp. 1**
Plate 8, fig. 10

Occurrence: 1 specimen from 1 sample.

Description: Test large, involute planispiral, with twelve chambers in the final whorl, chambers inflated, periphery subacute, sutures depressed at the periphery, radial, straight, angled slightly away from the direction of coiling, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, the outer layer is thin and fine-grained with a roughened finish.

Remarks: Differs from *R. acutidorsatum* by having depressed sutures at the margin, and more chambers in the final whorl.

Reticulophragmium amplectens (Grzybowski 1898)
Plate 8, fig. 11

Cyclammina amplectens GRZYBOWSKI 1898, p. 292, pl. 12, figs 1-3.
Reticulophragmium amplectens (Grzybowski). – KAMINSKI and GEROCH 1993, p. 266, pl. 11, figs 5-7c. – KAMINSKI and GRADSTEIN 2005, p. 495, pl. 123, figs 1-6.

Occurrence: 39 specimens from 15 samples

Description: Test medium size, circular in outline, robust, planispiral, involute, slightly depressed umbilicus, margin subacute, chambers numerous, eight to ten in the final whorl, sutures radial, straight, wall composed of two layers, the inner hypodermal layer is thick and perforated by elongate tubular alveoles, elongate in direction of coiling as observed from the dorsal view, the outer layer is thin and fine-grained, smooth, aperture a long interiomarginal slit, no supplementary areal apertures.

Remarks: Originally described from the Middle Eocene of the Polish Carpathians, this species is known globally from Eocene to Oligocene sediments and extending to Middle Miocene only in the Arctic.

***Reticulophragmium amplectens* ssp. 1**
Plate 9, fig. 1

Occurrence: 3 specimens from 2 samples.

Description: Test large, thick, circular in outline, involute planispiral, periphery subacute, sutures straight, depressed, umbilicus depressed, alveoles are elongated along to direction of coiling, wall smooth.

Remarks: This form resemblaes *R. acutidorsatum* with its much larger size and less acute periphery, but still show the characteristic elongated alveoles of *R. amplectens*. It therefore may be that *R. amplectens* ssp. 1 evolved from a transitional form of *R. acutidorsatum* due to its close appearance to this form, which would indicate elongated alveoles evolved more than once and are thus an example of convergent evolution. *R. amplectens* appears first in the Early Eocene.

Reticulophragmium gasparensis (Bermúdez 1949)
Plate 9, fig. 2

Cyclammina gasparensis BERMÚDEZ 1949, pl. 1, figs 47,48.
Reticulophragmium gasparensis (Bermúdez). – KENDER, KAMINSKI and JONES, in press, pl. 13, fig. 3.

Occurrence: 16 specimens from 11 samples

Description: Test large, circular to oval in outline, compressed, planispiral, involute, margin subacute, about fourteen chambers in the final whorl, increasing in size rapidly as added, apertural face broad and high, sutures radial, straight to slightly sigmoidal, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth, aperture a long interiomarginal slit, no supplementary areal apertures.

Remarks: Originally described from the Upper Oligocene of the Dominican Republic. This species differs from *R. acutidorsatum* by having a much larger apertural face.

Reticulophragmium orbicularis (Brady 1881)
Plate 9, fig. 4

Cyclammina orbicularis BRADY 1881, p. 53. – BRADY 1884, p. 353, pl. 37, figs 17-18.
Cyclammina rotundidorsata (Hantken). – JONES 1994, p. 43, pl. 37, figs 20-23.
Reticulophragmium orbicularis (Brady). – KAMINSKI et al. 2005, p. 390, pl. 7, fig. 2.

Occurrence: 5 specimens from 5 samples

Description: Test large, circular in outline, robust, planispiral, almost as thick as wide, involute, peripheral margin broadly rounded, about fourteen chambers in the final whorl, increasing in size steadily as added, apertural face high and wide, sutures inclined in the direction of growth, straight to slightly curved forwards, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth, aperture a long interiomarginal slit, no supplementary areal apertures.

Remarks: Originally described from the Recent of the South Atlantic, has also been recorded from the Miocene of the Fram Strait.

Reticulophragmium rotundidorsatum (Hantken 1875)
Plate 9, fig. 3

Haplophragmoides rotundodorsatum HANTKEN 1875, p. 12, pl. 1, fig. 2.
Cyclammina (Reticulophragmium) rotundidorsatum (Hantken). – CHARNOCK and JONES 1990, pl. 7, figs. 13-15, pl. 19, fig. 1.
Reticulophragmium rotundidorsatum (Hantken). – CICHA, RÖGL, RUPP and CTYROKA 1998, pl. 5, fig. 5. – KAMINSKI and GRADSTEIN 2005, p. 507, pl. 127, figs 1a-5c.

Occurrence: 19 specimens from 16 samples.

Description: Test large, circular in outline, compressed, planispiral, involute, peripheral margin broadly rounded, about eleven chambers in the final whorl, increasing in size steadily as added, sutures radial, straight, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth, aperture a long interiomarginal slit, no supplementary areal apertures.

Remarks: Originally described from the Early Oligocene of Hungary, this species has been recorded from the North Sea, Labrador Sea, West Africa and South China Sea from Eocene to Miocene sediments.

***Reticulophragmium* sp. 1**
Occurrence: 37 specimens from 12 samples

Description: Test small, circular in outline, planispiral, involute, chambers numerous, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth.

Remarks: This category contains mostly juvenile forms of *Reticulophragmium* spp.

***Reticulophragmium* spp.**
Occurrence: 36 specimens from 18 samples

Description: Included in this group are all fragmentary, poorly preserved and unassigned forms displaying the following characteristics: test circular in outline, planispiral, involute, chambers numerous, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth.

Family CYCLAMMINIDAE Marie 1941
Subfamily CYCLAMMININAE Marie 1941
Genus *Cyclammina* Brady 1879

Cyclammina cancellata Brady 1879
Plate 9, figs 5,6

Cyclammina cancellata BRADY 1879, p. 62. – BRADY 1884, pl. 37, figs 8-15. – KAMINSKI and GRADSTEIN 2005, p. 476, pl. 118, figs 1-4.

Occurrence: 2 specimens from 2 samples

Description: Test very large, circular to oval in outline, robust, planispiral, involute, margin rounded, fourteen to sixteen chambers in the final whorl, increasing in size rapidly as added, apertural face broad and high, sutures radial, sigmoidal, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the

dorsal view, the outer layer is thin and fine-grained, smooth, apertural face contains coarse grains, aperture a long interiomarginal slit, supplementary areal apertures numerous, each surrounded by a raised lip.

Remarks: Originally described from the Recent of the North Atlantic, this species is a cosmopolitan form described from sediments ranging from the Late Eocene to Recent, although it is possible that early forms would here be classified under *C. cancellata* ssp. 1.

***Cyclammina cancellata* ssp. 1**
Plate 9, fig. 7

Occurrence: 2 specimens from 2 samples

Description: Test very large, circular to oval in outline, robust, planispiral, involute, margin rounded, fourteen to sixteen chambers in the final whorl, increasing in size rapidly as added, apertural face broad and high, sutures radial, sigmoidal, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, circular in appearance from the dorsal view, the outer layer is thin and fine-grained, smooth, apertural face contains coarse grains, aperture a long interiomarginal slit, about eight supplementary areal apertures arranged in a circle, each surrounded by a raised lip.

Remarks: This species differs from C. cancellata in having fewer supplementary apertures arranged in a circle.

***Cyclammina* sp. 1**
Plate 10, figs 1-3

Cyclammina (Cyclammina) acutidorsata (Hantken). – CHARNOCK and JONES 1997, p. 188, fig. 6, figs 2a-c.

Occurrence: 2 specimens from 2 samples.

Description: Test large, involute, planispiral, with twelve to fourteen chambers in the final whorl, test approximately half as thick as wide, periphery subacute, sutures depressed, sigmoidal in later stages, umbilicus depressed, apertural face large, convex, containing coarse grains, primary aperture is a basal slit covered by a small lip, a single round supplementary aperture is present in the centre of the apertural face, sometimes surrounded by a raised lip, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, the outer layer is thin and fine-grained with a smooth finish.

Remarks: This species is distinct due to its single supplementary aperture in the centre of the apertural face, and differs from *C. cyclops* McNeil (1988) by having a much thicker test, larger apertural face and more involute coiling. Charnock and Jones (1997) also illustrate this species from the North Sea, and class it under the name *C. acutidorsata*, along with other specimens containing more supplementary apertures but with an otherwise similar morphology.

***Cyclammina* sp. 2**
Plate 10, fig. 4, Plate 11, figs 1-5

Cyclammina sp. KAMINSKI, SILYE and KENDER 2005, p. 395, pl. 7, figs 3a-c.

Occurrence: 3 specimens from 2 samples.

Description: Test large, involute, planispiral, with ten to thirteen chambers in the final whorl, test approximately half as thick as it is wide, periphery acute, sutures depressed and sigmoidal in later stages, umbilicus depressed, apertural face large, convex, containing coarse grains, primary aperture is a basal slit covered by a small lip, three to four round supplementary apertures are present in the centre of the apertural face formed in a diamond arrangement, each surrounded by raised lips, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, the outer layer is thin and fine-grained with a smooth finish.

Remarks: This species is distinct due to its three to four supplementary apertures on the apertural face arranged as an oblique 'diamond'. Charnock and Jones (1997) have found similar cyclamminids from the North Sea and generally classed them under *C. acutidorsata.*

***Cyclammina* spp.**
Occurrence: 36 specimens from 17 samples.

Description: Included in this group are all fragmentary, poorly preserved and unassigned forms displaying the following characteristics: test large, involute, planispiral, sutures depressed and sigmoidal in later stages, apertural face large, convex, containing coarse grains, wall composed of two layers, the inner hypodermal layer is thick and perforated by tubular alveoles, the outer layer is thin and fine-grained with a smooth finish.

Family EGGERELLIDAE Cushman 1937
Subfamily DOROTHIINAE Balakhmatova 1972
Genus *Dorothia* Plummer 1931

Dorothia brevis Cushman and Stainforth 1945
Plate 11, figs 6,7

Dorothia brevis CUSHMAN and STAINFORTH 1945, p. 18, pl. 2, fig. 5.
Dorothia brevis Cushman and Stainforth. – KURIHARA and KENNETT 1986, p. 1069, pl. 1, fig. 10.

Occurrence: 2 specimens from 2 samples.

Description: Test biserial, inflated, almost as wide as high, initial end acute, chambers inflated, increasing is size rapidly as added, sutures slightly depressed, wall smooth, containing a high proportion of cement, aperture at the base of the final chamber, an elongate slit covered by a lip.

Remarks: Originally described from the Oligocene of Trinidad, this species has also been recorded from the Miocene of the South Pacific.

Subfamily EGGERELLINAE Cushman 1937
Genus *Eggerella* Cushman 1935

Eggerella bradyi (Cushman 1911)
Plate 12, figs 1,2

Verneuilina bradyi CUSHMAN 1911, p. 54, text-fig. 87.
Eggerella bradyi (Cushman). – CUSHMAN 1937a, p. 52, pl. 5, fig. 19. – KOHL 1985, p. 32, pl. 3, fig. 3.

Occurrence: 11 specimens from 8 samples.

Description: Test trochospiral becoming triserial, elongate, chambers inflated, increasing in size rapidly as added, sutures depressed, wall smooth, containing a high proportion of cement, aperture at the base of the final chamber, an elongate slit surrounded by a lip.

Remarks: Originally described from the Recent of Atlantic and Pacific, this species is cosmopolitan and has also been recorded from the Miocene.

Genus *Karreriella* Cushman 1933

Karreriella* aff. *bradyi (Cushman 1911)
Plate 12, figs 3,4

Gaudryina bradyi CUSHMAN 1911, p. 67, text-fig. 107.
Karreriella bradyi (Cushman). – CUSHMAN 1937a, p. 135, pl. 16, figs 6-11. – KOHL 1985

Occurrence: 2 specimens from 1 sample.

Description: Test triserial becoming biserial, elongate, tapering towards the apical end, chambers inflated, initially increasing in size rapidly as added, then only slowly, sutures depressed, wall smooth, containing a high proportion of cement, aperture near the base of the final chamber, an oval opening surrounded by a lip.

Remarks: Originally described from the Recent of Atlantic and Pacific, this species is cosmopolitan and has also been recorded from the Miocene. Our speimens differ from the original pictured by Cushman in not having a slit-like aperture. However the type *description* stipulates "aperture oval … with a border raised … and thickened", which does fit with our specimens.

Karreriella microgranulosa Graham, de Klasz and Rérat 1965
Plate 12, figs 5-7

Karreriella microgranulosa GRAHAM, DE KLASZ and RÉRAT 1965, p. 77, pl. 2, fig. 1.

Occurrence: 12 specimens from 8 samples.

Description: Test small, triserial becoming biserial, elongate, tapering towards the apical end, chambers compact, strongly overlapping, initially increasing in size rapidly as added, then only slowly, sutures only slightly depressed, becoming more so in later portion, wall smooth, containing a high proportion of cement, aperture near the base of the final chamber, a circular opening surrounded by a lip.

Remarks: Originally described from the Lower Miocene of Gabon.

Remarks: Differs from *K.* aff. *bradyi* in having a much smaller size and not inflated chambers.

Genus Martinotiella Cushman 1933

Martinotiella communis (d'Orbigny 1846)
Plate 12, figs 8-10

Clavulina communis D'ORBIGNY 1846, p. 196, pl. 12, figs 1,2.
Martinotiella communis (d'Orbigny). – ASANO 1950, p. 3, figs 16,17. – KOHL 1985, p. 33, pl. 4, fig. 2. – CICHA et al. 1998, p. 111, pl. 9, figs 6,7.

Occurrence: 3 specimens from 3 samples.

Description: Test triserial becoming biserial and uniserial, uniserial portion making up the majority of test, elongate, chambers slightly inflated, initially increasing in size rapidly as added, then only slowly, sutures depressed, wall coarse, containing a high proportion of cement, surface roughened, aperture a terminal round opening, ain the centre of the final chamber.

Remarks: This species has only been recovered as fragments of the uniserial portion of test. *M. communis* is a cosmopolitan species ranging from the Miocene to Recent.

***Martinotiella* sp.**
Plate 12, fig. 11

Occurrence: 1 specimen from 1 sample.

Description: Fragmentary test uniserial, probably triserial initial part lost, uniserial portion elongate, chambers slightly inflated, increasing in size rapidly as added, sutures depressed, wall coarse, containing a high proportion of cement, surface roughened, aperture a terminal round opening, ain the centre of the final chamber.

Remarks: Differs from *M. communis* in having a strongly tapering uniserial portion.

Family VALVULINIDAE Berthelin 1880
Subfamily VALVULININAE Berthelin 1880
Genus *Valvulina* d'Orbigny 1826

Valvulina flexilis Cushman and Renz 1941
Plate 12, figs 12,13

Valvulina flexilis CUSHMAN and RENZ 1941, p. 7, pl. 1, figs 16-17.
Valvulina flexilis Cushman and Renz. – CUSHMAN and STAINFORTH 1945, p. 17, pl. 2, fig. 4. CUSHMAN and RENZ 1948, p. 177, pl. 2, fig. 12. – RENZ 1948, p. 177, pl. 2, figs 11-12. – GREEN et al. 2004, p. 129, pl. 7, figs 4-6.

Occurrence: 29 specimens from 16 samples.

Description: Test small to large, triserial, later becoming biserial, elongate tapering, chambers inflated, almost sac-like, increasing in size rapidly, sutures depressed, wall coarse, with a rough texture, aperture an interiomarginal opening at the base of the final chamber, with a projecting tooth.

Remarks: Originally described from the Oligocene and Miocene of Venezuela, this species has also been recorded from the Miocene of the Gulf of Mexico and offshore West Africa.

Family TEXTULARIIDAE Ehrenberg 1838
Subfamily TEXTULARIINAE Ehrenberg 1838
Genus *Bigenerina* d'Orbigny 1826

***Bigenerina* sp.**
Plate 12, fig. 14

Occurrence: 1 specimen from 1 sample.

Description: Test small, elongate, biserial becoming uniserial, chambers inflated, sutures depressed, wall canaliculated, coarse, surface rough, aperture a terminal rounded opening.

Genus *Textularia* Defrance 1824

Textularia earlandi Parker 1952
Plate 12, fig. 15

Textularia tenuissima Earland 1933, p. 95, pl. 3, figs 21-30.
Textularia earlandi PARKER 1952, p. 458.

Occurrence: 1 specimen from 1 sample.

Description: Test small biserial, elongate, usually broken, chambers very numerous, slightly inflated, increasing in size only slowly with growth, sutures depressed, wall thin,

fine-grained, with a roughish texture, aperture a curved opening at the base of the final chamber.

Remarks: Originally described from the Recent, this is a cosmopolitan species. It probably contains an organic wall as it occurs in samples devoid of calcareous forms, which suggests that it should actually be placed in a different genus.

Family OPTHALMIDIDAE Wiesner 1920
Genus *Opthalmidium* Kubler and Zwingli 1870

***Opthalmidium* species A** Kohl 1985
Plate 13, fig. 1

Opthalmidium species A KOHL 1985, pl. 4, figs 8-10**.**

Occurrence: 2 specimens from 2 samples.

Description: Test planispiral, strongly compressed, fusiform in shape, length twice that of the width, chambers half coil in length, each one initially thicker and becoming thinner towards the terminus, chambers added regularly to form 12 to 14 in adult, wall porcellaneous, smooth, aperture a terminal rounded opening.

Remarks: *Opthalmidium* sp. A was reported as rare in the Pliocene of the Salina Basin by Kohl (1985).

Family SPIROLOCULINIDAE Wiesner 1920
Genus *Spiroloculina* d'Orbigny 1826

Spiroloculina excavata d'Orbigny 1846
Plate 13, fig. 2

Spiroloculina excavata D'ORBIGNY 1846, p. 271, pl. 16, figs 19-21.
Spiroloculina dilatata d'Orbigny 1846, p. 271, pl. 16, figs 16-18.

Occurrence: 2 specimens from 2 samples.

Description: Test planispiral, compressed, almost as wide as long, coiling spiroloculine, chambers increasing in size gradually, aperture terminal at the end of a slightly protruding neck.

Remarks: Specimens of this species are poorly preserved such that margin and aperture of test is not observed. Papp and Schmid (1985) record a sharply marginated last coil and the presence of an apertural tooth.

Subfamily HAURININAE Schwager 1876
Genus *Quinqueloculina* d'Orbigny 1826

Quinqueloculina triloculiniforma McLean 1956
Plate 13, fig. 3

Quinqueloculina triloculiniforma MCLEAN 1956, p. 322, pl. 37, figs 9-11.

Occurrence: 2 specimens from 2 samples.

Description: Test large, round in outline, coiling quinqueloculine so that four chambers are visible from one side and three from the other, chambers inflated, rounded, increasing in size rapidly, wall smooth, aperture terminal, large, with a broad simple tooth.

Quinqueloculina triangularis d'Orbigny 1846
Plate 13, fig. 4

Quinqueloculina triangularis D'ORBIGNY 1846, p. 288, pl. 18, figs 7-9. – ZUCZKOWSKA 1974, p. 63, pl. 8, figs 4-5, pl. 9, fig. 1, text fig. 23.

Occurrence: 2 specimens from 2 samples.

Description: Test rounded elongate in outline, distinctly triangular in section, coiling quinqueloculine so that four chambers are visible from one side and three from the other, chambers inflated, rounded, increasing in size rapidly, wall smooth.

Remarks: Specimens of this species are poorly preserved such that the aperture of test is not observed. Papp and Schmid (1985) record a large terminal apertural with a distinct tooth.

Subfamily MILIOLINELLINAE Vella 1957
Genus *Pyrgo* Defrance 1824

Pyrgo magnacaudata Smith 1948
Plate 13, fig. 5

Pyrgo magnacaudata SMITH 1948, p. 58, pl. 11, figs 14-16.

Occurrence: 1 specimen from 1 sample.

Description: Test bulbous, small, outline almost spherical, two chambers visible, inflated, increasing in size as added, appendage at basal portion of final chamber is broad, thick, with parallel sides, surface smooth, aperture large, with thickened rim and wide tooth.

***Pyrgo* spp.**
Plate 13, fig. 6

Occurrence: 3 specimens from 2 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test bulbous, outline rounded, two chambers visible, inflated, increasing in size as added, sometimes has appendage at basal portion of final chamber, surface smooth, terminal aperture.

Subfamily SIGMOILINITINAE £uczkowska 1974
Genus *Sigmoilinita* Seiglie 1965

Sigmoilinita elliptica (Galloway and Wissler 1927)
Plate 14, fig. 1

Sigmoilina elliptica GALLOWAY and WISSLER 1927, p. 39, pl. 7, figs 2a-b.
Sigmoilina miocenica Cushman 1946, p. 33, pl. 5, figs 19-22.
Sigmoilinita elliptica (Galloway and Wissler). – KOHL 1985, pl. 5, fig. 4.

Occurrence: 4 specimens from 4 samples.

Description: Test free, slightly compressed, oval in outline, length one and a half to two times the width, coiling triloculine becoming biloculine, with chambers added at slightly more than 180°from one another forming a sigmoidal curve, chambers inflated, elongate and narrow, sutures slightly depressed, aperture a terminal circular opening at the end of a projected neck.

Remarks: Differs from *S. tenuis* in its less distinct sutures and less compressed form.

Sigmoilinita tenuis (Czjzek 1848)
Plate 14, fig. 2

Quinqueloculina tenuis CZJZEK 1848, p. 149, pl. 13, figs 31-34
Spiroloculina tenuissima Reuss 1867, p. 71, pl. 1, fig. 11.

Sigmoilina tenuis (Czjzek). – CUSHMAN and TODD 1945, p. 10, pl. 2, fig. 4.
Sigmoilinita tenuis (Czjzek). – KOHL 1985, pl. 5, fig. 5.

Occurrence: 1 specimen from 1 sample.

Description: Test small, compressed, oval in outline, length one and a half times the width, coiling triloculine becoming biloculine, with chambers added at slightly more than 180° from one another forming a sigmoidal curve, chambers elongate and narrow, sutures distinct, aperture a terminal circular opening at the end of a projected neck.

Subfamily NODOSARIINAE Ehrenberg 1838
Genus *Chrysalogonium* Schubert 1908

Chrysalogonium lanceoleum Cushman and Jarvis 1934
Plate 14, fig. 3

Chrysalogonium lanceoleum CUSHMAN and JARVIS 1934, p. 75, pl. 10, fig. 16
Chrysalogonium lanceoleum Cushman and Jarvis. – CUSHMAN and STAINFORTH 1945, p. 25, pl. 3, fig. 29, pl. 16, fig. 5. – BECKMANN 1953, p. 352, pl. 19, fig. 9. – BOLLI et al. 1994, p. 256, pl. 63, fig. 26, p. 317, pl. 87, fig. 35.

Occurrence: 13 specimens from 5 samples.

Description: Test small, elongate, uniserial, rectilinear, initial chambers short in length, sutures indistinct so that surface is completely smooth, wall thick.

Remarks: Specimens of this species are not common but persistently occur. Only the first few chambers are ever preserved so that full adult test is not observed. Bolli et al. (1994) picture adult forms with eight chambers increasing in length and breadth very gradually, sutures becoming more depressed, aperture terminal.

***Chrysalogonium* sp. 1**
Plate 14, fig. 4

Occurrence: 4 specimens from 2 samples.

Description: Test uniserial, elongate, chambers spherical to slightly elongate, changing in size and shape as added, sutures depressed, wall smooth, covered in numerous fine longitudinal costae extending sometimes the full length of test, aperture terminal.

Genus *Nodosaria* Lamark 1812

Nodosaria anomala Reuss 1866
Plate 14, fig. 5

Nodosaria anomala REUSS 1866, p. 129, pl. 1, figs 20-22 (fide Ellis and Messina 1940).

Occurrence: 12 specimens from 9 samples.

Description: Test uniserial, elongate, consisting of up to seven rectilinear chambers, chambers globular, generally spherical to ovoid, increasing in size slowly, overlapping the previous one to varying degrees so as to give a somewhat irregular appearance, sutures usually constricted, wall smooth, aperture a terminal round opening.

Remarks: Originally described from the Oligocene of Germany.

Nodosaria glandulinoides Neugeboren 1852
Plate 14, fig. 6

Nodosaria glandulinoides NEUGEBOREN 1852, p. 37, pl. 1, fig. 2.
Nodosaria sp. (?). Cushman and Jarvis 1930, p. 361, pl. 33, fig. 2.

Occurrence: 2 specimens from 1 samples.

Description: Test elongate, uniserial, rectilinear, chambers inflated, spherical in outline, three to four slightly overlapping, constricted at sutures, final chamber slightly elongated and tapering towards terminal aperture.

Remarks: These specimens have a poorly preserved aperture. Kohl (1985) describes a radiate aperture, covered with a plate-like process held aloft by eight solid bars.

Nodosaria pyrula d'Orbigny 1826
Plate 14, fig. 7

Nodosaria pyrula D'ORBIGNY 1826, p.253, fig. 13 (fide Ellis and Messina 1940).
Nodosaria pyrula d'Orbigny. – MACFADYEN 1930, pl. 2, fig. 16. – AKERS and DOORMAN 1964, pl.6, fig. 19. – PAPP and SCHMID 1985, pl. 4, figs 2-3. – KOHL 1985, pl.6, fig. 4. – FILIPESCU 1996, pl. 1, fig. 5.
Nodosaria cf. pyrula d'Orbigny. – CUSHMAN and STAINFORTH 1945, pl. 3, fig. 22.
Grigelis pyrula (d'Orbigny). – CICHA et al. 1998, pl. 21, fig. 9.

Occurrence: 5 specimens from 3 samples.

Description: Test elongate, uniserial, rectilinear, chambers circular in section, tapered at either end to form pear-shaped outline, separated by long tubular neck, wall smooth, aperture terminal.

Remarks: Poor preservation obscures certain characteristics. Papp and Schmid (1985) pictures specimens with up to seven chambers, straight to slightly arcuate in outline and with sometime spherical chambers. Kohl (1985) describes the aperture as radiate, with six to seven connected bars atop a circular opening.

***Nodosaria* spp.**
Plate 14, fig. 8

Occurrence: 21 specimens from 9 samples.

Description: Included in this group are all fragmentary and unassigned forms displaying the following characteristics: test uniserial, elongate, rectilinear, with chambers spherical to elongate in outline.

Subfamily PLECTOFRONDICULARIINAE Cushman 1927
Genus *Amphimorphina* Neugeboren 1850

Amphimorphina stainforthi (Cushman and Renz 1941)
Plate 14, figs 9-11

Nodosaria stainforthi CUSHMAN and RENZ 1941, pl. 3, fig. 4.
Nodosaria stainforthi Cushman and Renz. – CUSHMAN and RENZ 1947, pl. 4, fig. 20. – RENZ 1948, pl. 4, fig. 31. – BLOW 1959, p. 128. – PETTERS 1982, pl. 5, fig. 34.
Amphimorphina stainforthi (Cushman and Renz). – KOHL 1985, pl. 9, figs 4-5.
Pyramidulina stainforthi (Cushman and Renz). – BOLLI et al. 1994, pl. 63, fig. 18, pl. 77, figs 39-40.

Occurrence: 32 specimens from 12 samples.

Description: Test uniserial, elongate, rectilinear, chambers spherical to hexagonal in section, numerous, increasing in size rapidly and becoming inflated, sutures horizontal and depressed, wall smooth, ornamented with six to seven wide longitudinal costae extending the length of test and thickened at the sutures, aperture terminal, central.

Remarks: Kohl (1984) describes and pictures the aperture as the opening in between a radiate series of ten to fourteen ribs extending inward from a thickened polygonal rim.

Subfamily LENTICULININAE Chapman, Parr and Collins 1934
Genus *Lenticulina* Lamark 1804

Lenticulina americana (Cushman 1918)
Plate 14, figs 12,13

Cristellaria americana CUSHMAN 1918, pl. 10, figs 5-6.
Robulus americanus (Cushman). – CUSHMAN 1930, pl. 3, fig. 7. – CUSHMAN and CAHILL 1933, pl. 3, fig. 6. – RENZ 1948, pl. 12, fig. 3. – BLOW 1959, p. 130-131.
Lenticulina americana (Cushman). – BERMÚDEZ and FUENMAYOR 1966, pl. 3, figs 9-10. – PETTERS 1982, pl. 4, fig. 16. – BOLLI et al 1994, pl. 77, fig. 5.
Lenticulina (Robulus) americanus (Cushman). – WHITTAKER 1988, pl. 5, figs 1-2.

Occurrence: 37 specimens from 16 samples.

Description: Test involute planispiral, biconvex, subcircular in outline, periphery finely keeled, chambers increasing in size gradually, six to seven in the final whorl, sutures limbate, slightly raised and curved, wall smooth, aperture radiate, with a slit projecting down onto the upper part of the apertural face.

Lenticulina calcar (Linnaeus 1758)
Plate 14, fig. 14

Nautilus calcar LINNAEUS 1758, p. 709.
Robulina calcar (Linnaeus). – D'ORBIGNY 1846, p. 99, pl. 4, figs 18-20. – RENZ 1948, pl. 3, fig. 6.
Cristellaria calcar (Linnaeus). – NUTTALL 1928, pl. 5, fig. 8. – MACFADYEN 1930, pl. 3, fig. 17.
Lenticulina calcar (Linnaeus). – KOHL 1985, pl. 10, figs 4-5, – PAPP and SCHMID 1985, pl. 30, figs 1-3. – BOLLI 1994, p. 294, pl. 77, fig. 5.

Occurrence: 4 specimens from 4 samples.

Description: Test involute planispiral, biconvex, subcircular in outline, periphery keeled, with extended delicate spines opposite chambers, chambers increasing in size gradually, five to seven in the final whorl, sutures limbate, slightly curved, smooth with surface of the test, wall smooth, aperture radiate, with a slit projecting down onto the upper part of the apertural face.

Remarks: *Lenticulina calcar* is a cosmopolitan species described from many localities around the Atlantic and Pacific from the Miocene to Holocene, and is rare in most localities.

Lenticulina formosa (Cushman 1923)
Plate 15, fig. 1

Cristellaria formosa CUSHMAN 1923, p. 110, pl. 29, fig. 1, pl. 30, fig. 6.
Lenticulina formosa (Cushman). – HADLEY 1934, p. 11, pl. 1, fig. 11. – BARKER 1960, p. 146, pl. 70, figs 13-15.
Robulus formosus (Cushman). – BERMÚDEZ 1949, p.126, pl. 6, figs 57-58.

Occurrence: 16 specimens from 3 samples.

Description: Test large, involute planispiral, biconvex, subcircular in outline, periphery keeled, with thin spines protruding out, chambers increasing in size gradually, eight to twelve in the final whorl, sutures limbate, slightly curved, raised from surface of the test, wall smooth, aperture radiate, with a slit projecting down onto the upper part of the apertural face.

Remarks: *Lenticulina formosa* is a cosmopolitan species described from Miocene to Holocene localities from the Atlantic and Pacific, and is usually rare.

Lenticulina* aff. *multinodosa Schijfsma 1946
Plate 14, fig. 15, Plate 15, fig. 2

Lenticulina multinidosa SCHIJFSMA 1946, p. 57, pl. 3, fig. 10.

Occurrence: 4 specimens from 4 samples.

Description: Test large, involute planispiral, biconvex, subcircular in outline, periphery undulate, chambers increasing in size gradually, ten to twelve in the final whorl, sutures radiate to slightly curved, greatly thickened at margin, raised high from surface of the test giving a 'humped' appearance at the periphery, wall smooth, aperture radiate.

Remarks: This species is very similar to true *Lenticulina multinodosa* described by Schijfsma (1946) from the Upper Cretaceous of southern Limburg, Netherlands. Specimens in this study may be closely related, but appear to have more chambers than the eight to ten originally described. Species of *Lenticulina* with this morphology have not been described from other localities in the Atlantic.

Genus *Saracenaria* Defrance 1824

***Saracenaria* sp.**
Plate 15, fig. 3

Occurrence: 1 specimen from 1 sample.

Description: Test initially planispiral, becoming flared to almost rectilinear, periphery rounded, apertural face broad, flat, sutures slightly curved, depressed, surface smooth, aperture radiate.

Remarks: The single specimen is poorly preserved and abraded, hampering identification.

Family LAGENIDAE Reuss 1862
Genus *Pygmaeoseistron* Patterson and Richardson 1987

***Pygmaeoseistron* spp.**
Plate 15, fig. 4

Occurrence: 6 specimens from 3 samples.

Description: Test elongate, uniserial, rectilinear, consisting of straight series of globular spherical chambers attached by thin tubular necks, aperture terminal round opening.

Remarks: All specimens are fragmentary and poorly preserved, making identification of species difficult.

Subfamily GLANDULININAE Reuss 1860
Genus *Glandulina* d'Orbigny 1839

Glandulina ovula d'Orbigny 1846
Plate 15, fig. 5,6

Glandulina ovula D'ORBIGNY 1846, p. 29, pl. 1, figs 6-7.

Occurrence: 2 specimens from 2 samples.

Description: Test elongate, uniserial in megalospheric forms, biserial rapidly becoming uniserial in microspheric forms, circular in section, ovate in outline, tapering towards both ends, chambers initially increasing rapidly in size, strongly overlapping previous chambers, sutures straight, distinct, flush with surface, up to six visible in adult form, surface of test smooth, aperture terminal, central, with seven to eight bars converging to a point above the circular opening.

Remarks: Originally described from the Oligocene-Miocene of the Vienna basin, is distinguished from *G. laevigata* d'Orbigny by the lack of a pointed base, and possessing fewer radiating ribs at the aperture.

Subfamily CERATOBULIMININAE Cushman 1927
Genus *Ceratobulimina* Toula 1915

Ceratobulimina alazanensis Cushman and Harris 1927
Plate 15, fig. 7

Ceratobulimina alazanensis CUSHMAN and HARRIS 1927, p. 174, pl. 29, figs 5a-c. – WHITTAKER 1988, p. 110, pl.14, figs 14-16. – ROBERTSON 1998, p. 123, pl. 44, figs 1a-c.

Occurrence: 2 specimens from 2 samples.

Description: Test trochospiral, rounded to ovate in outline, chambers inflated, periphery rounded, five chambers in the final whorl increasing in size rapidly, sutures distinct, depressed, curved, surface smooth, aperture an elongate slit extending from the umbilicus to half way up the apertural face.

Remarks: Originally described from the Upper Oligocene of Mexico, this form has also been recorded from the Middle Miocene of Jamaica.

Subfamily EPISOMININAE Wedekind 1937
Genus *Hoeglundina* Brotzen 1948

Hoeglundina elegans (d'Orbigny 1826)
Plate 15, figs 8,9, Plate 16, fig. 1

Rotalia (Turbinulina) elegans D'ORBIGNY 1826, p. 276 (fide Ellis and Messina 1940)
Rotalina partschiana D'ORBIGNY 1846, p. 153, pl. 7, figs 28-30, pl. 8, figs 1-3.
Epistomina elegans (d'Orbigny). – CUSHMAN and JARVIS 1930, p. 365, pl. 34, figs 1a-c.
Hoeglundina elegans (d'Orbigny). – BERMÚDEZ 1949, p. 250, pl. 17, figs 34-36. – KOHL 1985, p. 59, pl. 14, figs 4-5. – VAN MORKHOVEN et al. 1986, p. 97, pl. 29, figs 1-2.

Occurrence: 27 specimens from 17 samples.

Description: Test trochospiral, circular in outline, biconvex, umbilical side involute, spiral side evolute, periphery acute, chambers distinct, increasing in size gradually, seven to nine in the final whorl, sutures flush with surface or slightly raised, straight, surface smooth, hyaline, aperture a marginal slit extending along the margin of the final chamber, infilled and closed in older chambers, secondary aperture a round opening at the base of the apertural face.

Remarks: Common cosmopolitan form recorded from Europe, the Atlantic, Pacific and Indian Oceans, ranging from Late Eocene to Pleistocene.

Family BOLIVINIDAE Glaessner 1937
Genus *Bolivina* d'Orbigny 1839

Bolivina multicostata (Cushman 1918)
Plate 16, fig. 2

Bolivina aenariensis (Costa) var. *multicostata* CUSHMAN 1918, pl. 10, fig. 2.
Bolivina marginata var. *multicostata* (Cushman). – CUSHMAN 1930, pl. 8, figs 13-14. – CUSHMAN and CAHILL 1933, pl. 8, fig. 10. – CUSHMAN 1937b, pl. 10, figs 7-10. – CUSHMAN and RENZ 1947, pl. 6, fig. 10. – RENZ 1948, pl. 7, figs 6-8.
Bolivina marginata multicostata (Cushman). – BLOW 1959, p. 146. – BOLLI et al. 1994, pl. 53, figs 8-9, pl. 78, figs 14-16.
Bolivina multicostata (Cushman). – Whittaker 1988, pl. 11, figs 10-13. – Finger 1992, pl. 17, fig. 56.

Occurrence: 24 specimens from 10 samples.

Description: Test biserial, elongate, three times as long as wide, initial end rounded in outline, sides becoming almost parallel, compressed in edge view, margin slightly carinate, chambers numerous, sutures curved and depressed, several longitudinal costae, some running the full length of test, occasionally bifurcating and anastomosing, wall finely perforate, aperture extending from the base of final chamber with a tooth plate.

Remarks: This species has been reported from various localities in Miocene of the Gulf of Mexico.

Bolivina tenuisstriata Cushman and Ellisor 1939
Plate 16, fig. 3

Bolivina tenuisstriata CUSHMAN and ELLISOR 1939, pl. 1, fig. 8.

Occurrence: 45 specimens from 6 samples.

Description: Test biserial, elongate, two to three times as long as wide, initial end rounded in outline, sides becoming almost parallel, compressed in edge view, margin acute, eight to nine chamber pairs, sutures curved and depressed, numerous longitudinal striae cover the surface, wall perforate, aperture extending from the base of final chamber with a tooth plate.

Genus *Brizalina* Costa,1856

Brizalina alazanensis (Cushamn 1926)
Plate 16, figs 4,5

Bolivina alazanensis CUSHAMN 1926, pl. 12, fig. 1.
Bolivina alazanensis (Cushamn). – CUSHMAN 1937b, pl. 8, figs 6-7. – RENZ 1948, pl. 12, fig. 7. – BLOW 1959, p. 144. – BOLLI et al. 1994, pl. 53, figs 2-3, pl. 78, fig. 3.

Occurrence: 565 specimens from 31 samples.

Description: Test biserial, elongate, two to three times as long as wide, initial end rounded to semi acute in outline, sides tapering to near parallel, compressed in edge view, margin acute to slightly carinate, chambers numerous, about seven pairs visible, sutures curved and depressed, surface smooth, wall perforate,

aperture extending from the base of final chamber with a tooth plate.

Brizalina* cf. *barbata (Phleger and Parker 1951)
Plate 16, figs 6-8

Bolivina barbata PHLEGER and PARKER 1951, p. 13, pl. 6, figs 12-13. – ANDERSEN 1961, p. 93, pl. 20, fig. 6. – AKERS and DOORMAN 1964, p. 24, pl. 8, fig. 34. – KOHL 1985, pl. 17, fig. 7.

Occurrence: 485 specimens from 24 samples.

Description: Test biserial, elongate, up to four times as long as wide in adult, initial end acute in outline, sides becoming almost parallel, compressed in edge view, margin slightly carinate, chambers numerous, about thirteen pairs in adult, ending in sharp downward pointing projections to give a 'serrated' outline, sutures curved and depressed, slightly inflated, wall smooth and very finely perforate, aperture extending from the base of final chamber with a tooth plate.

Remarks: *Brizalina* cf. *barbata* exhibits close affinities to true *B. barbata* described from the Holocene of the Gulf of Mexico, but differs from the latter in having a much finer perforate wall and a smaller proloculus. *B. barbata* is not known from the Miocene.

Brizalina* aff. *inflata (Heron-Allen and Earland 1913)
Plate 16, fig. 9

Bolivina inflata HERON-ALLEN and EARLAND 1913, p. 68, pl. 4, figs 19-16.
Bolivina inflata Heron-Allen and Earland. – CUSHMAN 1937b, p. 166, pl. 18, fig. 16.
Brizalina inflata (Heron-Allen and Earland). – KOHL 1985, pl. 17, fig. 9.

Occurrence: 130 specimens from 20 samples.

Description: Test biserial, elongate, twice as long as wide, initial end rounded in outline, sides becoming almost parallel, slightly compressed in edge view, margin rounded, chambers numerous, slightly inflated, five to nine pairs in adult, sutures straight, depressed, wall smooth and very finely perforate, aperture extending from the base of final chamber with a tooth plate.

Remarks: Original species described from the Holocene of the British Isles, the specimens in this report differ by having more parallel sides and a slightly higher apertural face.

Subfamily CASSIDULININAE d'Orbigny 1839
Genus *Cassidulinella* d'Orbigny 1826

Cassidulinella pliocenica Natland 1940
Plate 16, fig. 10

Cassidulinella pliocenica NATLAND 1940, p. 568. – LOEBLICH and TAPPAN 1987, pl. 554, figs 11-14.

Occurrence: 25 specimens from 14 samples.

Description: Test subcircular in outline, flattened in side view, biserial, chambers inflated, increasing in size rapidly as added, six pairs in the adult form, biserially enrolled in the early stage, becoming flared and elongated, final chamber encompassing nearly half the circumference of the test, wall smooth, finely perforate, aperture a long slit at the periphery of the final chamber.

Remarks: Always preserved as pyrite internal moulds. This is the type species of *Cassidulinella*, and was originally described from the Upper Pliocene of California.

Genus *Globocassidulina* Voloshinova 1960

Globocassidulina punctata Berggren and Miller 1986
Plate 16, figs 11,12

Globocassidulina punctata BERGGREN and MILLER 1986 (*in* Van Morkhoven et al. 1986), p. 119, pl. 37, fig. 1.

Occurrence: 46 specimens from 14 samples.

Description: Test subglobular, slightly tapering at on end, small, rounded in section, chambers inflated, biserially arranged, four two five pairs visible in adult increasing gradually in size, sutures slightly depressed, limbate, wall coarsely perforate, smooth, aperture an elongate slit in a depression on the apertural face, straight to slightly curved, lip attached to outer margin, elongate tooth.

Remarks: Distinguished from *G. subglobosa* by the presence of a more perforated wall, and generally smaller dimensions. Described originally from the Gulf of Mexico, Early to Late Miocene.

Globocassidulina subglobosa (Brady 1881)
Plate 17, figs 1,2

Cassidulina subglobosa BRADY 1881, p. 60.
Cassidulina subglobosa Brady. – BRADY 1884, p. 430, pl. 54, fig. 17. – CUSHMAN and TODD 1945, p. 61, pl. 10, fig. 8. – RENZ 1948, p. 125, pl. 9, figs 11-12. – PHLEGER and PARKER 1951, p. 27, pl. 14, figs 11-12
Globocassidulina subglobosa (Brady). – BELFORD 1966, p. 149, pl. 25, figs 11-16. – LEROY and LEVINSON 1974, p. 14, pl. 7, fig. 8.

Occurrence: 22 specimens from 10 samples.

Description: Test subglobular, rounded in section, periphery rounded, chambers inflated, biserially arranged, four two five pairs visible in adult increasing gradually in size, sutures slightly depressed, wall finely perforate, smooth, aperture an elongate slit in a depression on the apertural face, lip attached to outer margin, elongate tooth.

Remarks: G. subglobosa is a cosmopolitan species described from all of the worlds major oceans, and ranges from the Oligocene to Holocene.

Family BULIMINIDAE Jones 1875
Genus *Bulimina* d'Orbigny 1826

Bulimina buchiana d'Orbigny 1846
Plate 17, fig. 3

Bulimina buchiana D'ORBIGNY 1846, p. 186, pl. 11, figs 15-18.

Occurrence: 7 specimens from 4 samples.

Description: Test triserial, about twice as long as wide, circular in section, initial end rounded, chambers inflated, increasing in size slowly, stacked above one another in successive whorls, about four clear whorls in adult, sutures depressed, well defined, wall smooth, finely perforate, about six ridges run vertically down each chamber, widest at the margin, aperture an elongate opening surrounded by a lip and containing a tooth.

Remarks: This species was originally described form the Middle Miocene of the Vienna Basin.

Bulimina elongata d'Orbigny 1846
Plate 17, figs 4,5

Bulimina elongata D'ORBIGNY 1846, p. 187, pl. 11, figs 19-20. – PAPP and SCHMID 1985, p. 233, pl. 63, figs 5-9.

Occurrence: 1069 specimens from 33 samples.

Description: Test triserial, elongate, slender, often slightly curved, initial end acute, chambers inflated, increasing in size slowly, sutures depressed, well defined, wall smooth, finely perforate, aperture a rounded opening surrounded by a lip and containing a tooth.

Remarks: Described originally from the Tertiary of the Vienna Basin, this species is similar in form to *Stainforthia concava* (Höglund) described from the Holocene of Sweden and also recorded from the Pliocene of the Gulf of Mexico.

Bulimina falconensis Renz 1948
Plate 17, figs 7,8

Bulimina falconensis RENZ 1948, pl. 6, fig. 15. – BLOW 1959, p. 149-150. – BOLLI et al. 1994, pl. 78, fig. 32.

Occurrence: 125 specimens from 21 samples.

Description: Test triserial becoming biserial, elongate, three to four times as long as wide, circular in section, initial end rounded, chambers inflated, increasing in size slowly, sutures depressed, well defined, wall smooth, finely perforate, twelve to eighteen costae running length of test, some discontinuous, often plate-like, depressed at sutures, aperture an elongate opening surrounded by a lip and containing a tooth.

Remarks: This species was originally described from Venezuela. Differs from *B. sculptilis* Cushman in having more numerous costae.

Bulimina macilenta Cushman and Parker 1939
Plate 17, fig. 9

Bulimina denticulata Cushman and Parker 1936, p. 42, pl. 7, figs 7-8
Bulimina macilenta, new name, CUSHMAN and PARKER 1939, p. 93. – CUSHMAN and STAINFORTH 1945, p. 40, pl. 6, fig. 4. – BECKMAN 1953, p. 366, pl. 21, fig. 10. – WOOD et al. 1985.

Occurrence: 14 specimens from 8 samples.

Description: Test triserial, length only slightly greater than width, widest near the apertural end, initial end acute, last whorl encompasses approximately half the test, chambers inflated, increasing in size rapidly, slightly undercut, about four whorls, sutures depressed, obscured in early portion, wall smooth, finely perforate, margins of chambers cut into channels with short spines projecting downwards, aperture a rounded opening surrounded by a lip and containing a tooth.

Remarks: Originally described as a junior synonym of *B. truncana* Gümbel var. *denticulata* Protescu from the Eocene of California. This species was recorded ranging into the Early Miocene in Trinidad (Bolli et al. 1994).

Bulimina marginata d'Orbigny 1826
Plate 17, figs 10,11

Bulimina marginata D'ORBIGNY 1826, p. 296. – KOHL 1985, pl. 20, fig. 3.

Occurrence: 233 specimens from 18 samples.

Description: Test triserial, length one and a half width, widest near the apertural end, initial end acute, chambers inflated, increasing in size rapidly, slightly undercut, margins occupied by numerous downward projecting spines, about four whorls, sutures depressed, wall smooth, finely perforate, aperture a rounded opening surrounded by a lip and containing a tooth.

Remarks: Originally described from the Adriatic, this species has been recorded in many localities in the Miocene to Holocene of the Gulf of Mexico and Atlantic.

Bulimina mexicana Cushman 1940
Plate 17, fig. 12

Bulimina inflata Seguenza var. *mexicana* CUSHMAN 1922, p. 95, pl. 21, fig. 2.
Bulimina striata d'Orbigny var. *mexicana*Cushman. – in CUSHMAN and PARKER 1940, p. 16, pl. 3, fig. 9.
Bulimina striata mexicana Cushman. – KOHL 1985, pl. 20, fig. 4. – ROBERTSON 1998, p. 147, pl. 56, fig. 7.
Bulimina mexicana Cushman. – VAN MORKHOVEN et al. 1986, p. 61, pl. 19, figs 1-4.

Occurrence: 6 specimens from 3 samples.

Description: Test triserial, about twice as long as wide, circular in section, initial end acute, chambers inflated, increasing in size slowly, about five clear whorls in adult, sutures depressed, well defined, wall smooth, finely perforate, numerous costae run the length of test, ending in narrow spines at eh margin, aperture an elongate to rounded opening surrounded by a lip and containing a tooth.

Remarks: This species is recorded from many localities in the Miocene and Pliocene of the Atlantic, Gulf of Mexico, Caribbean, and Pacific. It has also been recorded from West Africa.

Bulimina sculptilis Cushman 1923
Plate 17, fig. 6

Bulimina sculptilis CUSHMAN 1923, p. 23, pl. 3, fig. 19. – BOLLI et al. 1994, p. 236, pl. 53, figs 34-35, p. 302, pl. 81, fig. 12.

Occurrence: 6 specimens from 6 samples.

Description: Test triserial, elongate, three times as long as wide, circular in section, initial end rounded, chambers inflated, increasing in size slowly, sutures depressed, well defined, wall smooth, finely perforate, eight to ten costae running length of test, often plate-like, sometimes depressed at sutures, aperture an elongate opening surrounded by a lip and containing a tooth.

Remarks: Occurs in the Late Eocene to Oligocene in Trinidad.

***Bulimina* spp.**
Plate 17, fig. 13

Occurrence: 5 specimens from 3 samples.

Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test triserial, elongate, chambers inflated, sutures depressed.

Family BULIMINELLIDAE Hofka,
Genus *Praeglobobulimina* Hofker 1951

Praeglobobulimina ovata (d'Orbigny 1846)
Plate 17, fig. 14

Bulimina ovata D'ORBIGNY 1846, p. 185, pl. 11, figs 13-14. – BRADY 1884, p. 400, pl. 50, fig. 13.
Praeglobobulimina ovata (d'Orbigny). – JONES 1994, pl. 50, fig. 13.

Occurrence: 5 specimens from 3 samples.

Description: Test triserial, elongate, two and a half times as long as wide, circular in section, initial end tapered, chambers inflated, strongly overlapping earlier ones, increasing in size rapidly, sutures depressed, strongly oblique, wall smooth, finely perforate, aperture an elongate loop-like opening surrounded by a lip and containing a tooth.

Praeglobobulimina socialis (Bornemann 1855)
Plate 18, fig. 1

Bulimina socialis BORNEMANN 1855, p. 342, pl. 16, fig. 10.
Praeglobobulimina socialis (Bornemann). – ROBERTSON 1998, p. 149, pl. 57, fig. 2.

Occurrence: 13 specimens from 5 samples.

Description: Test triserial, ovoid, one and a half times as long as wide, circular in section, initial end rounded, chambers inflated, strongly overlapping earlier ones, increasing in size rapidly, sutures flush with surface becoming slightly depressed, wall smooth, finely perforate, aperture an elongate loop-like opening surrounded by a lip and containing a tooth.

Remarks: Originally described from the Oligocene of Germany, has also been recorded from the Miocene of Jamaica. This species differs from *P. ovata* (d'Orbigny) in its broader outline and less oblique sutures.

Genus *Buliminella* Cushman 1911

***Buliminella* sp.1**
Plate 18, fig. 2

Occurrence: 7 specimens from 3 samples.

Description: Test elongate, trochospiral, few complete whorls, chambers numerous, elongate, broad, low, inflated, sutures depressed, slightly curved, perpendicular to the direction of growth and nearly parallel to the long axis, surface smooth, perforate, aperture a terminal loop.

Subfamily UVIGERININAE Haeckel 1894
Genus *Uvigerina* d'Orbigny 1826

Uvigerina* aff. *carapitana Hedberg 1937
Plate 18, figs 3,4,9

Uvigerina carapitana HEDBERG 1937, p. 677, pl. 91, fig. 20. – – CUSHMAN and RENZ 1947, p. 29, pl. 6, fig. 15. – BOERSMA 1984, p. 28, pl. 1, figs 1-5. – BOLLI et al. 1994, p. 238, pl. 54, figs 3-4, p. 296, pl. 78, fig. 33.

Occurrence: 648 specimens from 36 samples.

Description: Test triserial, elongate in adult, length three times the width, widest near the centre, initial end acute, chambers inflated, increasing in size rapidly in early stage, then increasing slowly, about eight whorls in total, sutures depressed, wall smooth, finely perforate, aperture a rounded opening at the end of a raised neck.

Remarks: This species usually occurs as the juvenile form in the studied samples. Differs slightly in morphology from *U. carapitana* by lacking feint striae, and occasionally possessing more than three chambers. Was originally described from the mid Tertiary of Venezuela.

Uvigerina hispida Schwager 1866
Plate 18, figs 6-8

Uvigerina hispida SCHWAGER 1866, p. 249, pl. 7, fig. 95. – VAN MORKHOVEN et al. 1986, p. 62, pl. 20, figs 1-4. – Boersma 1984, p. 74, pl. 1, figs 1-5.

Occurrence: 43 specimens from 16 samples.

Description: Test triserial, elongate in adult, length twice the width, widest near the apertural end, initial end rounded, chambers inflated, increasing in size rapidly, about three whorls in total, sutures depressed, wall finely perforate, hispid, covered in long narrow spines, aperture a rounded opening at the end of a raised neck.

Remarks: *Uvigerina hispida* is a cosmopolitan species recorded from the Miocene to Pleistocene of all major oceans.

Uvigerina macrocarinata Papp and Turnovsky 1953
Plate 18, figs 10-12

Uvigerina macrocarinata PAPP and TURNOVSKY 1953, p. 123. – BOERSMA 1984, p. 99, pl. 1, figs 1-5.

Occurrence: 105 specimens from 19 samples.

Description: Test triserial, circular in section, large in size, elongate, length twice the width, widest in mid to upper part of test, initial end rounded, chambers inflated, increasing in size rapidly, about three whorls in total, sutures depressed, wall finely perforate, covered in six to eight costae per chamber, sometimes platy, rarely running full length of test, aperture a rounded opening at the end of a raised neck, set into a slight depression.

Remarks: Originally described from the Early Miocene of Europe, this is a widespread Tethyan form ranging up to the Pliocene.

Uvigerina mantaensis Cushman and Edwards 1938
Plate 19, figs 1,2

Uvigerina mantaensis CUSHMAN and EDWARDS 1938, p. 84, pl. 14, fig. 8. – CUSHMAN and STAINFORTH 1945, p. 47, pl. 7, fig. 17. – BERMÚDEZ 1949, p. 207, pl. 13, fig. 48. – BOERSMA 1984, p. 103, pl. 1, figs 1-6. – KOHL 1985, pl. 24, fig. 4.

Occurrence: 194 specimens from 18 samples.

Description: Test triserial, elongate, length twice the width, widest in mid part of test, initial end rounded, chambers very inflated, increasing in size rapidly, about three whorls in total, sutures depressed, wall finely perforate, covered in densely spaced fine hisps, , aperture a rounded opening at the end of a raised neck, set into a slight depression.

Remarks: Originally described from the Tertiary of Ecuador, this species ranges from the Oligocene to Miocene in the Caribbean, and the Miocene of West Africa (Boersma 1984).

Uvigerina* aff. *mediterranea Hofker 1932
Plate 19, fig. 3

Uvigerina mediterranea HOFKER 1932, p. 118, fig. 32 – VAN DER ZWAAN et al. 1986, pl. 5, figs 1-7.

Occurrence: 4 specimens from 3 samples.

Description: Test triserial, circular in section, large in size, length about twice the width, widest in mid to upper part of test, initial end rounded, chambers much inflated, increasing in size rapidly, about two to three whorls in total, sutures depressed, wall finely perforate, ornamented with costae usually restricted to each chamber, ridge-like, either running parallel to long axis, or in irregular plane, aperture a rounded opening at the end of a raised neck, set into a slight depression, containing lip.

Remarks: Common from the Mediterranean and Atlantic regions, true *U. mediterranea* posses slightly longer tests and is restricted from Pliocene to Recent. It is possible that these few specimens are caved from stratigraphically younger sections in the well.

Uvigerina proboscidea Schwager 1866
Plate 19, fig. 4

Uvigerina proboscidea SCHWAGER 1866, p. 250, pl. 7, fig. 96. – BOERSMA 1984, p. 131, pl. 1, figs 1-5. – VAN MORKHOVEN et al. 1986, p. 29, pl. 6, figs 1-4.

Occurrence: 5 specimens from 1 sample.

Description: Test triserial becoming biserial, elongate in adult, length twice the width, widest near the central part of test, initial end rounded, chambers inflated especially in the middle of test, increasing in size rapidly, sutures depressed, wall finely perforate, ornamented with numerous short hisps, aperture a rounded opening at the end of a raised neck.

Remarks: Boersma (1984) records this taxon as a cosmopolitan form from the Early Miocene to Recent but however, migrated to depths greater than 1000 metres only by the Late Miocene.

Uvigerina spinulosa Hadley 1934
Plate 18, fig. 5

Uvigerina spinulosa HADLEY 1934, p. 18, pl. 2, fig. 17. – BOERSMA 1984, p. 163, pl. 1, figs 1-6. – VAN MORKHOVEN et al. 1986, p. 218, pl. 74, figs 1-3.

Occurrence: 5 specimens from 4 sample.

Description: Test triserial, elongate in adult, length two to three times the width, widest near the centre, initial end rounded, chambers inflated, increasing in size rapidly, about five whorls in total, sutures much depressed, wall smooth, coarsely perforate, coarse striae run vertically down each chamber, sometimes bifurcating, sometimes forming slight spines at margin, aperture a rounded opening at the end of a raised neck.

Remarks: Originally described from Cuba, this species is recorded from Oligocene to Pliocene localities around the Pacific and Atlantic Oceans.

Family FURSENKOINIDAE Loeblich and Tappan 1961
Genus *Fursenkoina* Loeblich and Tappan 1961

Fursenkoina bramlettei (Galloway and Morrey 1929)
Plate 19, fig. 5

Virgulina bramlettei GALLOWAY and MORREY 1929, p. 37, pl. 5, fig. 14. – CUSHMAN 1937b, p. 19, pl. 3, figs 6-9.
Fursenkoina bramlettei (Galloway and Morrey). – KOHL 1985, pl. 29, fig. 1.

Occurrence: 3 specimens from 2 samples.

Description: Test biserial, elongate, narrow, width about five times the length, slightly compressed, ovate in section, chambers slightly inflated, about five pairs in total, sutures depressed, wall smooth, aperture terminal narrow opening.

Remarks: Originally described from the Tertiary of Ecuador, this species has been recorded also from California and Mexico where it possesses a slight twist in the initial portion.. Ranges from Oligocene to Holocene.

Family STILOSTOMELLIDAE Finlay 1947
Genus *Neugeborina* Popescu 1998

Neugeborina longiscata (d'Orbigny 1846)
Plate 19, fig. 6

Nodosaria longiscata D'ORBIGNY 1846, p. 32, pl. 1, figs 10-12. – CUSHMAN and STAINFORTH 1945, p. 24, pl. 3, figs 19-21. – BERMÚDEZ 1949, p. 145, pl. 9, fig. 57. – KOHL 1985, pl. 6, fig. 3. – PAPP and SCHMID 1985, p. 113, pl. 3, figs 1-5.
Neugeborina longiscata d'Orbigny. – CICHA et al.,1998, p. 195, pl. 21, fig. 12.

Occurrence: 2 specimens from 2 samples.

Description: Test much elongated, chambers cylindrical, not increasing in width as added, sutures slightly depressed, wall smooth.

Remarks: Transferred by Cicha et al. (1998), this species is cosmopolitan from the Oligocene to Miocene.

Genus *Siphonodosaria* Silvestri 1924

***Siphonodosaria* aff. abyssorum** (Brady 1881)
Plate 19, fig. 7

Nodosaria abyssorum BRADY 1881, pl. 63, figs 8-9.
Siphonodosaria abyssorum (Brady). – LOEBLICH and TAPPAN 1987, pl. 858, figs 5-7.
Stilostomella abyssorum (Brady). – JONES 1994, pl. 63, figs 8-9, suppl. pl. 2, figs 8-9.

Occurrence: 14 specimens from 7 samples.

Description: Test uniserial, elongate, rectilinear to arcuate, chambers globular, increasing gradually in size as added, sutures slightly depressed, striae sometimes present at sutures, wall smooth, aperture terminal.

Remarks: Originally described from the Recent of the South Pacific.

Genus *Stilostomella* Guppy 1894

Stilostomella adolphina (d'Orbigny 1846)
Plate 19, fig. 8

Dentalina adolphina D'ORBIGNY 1846, p. 51, pl. 2, figs 18-20.
Stilostomella adolphina (d'Orbigny). – PAPP and SCHMID 1985, p. 135, pl. 14, figs 8-11.

Occurrence: 22 specimens from 12 samples.

Description: Test uniserial, elongate, rectilinear, chambers globular, increasing gradually in size as added, occasionally decreasing as added, sutures depressed, wall smooth, spines present at margin in the form of downward pointing projections, up to two rows per chamber, aperture terminal.

Remarks: Originally described from the Tertiary of the Vienna Basin.

Stilostomella subspinosa (Cushman 1943)
Plate 19, figs 9-11

Ellipsonodosaria subspinosa CUSHMAN 1943, p. 92, pl. 16, figs 6-7. – CUSHMAN and STAINFORTH 1945, p. 56, pl. 9, figs 9-10.
Stilostomella subspinosa (Cushman). – BOLLI et al 1994, p. 256, pl. 63, fig. 30.

Occurrence: 29 specimens from 14 samples.

Description: Test uniserial, elongate, rectilinear, chambers globular, increasing gradually in size as added, overlapping previous chambers by varying degrees, sutures slightly depressed, wall spinose, either covering the entirety of the chamber, or on the lower half in the early chambers, aperture terminal.

Remarks: This species was first described from the Middle Miocene of Trinidad.

Subfamily BAGGINA Cushman 1926
Genus *Valvulineria* Cushman 1926

Valvulineria pseudotumeyensis Futyan1976
Plate 19, fig. 12-15

Valvulineria pseudotumeyensis FUTYAN,1976, p. 531, pl. 83, figs 4-6.

Occurrence: 453 specimens from 22 samples.

Description: Test low trochospiral, periphery broadly rounded to slightly elongate, biconvex in side view, chambers distinct, increasing in size steadily as added, nine to ten in the final whorl, sutures distinct, curved on spiral side, straighter on umbilical side, limbate, raised on spiral side, sometimes slightly raised on umbilical side, wall smooth, perforate, aperture an extraumbilical slit covered by a large umbilical flap, and bordered by a fine lip at the base of the apertural face.

Remarks: This species was originally described from the Early Eocene of southern Jordan, and appears there in chalk overlying the Paleocene / Eocene boundary in high abundance but only four samples. Our specimens differ only in having slightly smaller and less raised sutures on the spiral side.

Family DISCORBIDAE Ehrenberg 1838
Genus *Neoeponides* Reiss 1960

Neoeponides campester (Palmer and Bermúdez 1941)
Plate 20, figs 1,2

Eponides byramensis (Cushman) var. *cubensis* PALMER and BERMÚDEZ 1936, p. 302, pl. 20, figs 4-6.
Eponides byramensis (Cushman) var. *campester* Palmer and Bermúdez, *in* Palmer 1941, *nom. nov*., p. 192.
Gyroidinoides byramensis (Cushman) var. *campester* (Palmer and Bermúdez). – RENZ 1948, p. 139, pl. 8, fig. 15, pl. 9, fig. 1.
Neoeponides campester (Palmer and Bermúdez). – VAN MORKHOVEN et al. 1986, p. 153, pl. 50, fig. 1. – ROBERTSON 1998, p. 181, pl. 73, fig. 4.

Occurrence: 27 specimens from 6 samples.

Description: Test low trochospiral, periphery acute and limbate, biconvex in side view, umbilical side slightly more elevated, chambers narrow on spiral side, increasing in size only gradually as added, seven to ten in the final whorl, sutures oblique on spiral side, slightly curved on umbilical, limbate, wall smooth, coarsely perforate, aperture a long slit stretching from the umbilicus to the margin along the base of the apertural face, bordered by a fine lip at the base of the apertural face.

Remarks: This species was first described from the Oligocene of Cuba, and has since been reported from Venezuela, Trinidad, Jamaica, Pacific, Atlantic and Europe from Oligocene to Middle Miocene sediments.

Family SPHAEROIDINIDAE Cushman 1927
Genus *Sphaeroidina* d'Orbigny 1826

Sphaeroidina bulloides d'Orbigny 1826
Plate 20, fig. 3

Sphaeroidina bulloides D'ORBIGNY 1826, p. 267, Modeles no. 65.
Sphaeroidina bulloides d'Orbigny. – CUSHMAN and TODD 1945, p. 65, pl. 11, fig. 9. – LEROY and LEVINSON 1974, p. 8, pl. 5, fig. 2. – KOHL 1984, pl. 14, fig. 6. – VAN MORKHOVEN et al. 1986, p. 81, pl. 24, figs 1-2.

Occurrence: 30 specimens from 11 samples.

Description: Test rounded globular in outline, coiling trochospiral becoming irregular streptospiral, chambers inflated, three visible in the outer whorl, strongly embracing, sutures distinct and depressed, wall smooth, imperforate, aperture at the base of the final chamber, crescent shaped, surrounded by a slight lip.

Remarks: This species has been reported from Oligocene to Pliocene sediments in the Atlantic, Gulf of Mexico, California, Pacific, Europe and the Mediterranean.

Family PARRELLOIDINIDAE Hofka 1956
Genus *Cibicidoides* Thalmann 1939

Cibicidoides crebbsi (Hedberg 1937)
Plate 20, figs 4, 5

Eponides crebbsi HEDBERG 1937, pl. 92, fig. 1. – CUSHMAN and RENZ 1947, pl. 7, fig. 19. – RENZ 1948, pl. 12, fig. 26. – BOLLI et al. 1994, p. 240, pl. 55, figs 16-17, p. 298, pl. 79, fig. 8.
Cibicidoides crebbsi (Hedberg). – DÍAZ DE GAMERO 1985, pl. 7, fig. 12. – VAN MORKHOVEN et al. 1986, p. 140, pl. 45A, figs 1-2, p. 142, pl. 45B, fig. 1.

Occurrence: 715 specimens from 24 samples.

Description: Test low trochospiral, periphery acute and limbate, biconvex to planoconvex in side view, spiral side sometimes flat, chambers narrow on spiral side, increasing in size only gradually as added, ten to thirteen in the final whorl, sutures curved on spiral side, curved sigmoidal on umbilical, meeting in centre to form an umbo, wall smooth, coarsely perforate, aperture a basal slit stretching from the umbilicus to the margin along the base of the apertural face, bordered by a lip at the base of the apertural face.

Remarks: Originally described from the Middle Tertiary of Venzuela, this species had been recorded from Late Oligocene

to Middle Miocene bathyal deposits from the Gulf of Mexico and West Africa.

Cibicidoides dohmi Bermúdez 1949
Plate 21, figs 1, 3

Cibicidoides dohmi BERMÚDEZ 1949, p. 297, pl. 24, figs 25-27. – VAN MORKHOVEN, et al. 1986, p. 197, pl. 66, figs 1-2.

Occurrence: 9 specimens from 7 samples.

Description: Test low trochospiral, rounded in outline, stout in side view, flattened to slightly convex spiral side, strongly convex dorsal side, umbo on spiral side, margin sub rounded, chambers numerous, fourteen to fifteen in final whorl, sutures not distinct, curved on both sides, wall smooth, very coarsely perforate on both sides, aperture a slit at the base of the last chamber, extending partly towards the umbilicus.

Remarks: This species was originally described from the Tertiary of the Dominican Republic. It has been observed also in the Atlantic and Pacific Oceans throughout the Late Oligocene to Middle Miocnene.

Cibicidoides grimsdalei (Nuttall 1930)
Plate 21, fig. 2

Cibicides grimsdalei NUTTALL 1930, p. 291, pl. 25, figs 7-8 11. – VAN MORKHOVEN et al. 1986, p. 248, pl. 83A, figs 1-3, p. 250, pl. 83B, figs 1-7.

Occurrence: 10 specimens from 6 samples.

Description: Test low trochospiral, rounded in outline, stout in side view, almost as thick as wide, flattened to slightly convex spiral side, strongly convex dorsal side, margin rounded, chambers increase in size gradually, sutures depressed, curved on both sides, wall smooth, very coarsely perforate on both sides, irregular pitting on spiral side, aperture small and arched, located on the margin and extending into the spiral side, bordered by a prominent lip.

Remarks: Originally described from the Eocene of Mexico, this species has been recorded ranging up to the Early Miocene in the Pacific Ocean.

Cibicidoides guazumalensis (Bermúdez 1949)
Plate 21, fig. 4

Cibicides subtenuissimus (Nuttall) var. *guazumalensis* BERMÚDEZ 1949, p. 306, pl. 25, figs 43-45.
Cibicidoides guazumalensis (Bermúdez). – VAN MORKHOVEN et al. 1986, p. 144, pl. 46, figs1-2.

Occurrence: 3 specimens from 3 samples.

Description: Test low trochospiral, rounded to oval in outline, planoconvex, spiral side flat, umbilical side conical, periphery acute, chambers numerous, nine to ten in final whorl, sutures slightly depressed on umbilical side, strongly sigmoidal, flush on spiral side, curved, aperture a small low slit at the base of the apertural face, bordered by a lip.

Remarks: Miocene species from localities in Europe and the Atlantic.

Cibicidoides havanensis (Cushman and Bermúdez 1937)
Plate 21, fig. 5, Plate 22, fig. 1

Cibicides havanensis CUSHMAN and BERMÚDEZ 1937, p. 28, pl. 3, figs 1-3. – VAN MORKHOVEN et al. 1986, p. 191, pl. 64A, figs 1-4, p. 192, pl. 64B, figs 1-2. – ROBERTSON 1998, p. 195, pl. 80, fig. 1. – KUHNT et al. 2002, p. 143, pl. 8, figs 1-11.

Occurrence: 36 specimens from 19 samples.

Description: Test low trochospiral, round in outline, biconvex, half as thick as wide, margin acute, chambers increase in size only gradually, numerous, sutures straight and oblique on umbilical side, largely obscured on spiral, wall smooth, coarsely perforate on both sides, aperture small and arched, located on the margin of final chamber.

Remarks: Originally described from the Eocene of Cuba, this species is cosmopolitan and has been recorded in deposits as young as Middle Miocene.

Cibicidoides mundulus (Brady, Parker and Jones 1888)
Plate 22, figs 2,3

Truncatulina mundula BRADY, PARKER and JONES 1888, p. 228, pl. 45, fig. 25.
Cibicidoides mundulus (Brady, Parker and Jones). LOEBLICH and TAPPAN 1955, p. 25, pl. 4, fig. 4. – VAN MORKHOVEN et al. 1986, p. 66, pl. 21, fig. 1.

Occurrence: 145 specimens from 40 samples.

Description: Test low trochospiral, round in outline, biconvex, margin acute, chambers increase in size only gradually, ten to twelve in final whorl, sutures curved, flush with surface, wall smooth, coarsely perforate, aperture small and arched, located on the margin of final chamber.

Remarks: A long ranging species, *C. mundulus* is cosmopolitan throughout from Oligocene to Pleistocene.

Cibicidoides pachyderma (Rzehak 1886)
Plate 22, fig. 4

Truncatulina pachyderma RZEHAK 1886, p. 87, pl. 1, fig. 5.
Cibicidoides pachyderma (Rzehak). – VAN MORKHOVEN et al. 1986, p. 71, pl. 22, fig. 1.

Occurrence: 82 specimens from 21 samples.

Description: Test low trochospiral, round in outline, biconvex, margin acute with keel, chambers increase in size only gradually, numerous, ten to twelve in final whorl, sutures slightly curved and oblique on umbilical side, strongly curved on spiral side, wall smooth, coarsely perforate on both sides, aperture small and arched, located on the margin of final chamber.

Remarks: This species has been reported in Oligocene to Pleistocene sediments and has a cosmopolitan distribution.

***Cibicidoides* spp.**
Occurrence: 372 specimens from 21 samples.

Description: Included in this group are all fragmentary and unassigned forms, including internal moulds, displaying the following characteristics: test trochospiral, rounded in outline, chambers increase in size only gradually, wall smooth.

Subfamily PSEUDOPARRELLINAE Voloshinova 1952
Genus *Megastomella* Faulkner, de Klasz and Rérat 1963

Megastomella africana Faulkner de Klasz and Rérat 1963
Plate 22, fig. 6

Megastomella africana FAULKNER, DE KLASZ and RÉRAT 1963, p. 19.

Megastomella africana Faulkner, de Klasz and Rérat. – LOEBLICH and TAPPAN 1987, p. 574, pl. 627, fig. 1.

Occurrence: 6 specimens from 5 samples.

Description: Test low trochospiral, oval in outline, flattened biconvex, margin acute, chambers increase in size rapidly, eight to nine in final whorl, sutures slightly curved, wall smooth, perforate, aperture a long vertical slit extending up the face of the relatively high apertural face, from the umbilicus to the margin.

Remarks: This species has been recorded from the Lower to Upper Miocene of Gabon, West Africa, and California.

Family PLANULINIDAE Bermúdez 1952
Genus *Planulina* d'Orbigny 1826

Planulina renzi Cushman and Stainforth 1945
Plate 23, figs 1-3

Planulina renzi CUSHMAN and STAINFORTH 1945, p. 72, pl. 15, fig. 1. – VAN MORKHOVEN et al. 1986, p. 134, pl. 43A, figs 1-5, p. 136, pl. 43B, figs 1-2.

Occurrence: 10 specimens from 8 samples.

Description: Test large, low trochospiral, oval in outline, very flattened biconvex, margin acute, strong keel, sixteen to eighteen chambers in final whorl, increasing in size slowly, sutures curved, limbate, raised greatly and ornamented with pustules, wall smooth, highly perforate, aperture a narrow basal opening bordered by a lip.

Remarks: A truly cosmopolitan species ranging from the Oligocene to Miocene from bathyal environmants.

Subfamily NONIONINAE Schultz 1854
Genus *Nonion* de Montford 1808

***Nonion* sp. 1**
Plate 22, fig. 5

Occurrence: 49 specimens from 18 samples.

Description: Test planispiral, oval in outline, coiling involute, slightly compressed, periphery broadly rounded, chambers inflated, increasing in size rapidly as added, about seven in the final whorl, sutures intensely depressed at umbilicus, becoming less so towards to periphery, curved, wall smooth, aperture a slit at the base of the apertural face.

Subfamily PULLENIINAE Schwager 1877
Genus *Melonis* de Montford 1808

Melonis pompilioides (Fichtel and Moll 1798)
Plate 23, fig. 4

Nautilus pompilioides FICHTEL and MOLL 1798, p. 31, pl. 2, figs a-c.
Melonis pompilioides (Fichtel and Moll). – RÖGL and HANSEN 1984, p. 30, pl. 2, figs 1-2. – VAN MORKHOVEN et al. 1986, p. 73, pl. 23A, figs 1-2, p. 75, pl. 23B, figs 1-2, p. 77, pl. 23C, fig. 1, p. 73, pl. 23A, figs 1-2, p. 78, pl. 23D, fig. 1, p. 79, pl. 23E, fig. 1.

Occurrence: 31 specimens from 17 samples.

Description: Test small, planispiral, involute, round in outline, almost as broad as wide, margin round, nine to eleven chambers in final whorl, increasing in size slowly, sutures straight, flush with surface, wall smooth, coarsely perforate, aperture wide narrow interiomarginal basal slit bordered by a lip.

Remarks: Recorded globally from deposits spanning the Oligocene to Pleistocene.

Genus *Pullenia* Parker and Jones,1862

Pullenia bulloides (d'Orbigny 1846)
Plate 23, fig. 5

Nonionina bulloides D'ORBIGNY 1826, p. 293. – D'ORBIGNY 1846, p. 107, pl. 5, figs 9-10.
Pullenia bulloides (d'Orbigny). – GALLOWAY and MORREY 1929, p. 43, pl. 6, fig. 16. KOHL 1985, pl. 32, fig. 5. – PAPP and SCHMID 1985, p. 175, pl. 34, figs 6-9.

Occurrence: 6 specimens from 5 samples.

Description: Test small, planispiral, involute, almost spherical, four to five chambers in final whorl, globular, increasing in size slowly, sutures straight, flush with surface, wall smooth, very finely perforate, aperture wide narrow interiomarginal basal slit bordered by a lip.

Remarks: This species, originally described from the Tertiary of the Vienna Basin, is cosmopolitan and has been recorded from sediments Oligocene to Recent in age.

Family ORIDORSALIDAE Loeblich and Tappan 1984
Genus *Oridorsalis* Andersen 1961

Oridorsalis umbonatus (Reuss 1851)
Plate 23, fig. 6, Plate 24, figs 1,2

Rotalia umbonata REUSS 1851, p. 75, pl. 5, fig. 35.
Rotalia ecuadorensis Galloway and Morrey 1929, p. 26, pl. 3, fig. 13.
Eponides umbonatus (Reuss) var. *ecuadorensis* (Galloway and Morrey). – Hedberg 1937, p. 679, pl. 91, fig. 22.
Oridorsalis umbonatus (Reuss). – SAUNDERS et al. 1984, p. 408, pl. 4, fig. 10. – BOLLI et al. 1994, p. 247, pl. 58, figs 10-13.

Occurrence: 265 specimens from 23 samples.

Description: Test trochospiral, round in outline, biconvex, about half as thick as wide, umbilical side more convex than spiral, margin acute, sometimes with developed fine keel, chambers increase in size gradually, six in final whorl, sutures radial, straight to slightly curved on spiral side, straight to becoming strongly curved on the umbilical side near the umbo, sutures flush to test, wall smooth, aperture a small arch, located in the bottom centre of the apertural face, surrounded by a lip.

Remarks: The species originally described by Reuss differs from some of our specimens in having a developed keel and straight umbilical sutures. These characteristics are present in some of the specimens analysed in this study, and we see a complete gradation between these forms and ones containing strongly curved sutures on the umbilical side and an acute periphery but no keel. We regard these features as variable within the species, and use wall structure, number of chambers, a high umbilical side and aperture as defining characteristics. Under this *description* falls the specimens described and pictured by Galloway and Morrey as *Rotalia ecuadorensis*.

Subfamily GYROIDINOIDINAE Saidova 1981
Genus *Gyroidinoides* Brotzen 1942

Gyroidinoides altiformis (Stewart and Stewart 1930)
Plate 24, fig. 3

Gyroidina soldanii (d'Orbigny) var. *altiformis* STEWART and STEWART 1930, p. 67, pl. 9, fig. 2.
Gyroidinoides altiformis (Stewart and Stewart). – BECKMAN 1953, p. 381, pl. 23, fig. 22. – BECKER and DUSENBURY 1958, p. 38, pl. 5, fig. 1. – KOHL 1985, p. 95, pl. 34, fig. 3.

Occurrence: 45 specimens from 15 samples.

Description: Test large, trochospiral, round in outline, biconvex, spiral side sometimes flat, umbilical side highly convex, margin sub acute, chambers increase in size gradually, ten in the final whorl, sutures limbate, straight and oblique on spiral side, radial on the umbilical side, slightly depressed, wall smooth, aperture a long slit located at the base of the apertural face stretching from the margin to the umbilicus, with a small flap extending into the umbilicus.

Remarks: Originally described form the Pliocene of California, this species has also been recorded from Oligocene to Holocene sediments from Central America and the Gulf of Mexico.

Gyroidinoides altispira (Cushman and Stainforth 1945)
Plate 24, fig. 4

Gyroidina altispira CUSHMAN and STAINFORTH 1945, p. 61, pl. 11, fig. 1. – BERMÚDEZ 1949, pl. 252, pl. 17, figs 58-60.
Gyroidinoides altispira (Cushman and Stainforth). – ROBERTSON 1998, p. 244, pl. 98, fig. 2.

Occurrence: 1 specimen from 1 sample.

Description: Test trochospiral, round in outline, biconvex, spiral side highly convex, margin sub acute, chambers increase in size gradually, ten in the final whorl, sutures limbate, straight and oblique on spiral side, radial on the umbilical side, slightly depressed, wall smooth, aperture a long slit located at the base of the apertural face stretching from the margin to the umbilicus, with a small flap extending into the umbilicus.

Remarks: Has been reported from the Oligocene to Miocene of Trinidad, the Dominican Republic and Jamaica.

Gyroidinoides soldanii (d'Orbigny 1826)
Plate 25, figs 1,2

Gyroidina soldanii D'ORBIGNY 1826, p. 278 (fide Ellis and Messina 1940). – CUSHMAN 1929, pl. 14, fig. 7. – PAPP and SCHMID 1985, p. 60, pl. 50, figs 4-9.
Rotalina soldanii D'ORBIGNY 1846, p. 155, pl. 8, figs 10-12.
Gyroidinoides cf. *soldanii* (d'Orbigny). – RENZ 1948, p.140, pl. 8, fig. 14. – Bolli et al. 1994, p. 378, pl. 80, fig. 4.
Gyroidinoides soldanii (d'Orbigny). – CIMERMAN and LANGER 1991, p. 75, pl. 85, figs 5-6.

Occurrence: 81 specimens from 20 samples.

Description: Test trochospiral, round in outline, biconvex, spiral side sometimes flat, umbilical side highly convex, margin sub acute, chambers inflated, increasing in size gradually, eight to ten in the final whorl, sutures depressed, radial and straight on spiral and umbilical sides, wall smooth, aperture a slit located at the base of the apertural face stretching from the margin to the umbilicus, with a small flap extending into the umbilicus.

Remarks: Originally described from the Recent of Italy, this species has also been reported from the Tertiary of the Vienna Basin, Venezuela and California. The presence of an umbilical flap in the studied specimens places the species in the genus *Gyroidinoides*.

Subfamily GRAVELLINAE Hofker 1956
Genus *Gyroidina* d'Orbigny 1826

Gyroidina orbicularis d'Orbigny 1826
Plate 25, figs 3,4

Gyroidina orbicularis D'ORBIGNY 1826, p. 278, Modeles no. 13 (a plaster-caste model was used to depict this species). – PHLEGER and PARKER 1951, p. 22, pl. 11, figs 11-12. – LEROY and LEVINSON 1974, p. 14, pl. 7, figs 14-16. – KOHL 1985, p. 93, pl. 33, figs 1-2.

Occurrence: 20 specimens from 11 samples.

Description: Test trochospiral, round in outline, biconvex, spiral side sometimes flat, umbilical side convex, margin sub acute, chambers increase in size gradually, eight to ten in the final whorl, sutures straight and oblique on spiral side, radial on the umbilical side, slightly depressed, wall smooth, aperture a slit located at the base of the apertural face stretching from the margin to the umbilicus, with a narrow lip.

Remarks: This species has been recorded from the Holocene of the Atlantic, Pacific, Adriatic and Gulf of Mexico, and from the Neogene of Papua New Guinea.

Gyroidina umbonata (Silvestri 1898)
Plate 26, fig. 1

Rotalia soldanii d'Orbigny var. *umbonata* SILVESTRI 1898, p. 239, pl. 6, fig. 14.
Gyroidina umbonata (Silvestri). – KOHL 1985, p. 94, pl. 33, fig. 3.

Occurrence: 1 specimen from 1 sample.

Description: Test trochospiral, round in outline, spiral side flat, umbilical side convex, margin sub rounded, chambers inflated, increasing in size gradually, seven in the final whorl, sutures straight, depressed, wall smooth, aperture a slit located at the base of the apertural face stretching from the margin to the umbilicus, with a narrow lip.

Remarks: Originally described from the Pliocene of Italy, this species is also recorded from the Miocene of Venezuela and Pliocene of Mexico.

Genus *Hanzawaia* Asano 1944

Hanzawaia mantaensis (Galloway and Morrey 1929)
Plate 26, figs 3,4

Anomalina mantaensis GALLOWAY and MORREY 1929, p. 28, pl. 4, fig. 5.
Cibicides mantaensis (Galloway and Morrey). – HEDBERG 1937, p. 683, pl. 92, fig. 12. – CUSHMAN and RENZ 1947, p. 44, pl. 8, fig. 7.
Hanzawaia mantaensis (Galloway and Morrey). – BOLLI et al. 1994, p. 379, pl. 61, figs 1-3, pl. 80, fig. 7.

Occurrence: 242 specimens from 25 samples.

Description: Test low trochospiral, oval in outline, higher than wide, spiral side flat to slightly convex, umbilical side slightly convex, margin acute, chambers increasing in size gradually, ten to thirteen in the final whorl, sutures strongly curved, strongly limbate, raised, wall smooth, perforate, aperture a slit located at the base of the apertural face, with a narrow lip.

Remarks: Originally described from the lower Tertiary of Ecuador, this species has also been recorded from Venezuela and Trinidad.

***Hanzawaia* sp. 1**
Plate 26, fig. 2

Occurrence: 16 specimens from 7 samples.

Description: Test low trochospiral, oval in outline, higher than wide, spiral and umbilical sides slightly convex, margin sub acute, chambers increasing in size gradually, nine in the final whorl, sutures curved, depressed, especially in the umbilical region, wall smooth, aperture a slit located at the base of the apertural face.

Remarks: Differs from *H. carstansi* (Cushman and Ellisor) in having depressed sutures rather than limbate, and a more rounded periphery.

Subfamily AMMONIINAE Saidova 1981
Genus *Ammonia* Brunnich 1772

Ammonia* cf. *parkinsoniana (d'Orbigny 1839)
Plate 26, fig. 5

Rosalina parkinsoniana D'ORBIGNY 1839, p. 99, pl. 4, figs 25-27.
Ammonia parkinsoniana (d'Orbigny). – LE CALVEZ 1977, p. 92, pl. 11, figs 1-3. – CIMERMAN and LANGER 1991, p. 76, pl. 87, figs 7-9.

Occurrence: 1 specimen from 1 sample.

Description: Test low trochospiral, round in outline, spiral side convex, umbilical side slightly convex, margin sub acute, chambers increasing in size gradually, nine in the final whorl, sutures straight, strongly depressed on the umbilical side, with deeply incised cavities between chambers, well developed knob in umbilicus, wall smooth, perforate, aperture an interiomarginal opening at the base of the apertural face, slit-like, extending toward the umbilicus.

Remarks: Differs from true *A. parkinsoniana* by having a more rounded outline, and more convex umbilical side. This species was first described from the Recent of Cuba.

***Ammonia* sp.**
Plate 26, fig. 6

Occurrence: 6 specimens from 4 samples.

Description: Included in this group are all unassigned forms, including internal moulds, displaying the following characteristics: test trochospiral, rounded in outline, biconvex, chambers increasing in size slowly, strongly depressed sutures on the umbilical side, with deeply incised cavities between chambers, wall smooth, aperture slit-like opening at the base of the apertural face.

PLANKTONIC FORAMINIFERA

Catapsydrax unicavus Bolli, Loeblich and Tappan 1957
Plate 27, fig. 1

Catapsydrax unicavus BOLLI, LOEBLICH and TAPPAN 1957, p. 37, pl. 7, fig. 9.
Catapsydrax unicavus Bolli, Loeblich and Tappan. – KENNETT and SRINIVASAN 1983, p. 26, pl. 3, figs 1-3.

Occurrence: 4 specimens from 5 samples.

Remarks: Contains three chambers in the final whorl, with a bulla attached by three sides. *G. suteri* differs in having four chambers and bulla, and an interiomarginal aperture.

Stratigraphic distribution: Late Eocene to top zone N6 (Kennett and Srinivasan 1983).

Dentoglobigerina altispira altispira (Cushman and Jarvis 1936)
Plate 29, fig. 3

Globigerina altispira CUSHMAN and JARVIS 1936, p. 5, pl. 1, fig. 13.
Dentoglobigerina altispira altispira (Cushman and Jarvis). – KENNETT and SRINIVASAN 1983, p. 188, pl. 46, figs 4-6.
Globoquadrina altispira altispira (Cushman and Jarvis). – BOLLI and SAUNDERS 1985, p. 183, pl. 15, fig. 1.

Occurrence: 3 specimens from 3 samples.

Stratigraphic distribution: Late Oligocene to Early Pliocene (Kennett and Srinivasan 1983).

Globigerina praebulloides Blow 1959
Globigerina praebulloides BLOW 1959, p. 180, pl. 8, fig. 47, pl. 9, fig. 48.

Occurrence: Several specimens present.

Stratigraphic distribution: Late Eocene to Late Miocene (Kennett and Srinivasan 1983).

Globigerinella obesa (Bolli 1957)
Plate 29, fig. 4

Globorotalia obesa BOLLI 1957, p. 119, pl. 29, figs 2,3.
Globigerinella obesa (Bolli 1957). – KENNETT and SRINIVASAN 1983, p. 234, pl. 59, figs 2,3.

Occurrence: 19 specimens from 11 samples.

Remarks: Four to four-and-a-half chambers in the final whorl, periphery strongly lobate.

Stratigraphic distribution: Late Oligocene to Recent.

Globigerinella praesiphonifera (Blow 1969)
Plate 29, fig. 6

Hastigerina (H.) siphonifera praesiphonifera BLOW 1969, p. 408, pl. 54, figs 7-9.
Globigerinella praesiphonifera (Blow 1969). – KENNETT and SRINIVASAN 1983, p. 238, pl. 60, figs 1-3.

Occurrence: 5 specimens from 4 samples.

Remarks: Five chambers in the final whorl, lobate periphery.

Stratigraphic distribution: Zone N4 to N13 (Kennett and Srinivasan 1983).

Globigerinoides bisphericus Todd 1954
Plate 27, figs 5, 8

Globigerinoides bisphericus TODD 1954, p. 681, pl. 1, fig. 1. – JENKINS et al. 1981, p. 265, pl. 1, fig. 1. – BOLLI and SAUNDERS 1985, p. 199, pl. 24, fig. 8.

Occurrence: 24 specimens from 14 samples.

Remarks: Distinguished from *G. trilobus* in possessing two slit-like apertures.

Stratigraphic distribution: Base N7 to top of *P. sicana* range intra N9 (Bolli and Saunders 1985).

Globigerinoides immaturus LeRoy 1939
Plate 27, fig. 3

Globigerinoides sacculiferus (Brady) var. *immature* LEROY 1939, p. 263, pl. 3, figs 19-21.
Globigerinoides immaturus LeRoy. – KENNETT and SRINIVASAN 1983, p. 64, pl. 13, figs 7-9.

Occurrence: Several specimens present.

Remarks: Distinguished from *G. trilobus* in possessing a less dominant final chamber.

Stratigraphic distribution: Zone N5 to Recent (Kennett and Srinivasan 1983).

Globigerinoides sacculifer (Brady 1877)
Plate 27, fig. 2

Globigerina sacculifer BRADY 1877, p. 604, pl. 80, figs 11-17, pl. 81, fig. 2, pl. 82, fig. 4.
Globigerinoides sacculifer (Brady 1877) – KENNETT and SRINIVASAN 1983, p. 66, pl. 14, figs 4-6.

Occurrence: 6 specimens from 5 samples.

Remarks: Several supplementary apertures on spiral side, whilst *G. altiaperturus* Bolli differs by having only one.

Stratigraphic distribution: Zone N4b to Recent (Spezzaferri 1994).

Globigerinoides subquadratus Brönnimann 1954
Globigerinoides subquadratus BRÖNNIMANN 1954, p. 680, pl. 1, fig. 8.

Occurrence: 5 specimens from 4 samples.

Stratigraphic distribution: Zone N4b to N15 (Kennett and Srinivasan 1983).

Globigerinoides trilobus (Reuss 1850)
Plate 27, fig. 4

Globigerina triloba REUSS 1850, p. 374, pl. 47, fig. 11.
Globigerinoides trilobus (Reuss 1850) – SPEZZAFERRI 1994, p. 37, pl. 13, fig. 1, pl. 15, fig. 6.

Occurrence: 58 specimens from 26 samples.

Remarks: Distinguished from *G. bisphericus* by possessing two high-arched apertures.

Stratigraphic distribution: Zone intra N4b to Recent (Spezzaferri 1994).

Globoquadrina dehiscens (Chapman, Parr and Collins 1934)
Plate 29, fig. 1

Globorotalia dehiscens CHAPMAN, PARR and COLLINS 1934, p. 569, pl. 11, fig. 36.
Globoquadrina dehiscens (Chapman, Parr and Collins 1934). – KENNETT and SRINIVASAN 1983, p. 184, pl. 45, figs 7-9.

Occurrence: 4 specimens from 3 samples.

Stratigraphic distribution: Zone N4b to N18 (Kennett and Srinivasan 1983).

Globoquadrina venezuelana (Hedberg 1937)
Plate 29, fig. 2

Globigerina venezuelana HEDBERG 1937, p. 681, pl. 92, fig. 72.
Globoquadrina venezuelana (Hedberg 1937). – KENNETT and SRINIVASAN 1983, p. 180, pl. 44, figs 5-7.

Occurrence: 2 specimens from 2 samples.

Stratigraphic distribution: Middle Eocene to Pliocene (Kennett and Srinivasan 1983).

Globorotalia archeomenardii Bolli 1957
Globorotalia archeomenardii BOLLI 1957, p. 119, pl. 28, fig. 11. – BOLLI and SAUNDERS 1985, p. 223, pl. 32, fig. 6.

Occurrence: 1 specimen from 1 sample.

Remarks: Has a more rounded outline and less well-developed keel than *G. Praemenardii*.

Stratigraphic distribution: Zones N8 to N11 16.26-13.87 Ma (Ogg and Lugowski 2007).

Globorotalia peripheroronda Blow and Banner 1966
Plate 28, fig. 3,4

Globorotalia (Turborotalia) peripheroronda BLOW and BANNER 1966, p. 294, pl. 1, fig. 1.
Globorotalia (Fohsella) peripheroronda Blow and Banner. – KENNETT and SRINIVASAN, p. 96, pl. 22, figs 1-3.
Globorotalia peripheroronda Blow and Banner. – SPEZZAFERRI 1994, p. 58, pl. 25, fig. 6.

Occurrence: 80 specimens from 26 samples.

Remarks: Both umbilical and spiral sides show curved sutures, periphery subrounded.

Stratigraphic distribution: Zones N4a to N10 (Spezzaferri 1994).

Globorotalia praemenardii Cushman and Stainforth 1945
Plate 28, fig. 6

Globorotalia praemenardii CUSHMAN and STAINFORTH 1945, p. 70, pl. 13, fig. 14. – BOLLI and SAUNDERS 1985, p. 223, pl. 32, fig. 7.

Occurrence: 1 specimen from 1 sample.

Remarks: Differs from *G. archeomenardii* in having a less developed keel and less rounded outline.

Stratigraphic distribution: Zones N9 to N14, base at 14.38 Ma (Ogg and Lugowski 2007).

Globorotalia praescitula Blow 1959
Globorotalia scitula (Brady) subsp. *praescitula* BLOW 1959, p. 221, pl. 19, fig. 128
Globorotalia praescitula Blow. – KENNETT and SRINIVASAN 1983, p. 108, pl. 25, figs 4-6. – BOLLI and SAUNDERS 1985, p. 217, pl. 31, fig. 6.

Occurrence: 10 specimens from 7 samples.

Stratigraphic distribution: Zone intra N5 (20.28 to 18.75 Ma) to N10. Miller et al. (1991) record the FAD of this species at the base of Chron C5En (18.52 Ma) at Site 608, northern North Atlantic. Berggren et al. (1995) use the FAD in the Mediterranean as a marker for the base of zone Mt3 (18.5 Ma). However, Morgans et al. (2002) record the species at the base Chron C5Er in New Zealand, and postulate a FAD somewhere between C6n to base C5Er (20.28 to 18.75 Ma). They also note that the population sizes are very small and regard the species as easy to overlook. Spezzaferri (1994) records the FAD of uppermost Zone N5 for this species as regionally synchronous in the Pacific and Indian oceans, but occurring lower in this zone at Site

526 in the South Atlantic. We therefore suspect that the FAD in this location may be significantly older than the widely used age of 18.5 Ma.

Globorotaloides hexagonus (Natland 1938)
Plate 29, fig. 5

Globigerina hexagona NATLAND 1938, p. 149, pl. 7, fig. 1.
Globorotaloides hexagona (Natland 1938). – KENNETT and SRINIVASAN 1983, p. 216, pl. 54, figs 3-5.

Occurrence: 1 specimen from 1 sample.

Stratigraphic distribution: Zones N7 to Recent (Kennett and Srinivasan 1983).

Globorotaloides permicrus (Blow and Banner 1962)
Globorotalia (Turborotalia) permicrus BLOW and BANNER 1962, p. 120, pl. 12, figs N-P.
Globorotaloides permicrus (Blow and Banner). – SPEZZAFERRI 1994, p. 46, pl. 35, fig. 2.

Occurrence: 1 specimen from 1 sample.

Stratigraphic distribution: Spezzaferri (1994) reported this species as ranging from the early Oligocene to early Miocene.

Globorotaloides suteri Bolli 1957
Globorotaloides suteri BOLLI 1957, p. 117, pl. 27, figs 9-13. – KENNETT and SRINIVASAN 1983, p. 214, pl. 53, figs 1, 3-5.

Occurrence: 18 specimens from 14 samples.

Stratigraphic distribution: Middle Eocene to within N8 (Kennett and Srinivasan 1983).

Orbulina bilobata (d'Orbigny 1846)
Plate 28, fig. 1

Globigerina bilobata D'ORBIGNY 1846, p. 164, pl. 9, figs 11-14.
Orbulina bilobata (d'Orbigny). – KENNETT and SRINIVASAN 1983, p. 88, pl. 20, figs 7-9.

Occurrence: 1 specimen from 1 sample.

Stratigraphic distribution: Kennett and Srinivasan (1983) recorded this species ranging from the base of N9 (14.74 Ma) to Recent.

Orbulina universa d'Orbigny 1839
Plate 28, fig. 2

Orbulina universa D'ORBIGNY 1839, p. 3, pl. 1, fig. 1.
Orbulina universa d'Orbigny. – KENNETT and SRINIVASAN 1983, p. 86, pl. 20, figs 4-6.

Occurrence: 1 specimen from 1 sample.

Stratigraphic distribution: Zone N9 (14.74 Ma) to Recent (Ogg and Lugowski 2007). Also given the same range as *O. bilobata* by Kennett and Srinivasan (1983).

Paragloborotalia bella Jenkins 1967
Paragloborotalia bella JENKINS 1967, p. 1069, fig. 3, nos. 1-6. – KENNETT and SRINIVASAN 1983, p. 174, pl. 43, figs 1-3.

Occurrence: 11 specimens from 5 samples.

Stratigraphic distribution: Zone M2 to M5a (Kennett and Srinivasan 1983).

Paragloborotalia mayeri (Cushman and Ellisor 1939)
Plate 28, fig. 5

Globorotalia mayeri CUSHMAN and ELLISOR 1939, p. 11, pl. 2, fig. 4. – KENNETT and SRINIVASAN 1983, p. 174, pl. 43, figs 4-6. – BOLLI and SAUNDERS 1985, p. 203, pl. 26, figs 31-43.

Occurrence: 12 specimens from 6 samples.

Remarks: Specimens with five to six chambers in the final whorl, periphery rounded, sutures slightly curved.

Stratigraphic distribution: Zones N3 to N14 (Bolli and Saunders 1985.

Paragloborotalia opima nana / continuosa **transitional form**
Globorotalia opima nana Bolli 1957, p. 118, pl. 28, fig. 3.
Globorotalia continuosa Blow 1959, p. 218, pl. 19, fig. 125.

Occurrence: 15 specimens from 6 samples.

Remarks: Specimens transitional from *P. opima nana* to *P. continuosa* have been recorded by Bolli and Saunders (1985) to range from zone P22 to top N6.

Paragloborotalia semivera (Hornibrook 1961)
Globigerina semivera HORNIBROOK 1961, p. 149, pl. 23, figs 455-457.
Paragloborotalia semivera (Hornibrook). – KENNETT and SRINIVASAN 1983, p. 172, pl. 42, figs 3-4. – SPEZZAFERRI 1994, p. 55, pl. 20, fig. 6, pl. 22, fig. 1.

Occurrence: 1 specimen from 1 sample.

Stratigraphic distribution: From late Oligocene to intra zone M5b (Kennett and Srinivasan 1983).

Praeorbulina glomerosa glomerosa Blow 1956
Plate 27, fig. 7

Praeorbulina glomerosa glomerosa BLOW 1956, p. 65, text-figs 2.3-4.

Occurrence: 2 specimens from 2 samples.

Remarks: Almost spherical in outline, with numerous apertures around the base of the final chamber. This is the species *P. glomerosa* s.str. of Berggren et al. (1995).

Stratigraphic distribution: Base zone M5b to top M5b 16.27-14.78 Ma (Ogg and Lugowski 2007). Oldest *occurrence* defines the base of zone M5b (Berggren et al. 1995).

Praeorbulina sicana (de Stefani 1952)
Plate 27, fig. 6

Globigerinoides conglobatus (Brady). – Cushman and Stainforth 1945, 68, pl. 13, fig. 6.
Globigerinoides sicana DE STEFANI 1952, p. 9, not re-illustrated.
Praeorbulina sicana (de Stefani). – JENKINS et al. 1981, p. 264, pl. 1, fig. 2.

Occurrence: 7 specimens from 7 samples.

Remarks: Possesses four slit-like apertures, with 30-40% of test enveloped by final chamber.

Stratigraphic distribution: Base zone M5a to intra M6 16.97-14.53 Ma (Ogg and Lugowski 2007).

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APPENDIX 1 (online at micropress.org)
Foraminiferal counts for the study well.

PLATE 1
(page 531)
Scale bar = 200μm (unless indicated)

1 *Psammosiphonella cylindrica*, 4100m
2 *Rhabdammina linearis*, 2820m
3 *Rhabdammina* sp.1, 2840m
4 *Bathysiphon* sp., 2840m
5 *Nothia excelsa*, 2840m
6 *Nothia latissima*, 3750m
7 *Nothia robusta*, 3740m
8 *Rhizammina* sp., 4160m
9 *Saccammina* cf. *spherica*, 3840m
10 *Saccammina* sp.1, 3810m
11 Unassigned form, 2870m
12-13 *Psammosphaera* sp.2, 3850m, 3800m
14 *Jaculella* sp.1, 3030m
15 *Hyperammina elongata*, 4010m
16 *Ammodiscus cretaceus*, 3200m
17 *Ammodiscus latus*, 3090

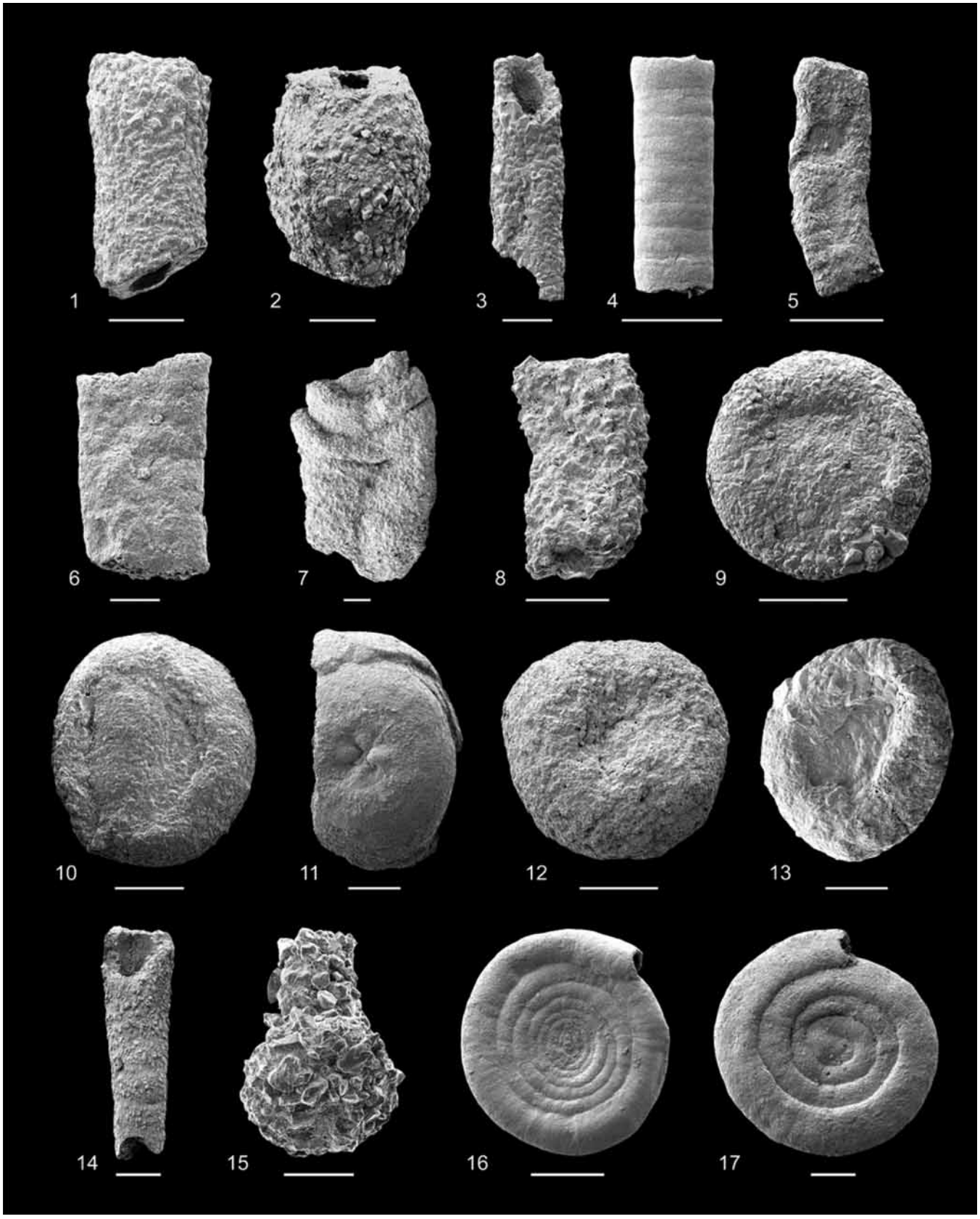
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PLATE 2
(page 533)
Scale bar = 200µm (unless indicated)

1-2 *Ammodiscus* aff. *peruvianus*, 3850m, 3340m

3 *Ammodiscus glabratus*, 3020m

4 *Ammolagena clavata* (attached to *Cyclammina cancellata*), 2810m

5 *Ammolagena clavata* (attached to *Ammodiscus cretaceus*), 3830m

6 *Ammolagena clavata* (attached to *Psammosphaera* sp.), 3020m

7-8 *Tolypammina* sp., 2810m, 2810m

9 *Glomospira charoides*, 2900m

10 *Glomospira glomerata*, 3030m

11 *Glomospira gordialis*, 3180m

12 *Glomospira irregularis*, 2820m

13 *Glomospira* aff. *serpens*, 3100m

14 *Glomospira* sp.1, 3810m

15 *Glomospira* sp.2, 3850m

16 *Hormosinella carpenteri*, 3900m

PLATE 3
(page 534)
Scale bar = 200µm (unless indicated)

1-2 *Reophanus* aff. *berggreni*, 3850m, 3010m

3-4 *Subreophax scalaris*, 3030m, 2810m

5 *Aschemocella grandis*, 2840m

6 *Subreophax* sp.1, 3200m

7 *Kalamopsis* sp., 4030m

8 *Hormosinelloides guttifer*, 3840m

9 *Reophax pilulifer*, 2860m

10 *Hormosina glabra*, 3100m

11 *Hormosina globulifera*, 3120m

12 *Pseudonodosinella nodulosa*, 2900m

13-15 *Lituotuba lituiformis*, 2810m, 3240m, 3010m

16 *Paratrochamminoides challengeri*, 3060m

17 *Paratrochamminoides deflexiformis*, 3150m

18 *Paratrochamminoides gorayskiformis*, 3850m

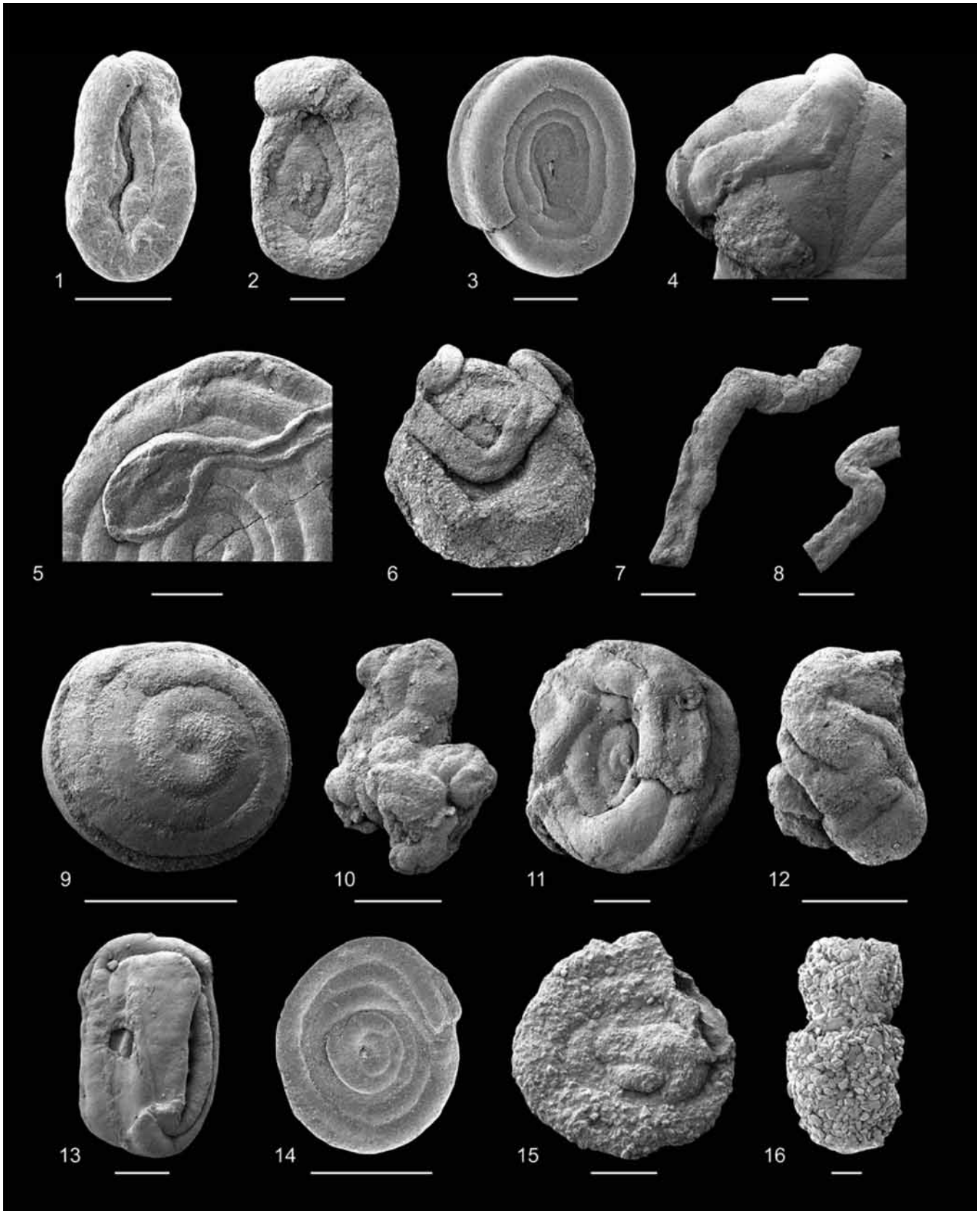
PLATE 4
(page 535)
Scale bar = 200µm (unless indicated)

1 *Paratrochamminoides heteromorphus*, 2810m

2 *Paratrochamminoides mitratus*, 3030m

3 *Paratrochamminoides olszewskii*, 3800m

4-9 *Paratrochamminoides* sp.1, 2810m, 3230m, 3030m, 3230m, 3080m, 3030m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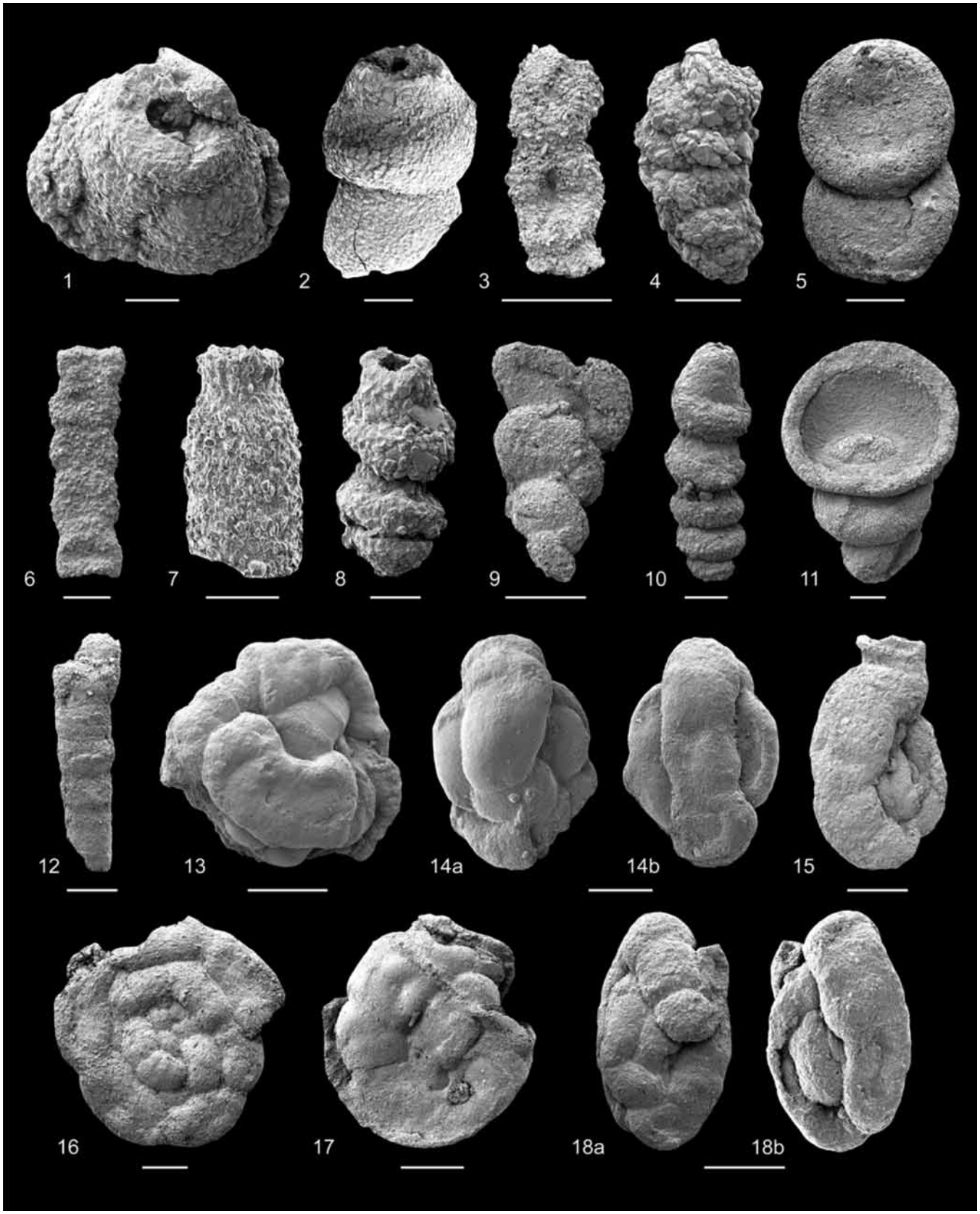
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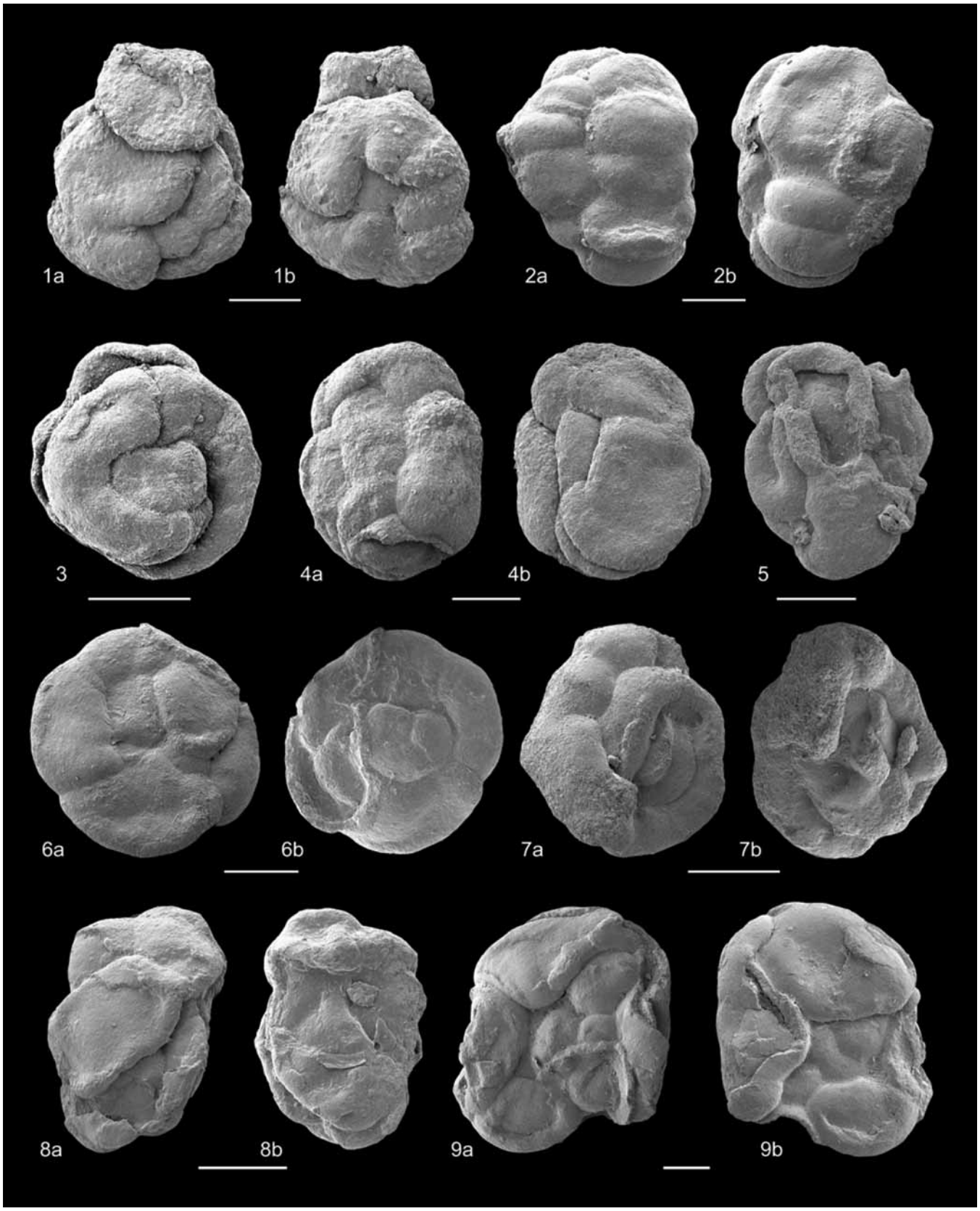
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PLATE 5
(page 537)
Scale bar = 200µm (unless indicated)

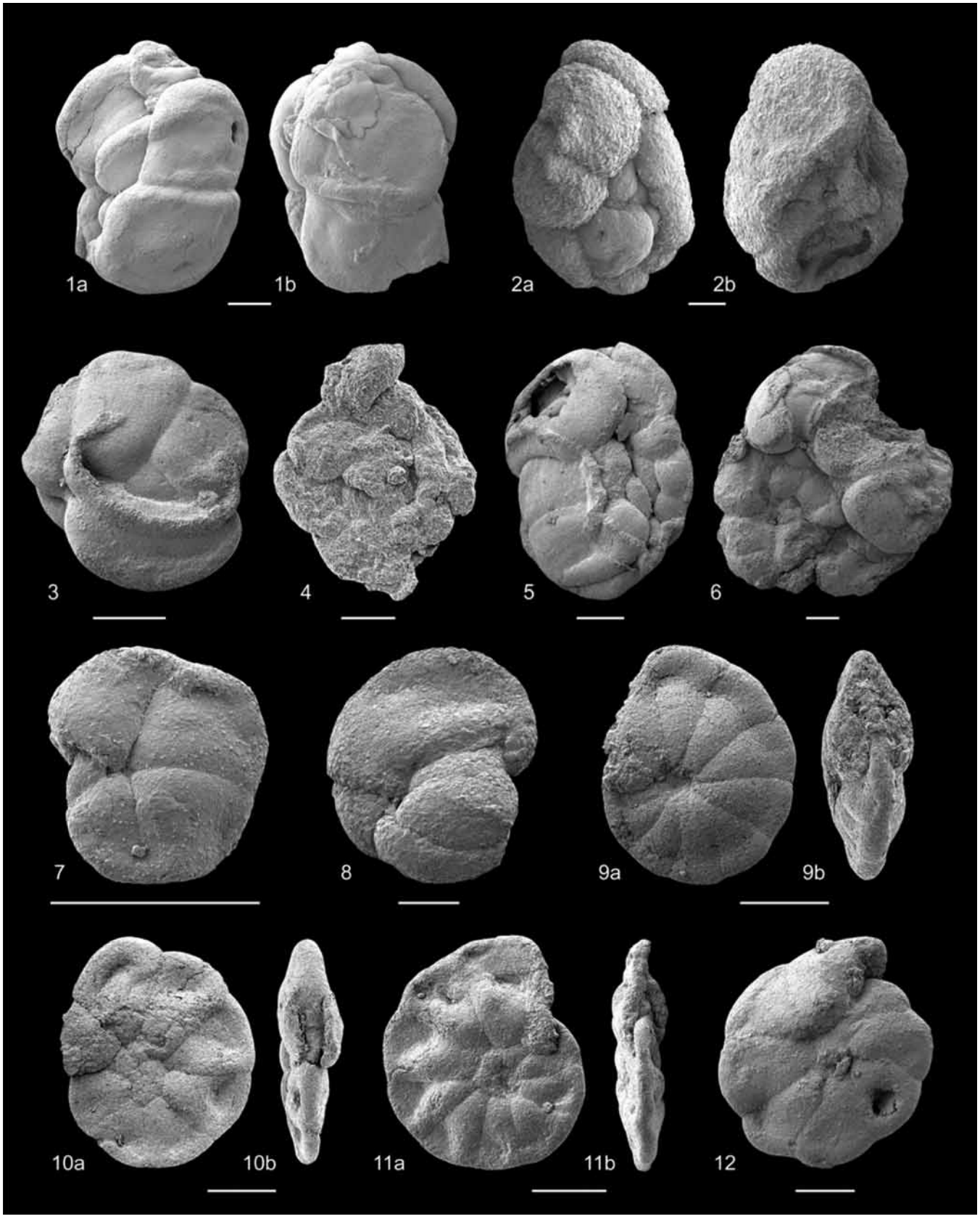
1-2 *Paratrochamminoides* sp.1, 3030m, 3040m
3 *Conglophragmium irregularis*, 3020m
4 *Trochamminoides folius*, 3960m
5-6 *Trochamminoides subcoronatus*, 3140m, 3250m
7 *Haplophragmoides* cf. *bradyi*, 2810m
8 *Haplophragmoides horridus*, 3100m
9 *Haplophragmoides carinatus*, 2900m
10-12 *Haplophragmoides nauticus*, 3030m, 3840m, 3060m

PLATE 6
(page 538)
Scale bar = 200µm (unless indicated)

1 *Haplophragmoides* sp.1, 3990m
2 *Haplophragmoides* sp., 3120m
3-4 *Glaphyrammina americana*, 3180m, 3100m
5 *Praesphaerammina* sp.1, 3300m
6 *Discamminoides* sp.1, 4030m
7 *Ammosphaeroidina pseudopauciloculata*, 3850m
8 *Budashevaella multicamerata*, 3100m
9 *Cribrostomoides subglobosus*, 3100m
10 *Cribrostomoides* sp.1, 2890m

PLATE 7
(page 539)
Scale bar = 200µm (unless indicated)

1 *Recurvoides azuaensis*, 2900m
2-3 *Recurvoides* sp.1, 3860m, 3860m
4 *Recurvoides azuaensis*, 3760m
5 *Bulbobaculites* sp.1,
6 *Vulvulina miocenica*, 3200m
7 *Spiropsammina primula*, 3860m
8-10 *Portatrochammina profunda*, 3860m, 3840m, 3830m
11-12 *Trochammina* sp.2, 3060m, 2810m
13 *Trochammina* sp.1, 3820m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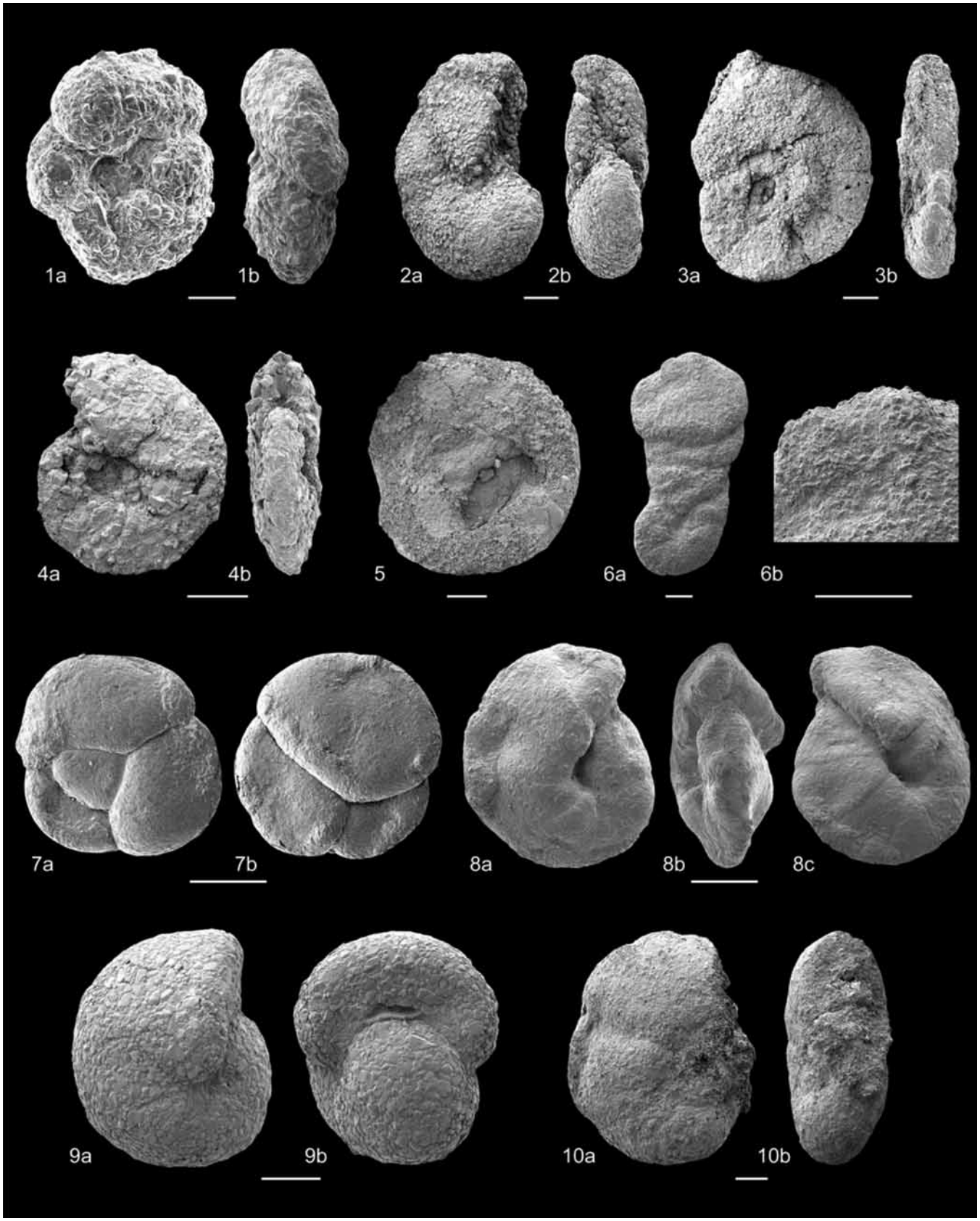
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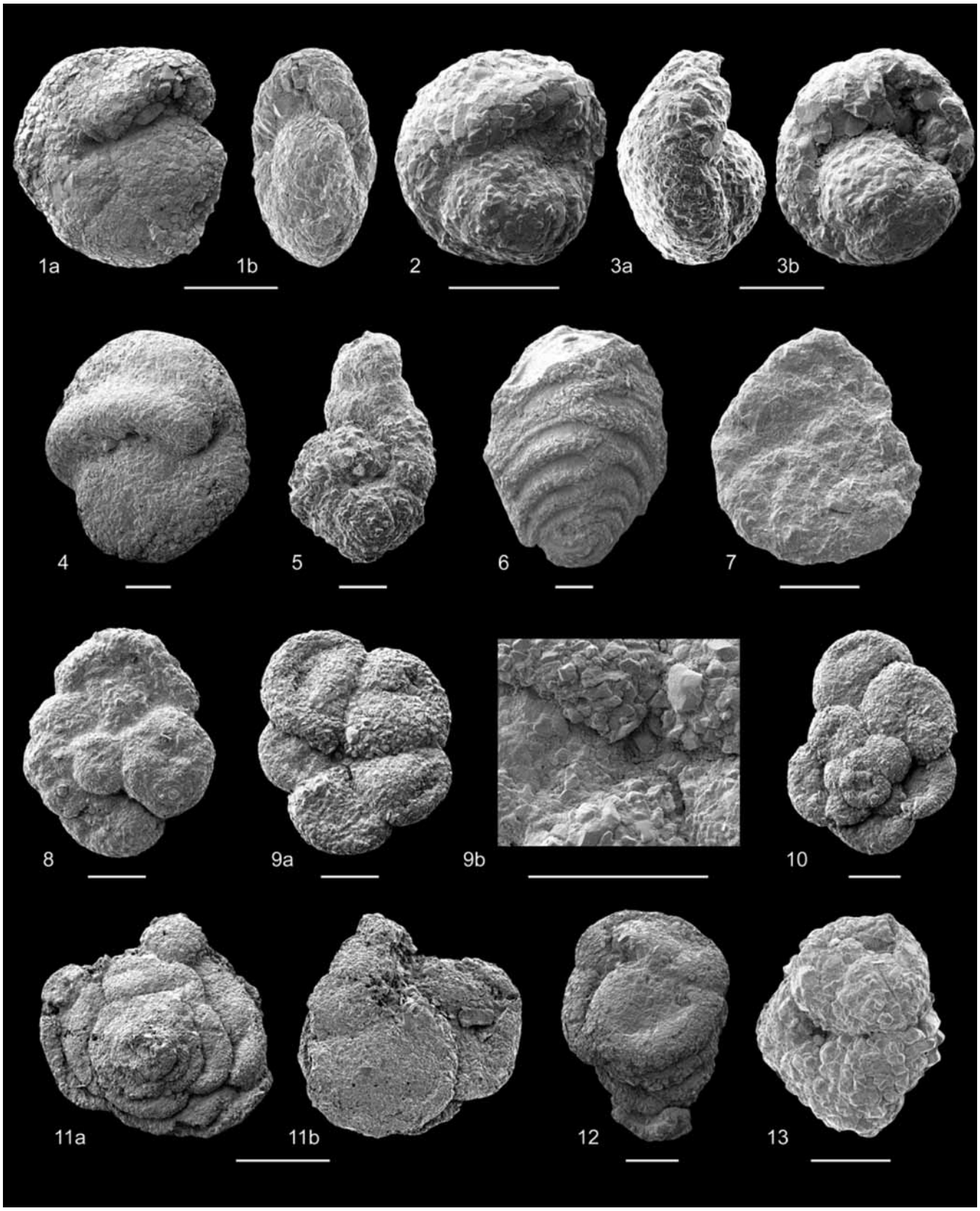
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PLATE 8
(page 541)
Scale bar = 200μm (unless indicated)

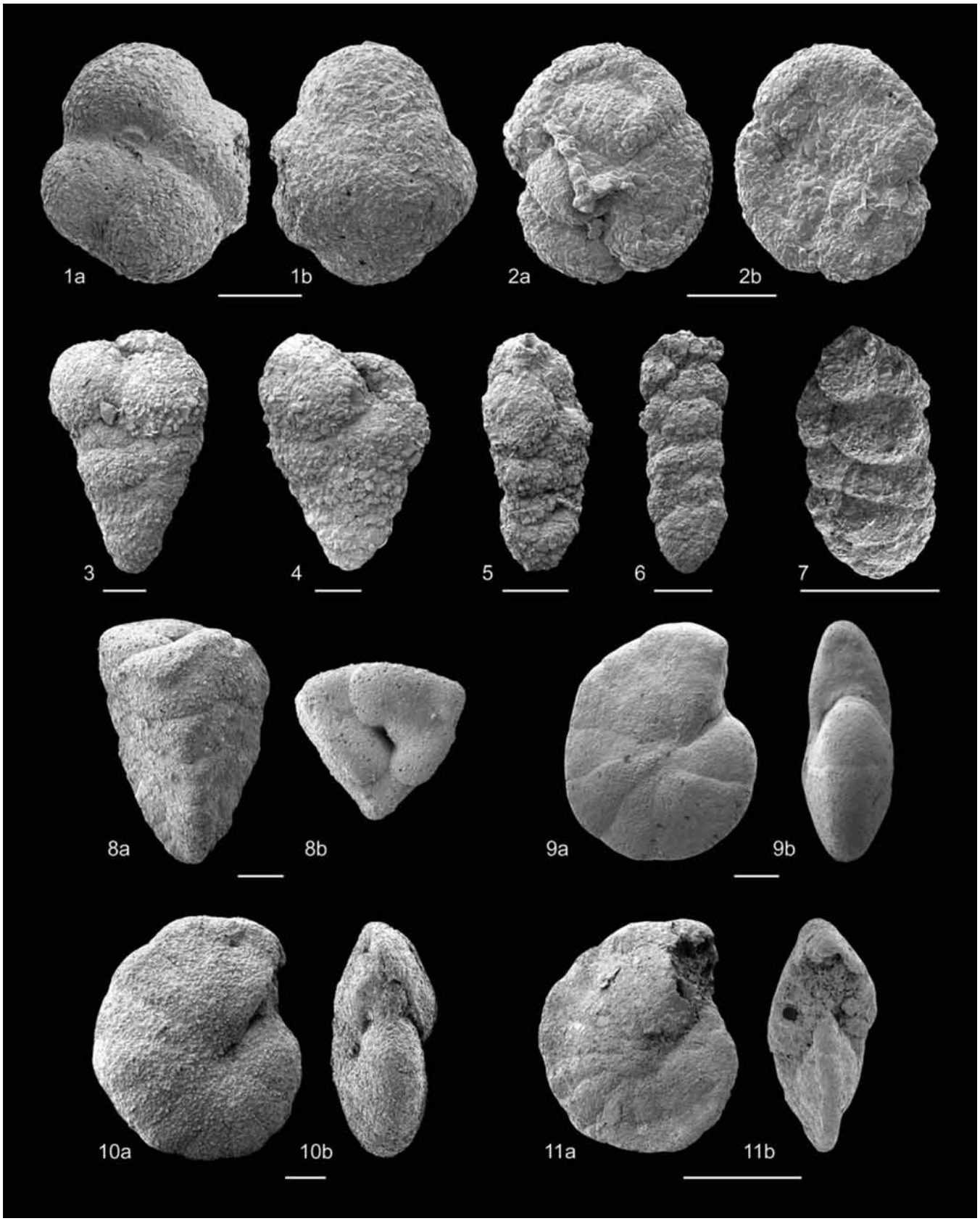
1 *Trochammina* sp.4, 3350m
2 *Ammosphaeroidina* sp., 2900m
3-4 *Eggerelloides* sp.1, 3130m, 2900m
5-7 *Karrerulina apicularis*, 2810m, 3100m, 2810m
8 *Gaudryina atlantica*, 3120m
9 *Reticulophragmium acutidorsatum*, 3750m
10 *Reticulophragmium acutidorsatum* ssp.1, 3330m
11 *Reticulophragmium amplectens*, 2850m

PLATE 9
(page 542)
Scale bar = 200μm (unless indicated)

1 *Reticulophragmium amplectens* ssp.1, 4100m
2 *Reticulophragmium gasparensis*, 3840m
3 *Reticulophragmium rotundidorsatum*, 2900m
4 *Reticulophragmium orbicularis*, 2810m
5 *Cyclammina cancellata* (with attached *Ammolagena clavata*), 2810m
6 *Cyclammina cancellata*, 2850m
7 *Cyclammina cancellata* ssp.1, 3110m

PLATE 10
(page 543)
Scale bar = 200μm (unless indicated)

1-3 *Cyclammina* sp.1, 3120m, 3040m, 3180m
4 *Cyclammina* sp.2, 3100m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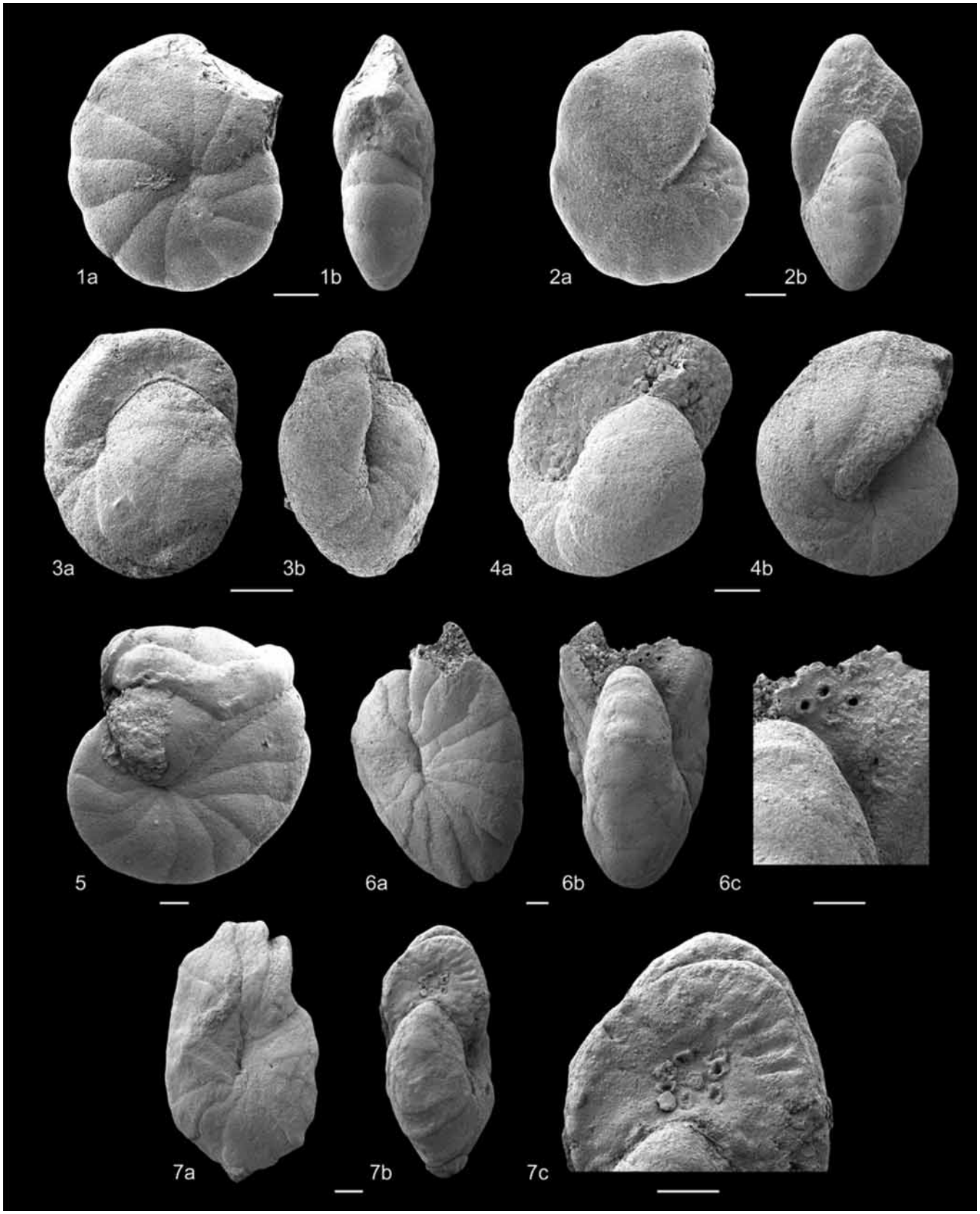
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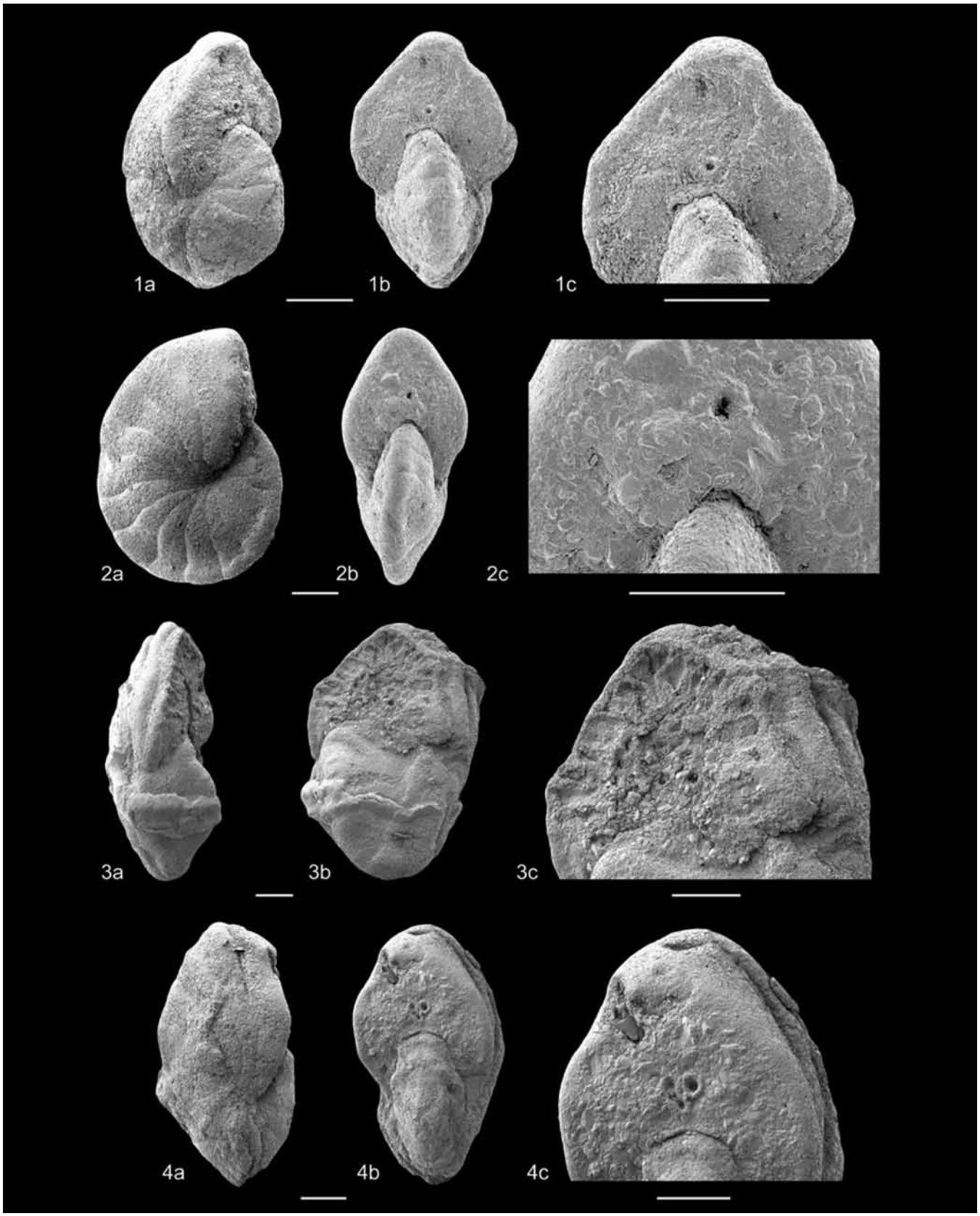
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PLATE 11
(page 545)
Scale bar = 200µm (unless indicated)

1-5 *Cyclammina* sp.2, 3100m, 3930m, 3040m, 3080m, 3100m

6-7 *Dorothia brevis*, 3120m, 3360m

PLATE 12
(page 546)
Scale bar = 200µm (unless indicated)

1-2 *Eggerella bradyi*, 2920m, 3170m

3-4 *Karreriella* aff. *bradyi*, 3130m, 3130m

5-7 *Karreriella microgranulosa*, 3070m, 3050m, 3140m

8-10 *Martinotiella communis*, 3140m, (with attached *Ammolagena clavata*) 3170m, 3330m

11 *Martinotiella* sp., 3140m

12-13 *Valvulina flexilis*, 3040m, 3110m

14 *Bigenerina* sp., 3150m

15 *Textularia earlandi*, 3860m

PLATE 13
(page 547)
Scale bar = 200µm (unless indicated)

1 *Opthalmidium* sp.A, 3250m

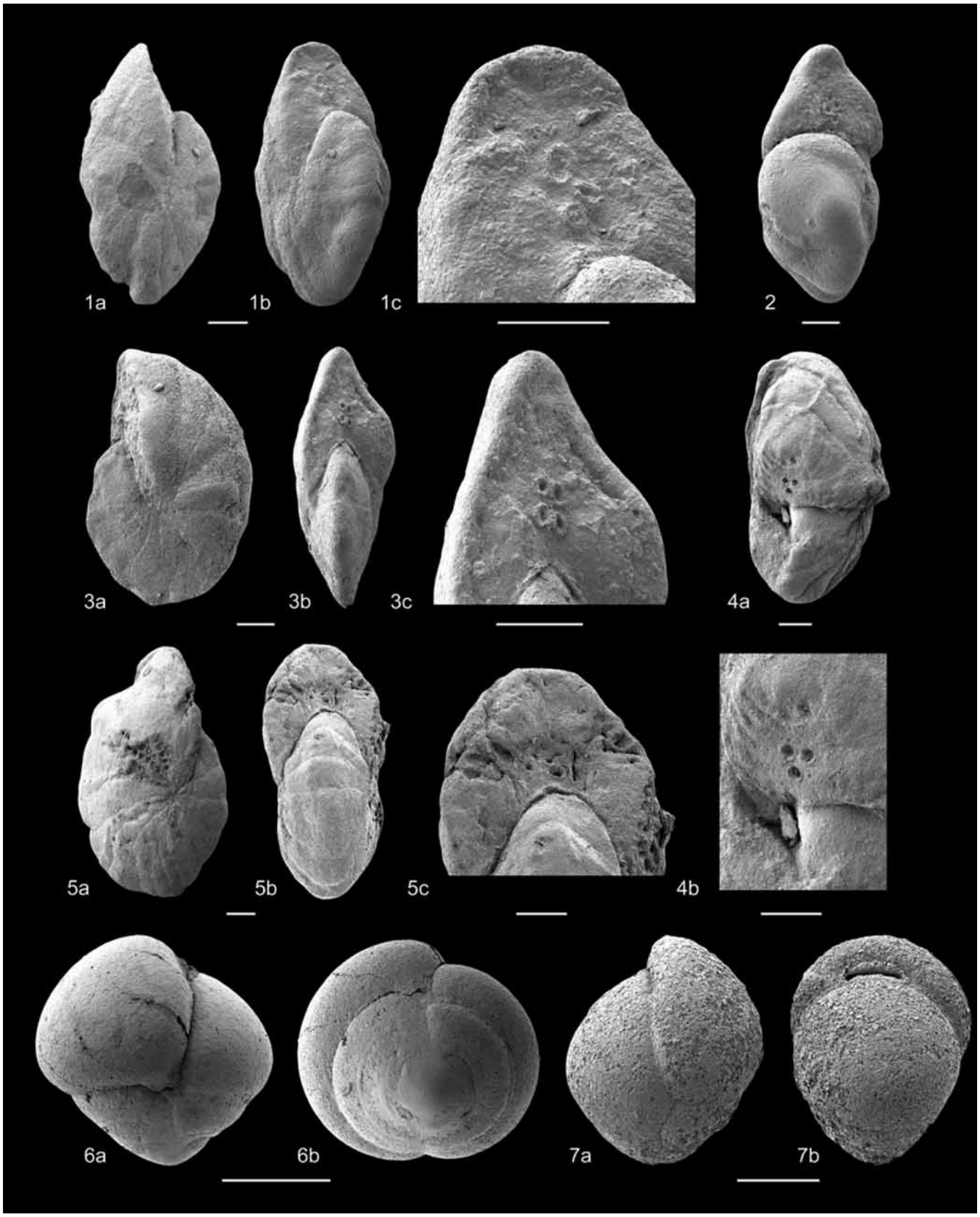
2 *Spiroloculina excavata*, 3070m

3 *Quinqueloculina triloculiniforma*, 2780m

4 *Quinqueloculina triangularis*, 2910m

5 *Pyrgo magnacaudata*, 2920m

6 *Pyrgo* sp., 2790m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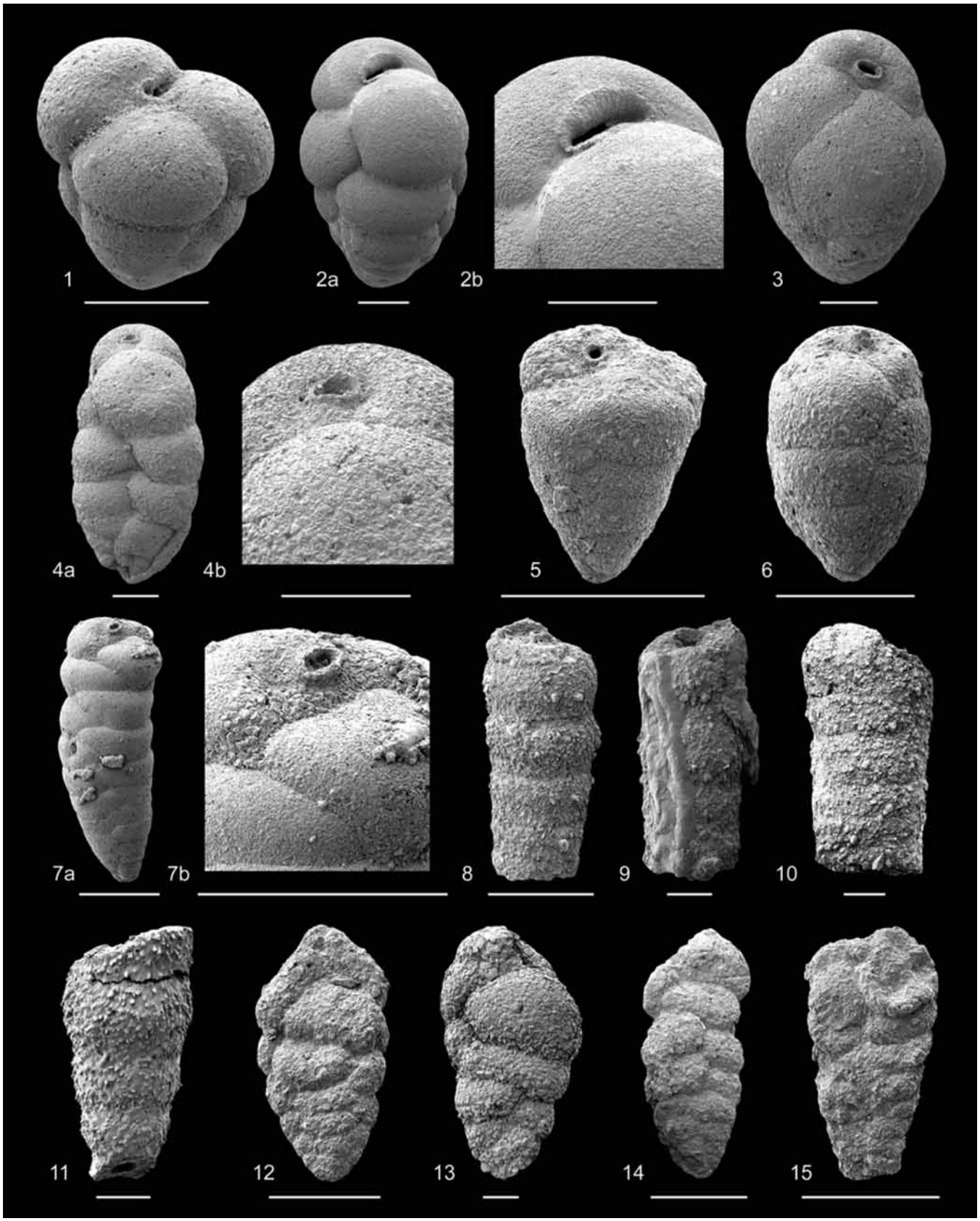
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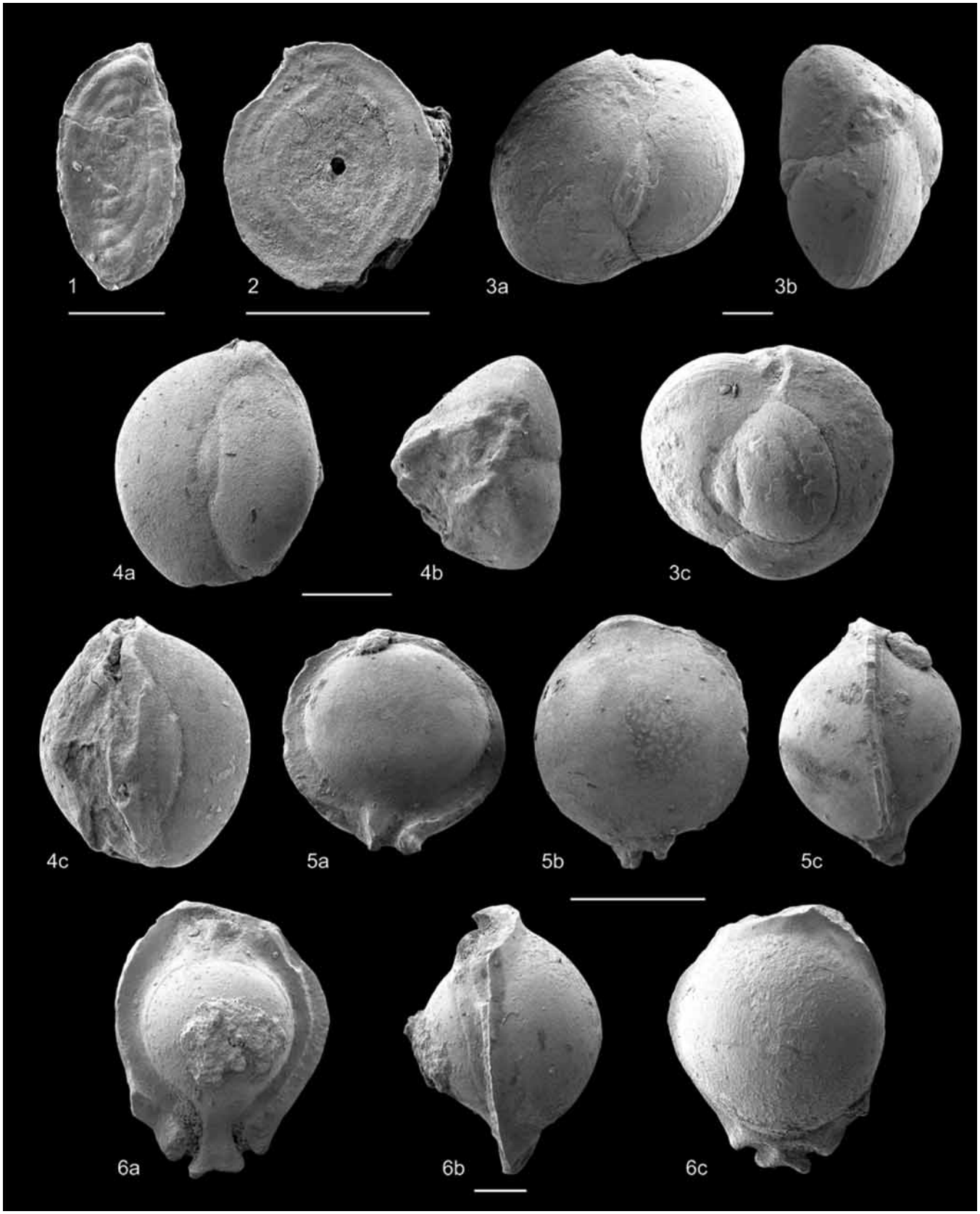
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PLATE 14
(page 549)
Scale bar = 200µm (unless indicated)

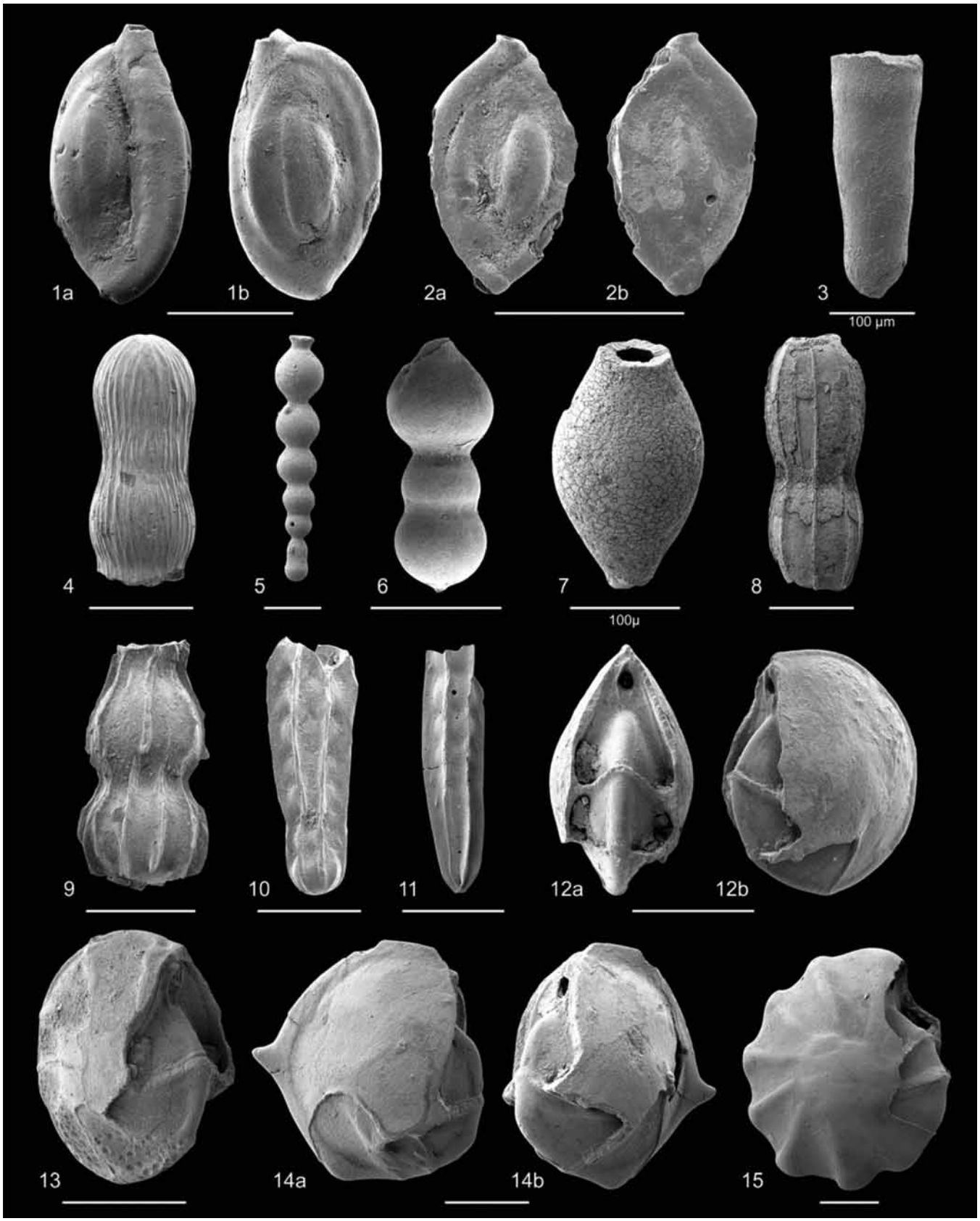
1 *Sigmoilinella elliptica*, 3140m
2 *Sigmoilinella tenuis*, 2940m
3 *Chrysalogonium lanceoleum*, 2940m
4 *Chrysalogonium* sp.1, 2890m
5 *Nodosaria anomala*, 3180m
6 *Nodosaria glandulinoides*, 3070m
7 *Nodosaria pyrula*, 3050m
8 *Nodosaria* sp., 3110m
9 *Amphimorphina* aff. *stainforthi*, 2840m
10-11 *Amphimorphina stainforthi*, 2910m, 3160m
12-13 *Lenticulina americana*, 2920m, 3100m
14 *Lenticulina calcar*, 2890m
15 *Lenticulina* aff. *multinodosa*, 3130m

PLATE 15
(page 550)
Scale bar = 200µm (unless indicated)

1 *Lenticulina formosa*, 3130m
2 *Lenticulina* aff. *multinodosa*, 3050m
3 *Saracenaria* sp., 3200m
4 *Pygmaeoseistron* sp., 2900m
5-6 *Glandulina ovula*, 2840m, 2890m
7 *Ceratobulimina alazanensis*, 3170m
8-9 *Hoeglundina elegans*, 3230m, 3120m

PLATE 16
(page 551)
Scale bar = 200µm (unless indicated)

1 *Hoeglundina elegans*, 3040m
2 *Bolivina multicostata*, 3110m
3 *Bolivina tenuisstriata*, 3070m
4-5 *Brizalina alazanensis*, 2890m, 2840m
6-8 *Brizalina* cf. *barbata*, 2840m, 2840m, 2840m
9 *Brizalina* aff. *inflata*, 2840m
10 *Cassidulinella pliocenica*, 2890m
11-12 *Globocassidulina punctata*, 3190m, 3050m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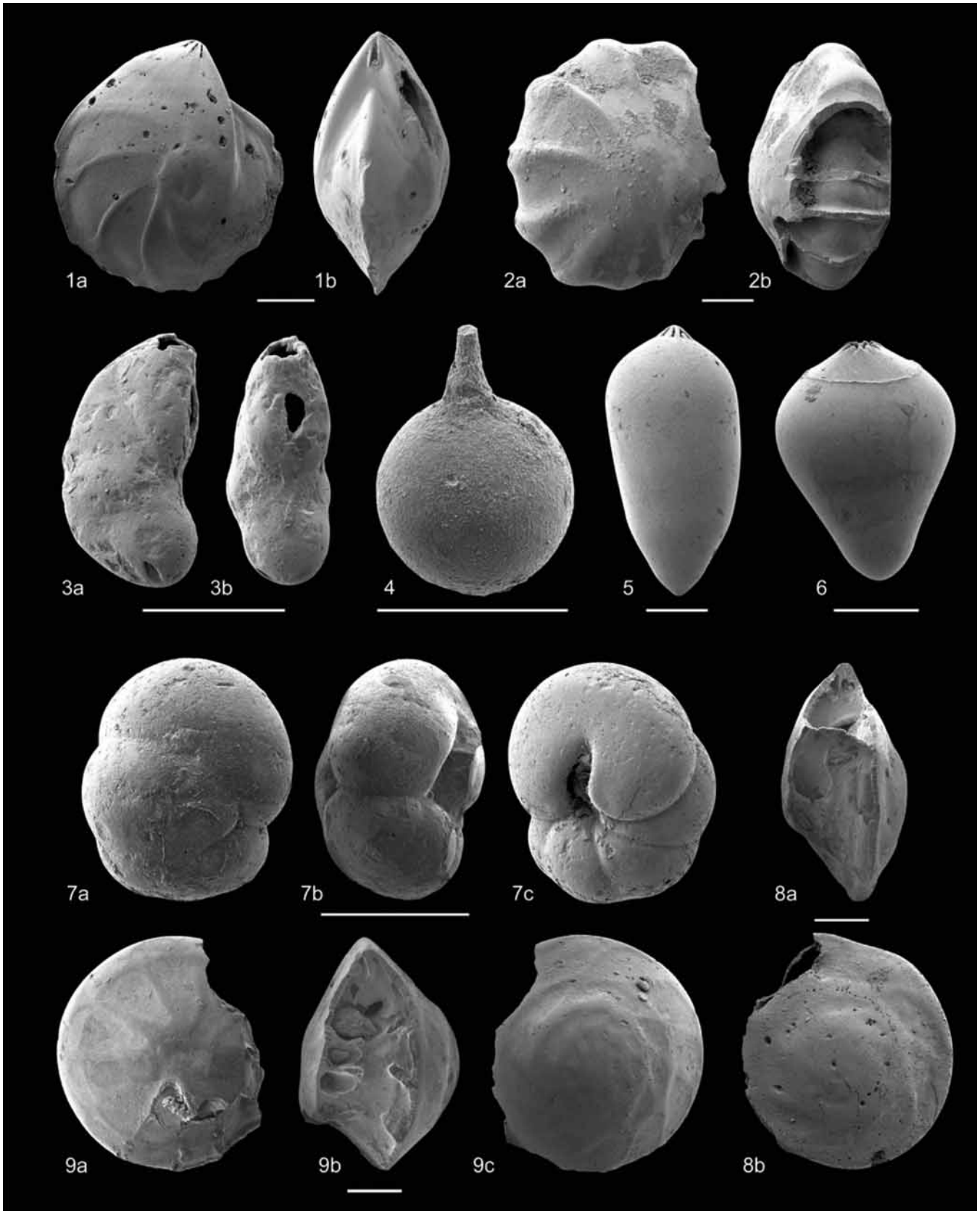
7
100µ
8
9
10
11
12a
12b
13
14a
14b
15


1a
1b
2a
2b
3a
3b
4
5
6
7a
7b
7c
8a
9a
9b
9c
8b

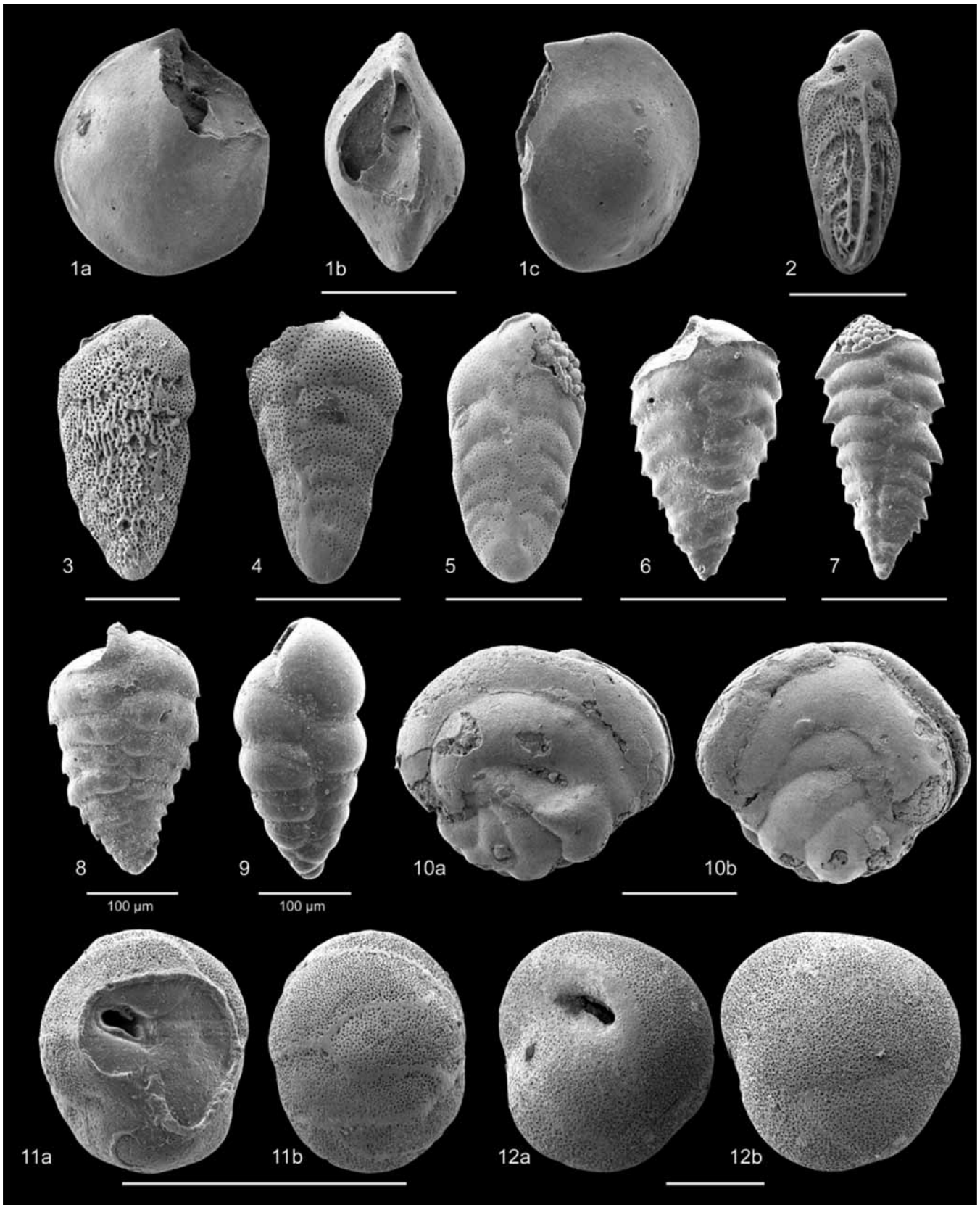

1a
1b
1c
2
3
4
5
6
7
8
9
10a
10b
100 µm
100 µm
11a
11b
12a
12b

PLATE 17
(page 553)
Scale bar = 200µm (unless indicated)

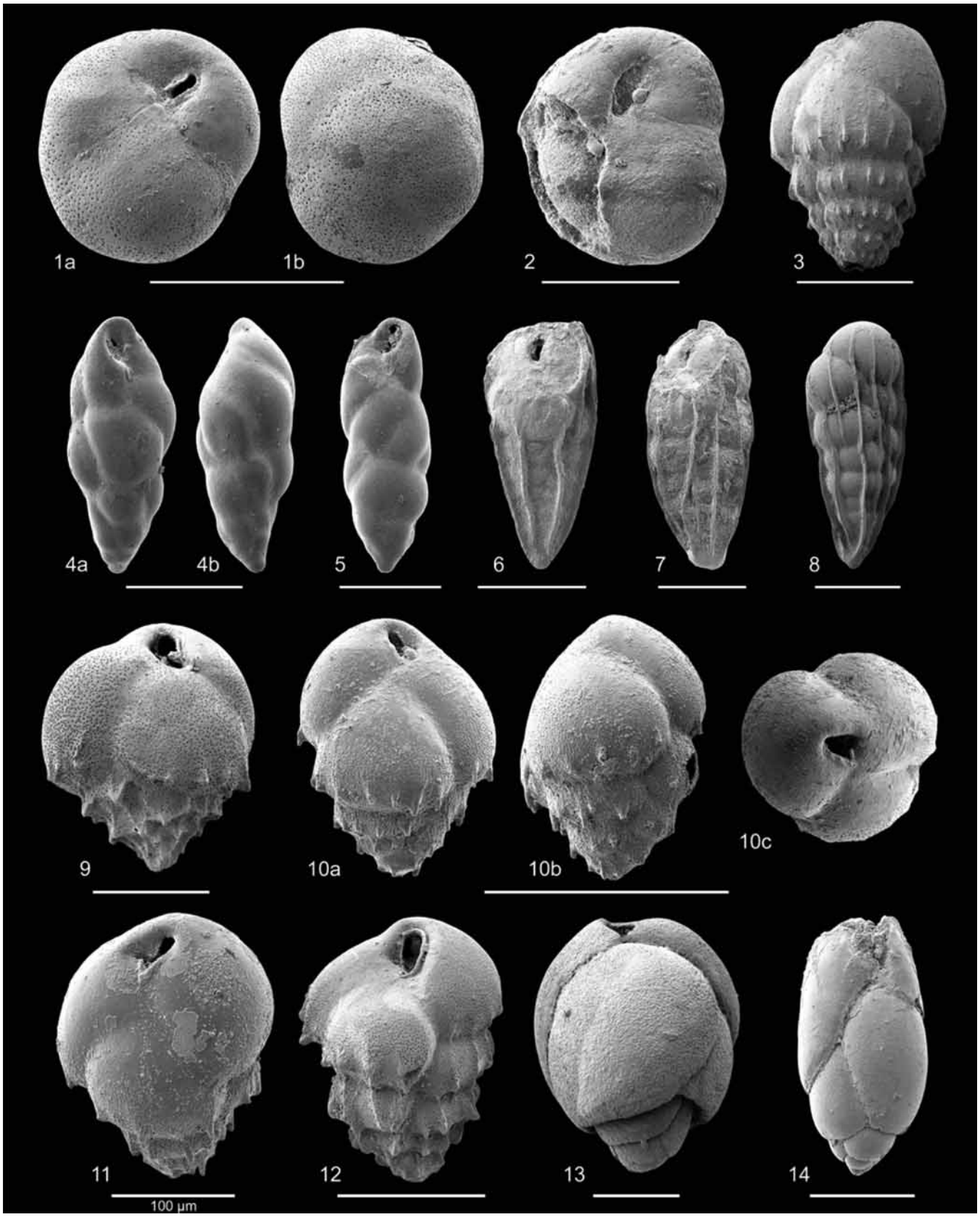
1-2 *Globocassidulina subglobosa*, 2940m, 2810m
3 *Bulimina buchiana*, 3050m
4-5 *Bulimina elongata*, 2940m, 2940m
6 *Bulimina sculptilis*, 3060m
7-8 *Bulimina falconensis*, 2840m, 3110m
9 *Bulimina macilenta*, 3050m
10-11 *Bulimina marginata*, 2840m, 2840m
12 *Bulimina mexicana*, 3070m
13 *Bulimina* sp., 3060m
14 *Praeglobobulimina ovata*, 2900m

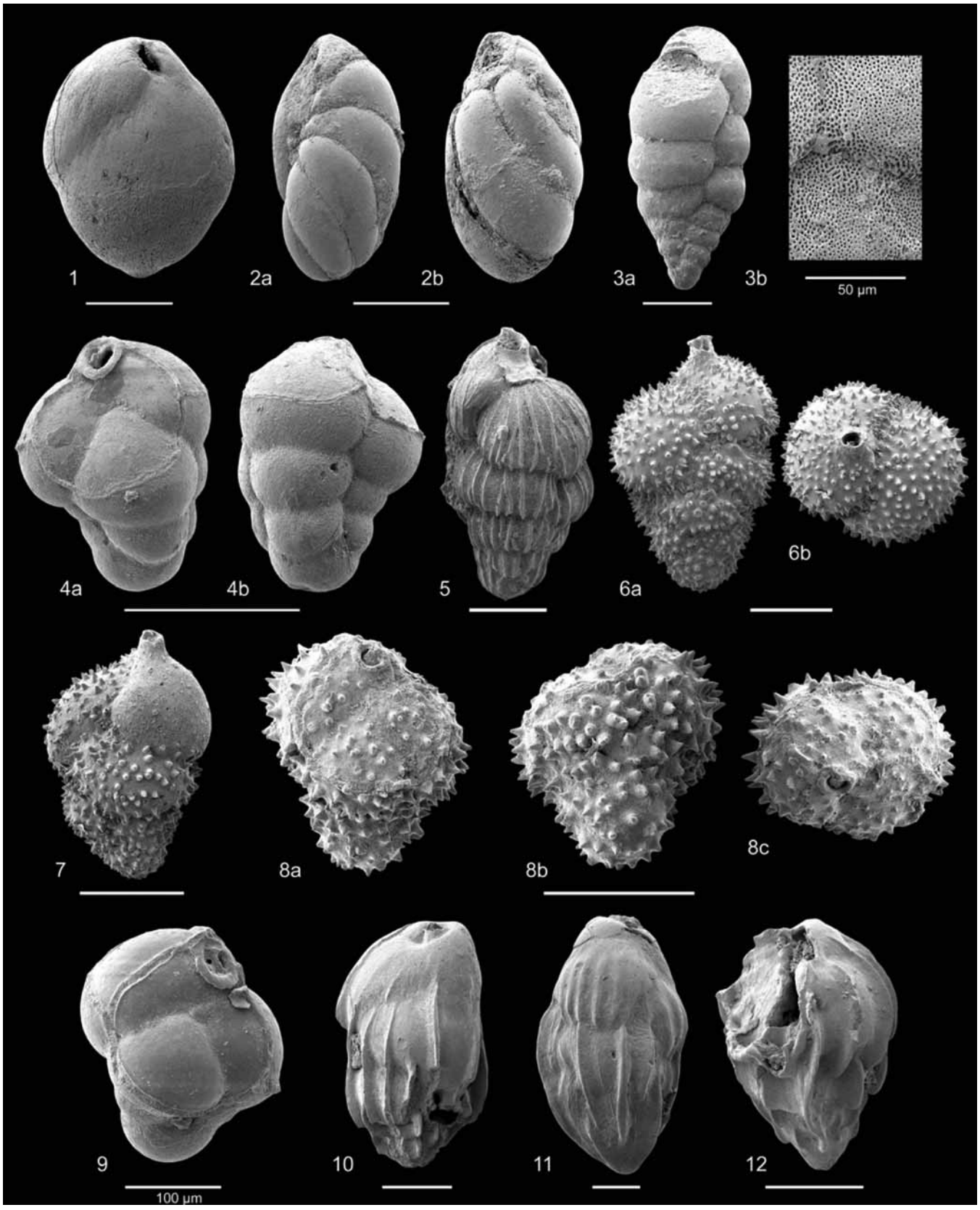
PLATE 18
(page 554)
Scale bar = 200µm (unless indicated)

1 *Praeglobobulimina socialis*, 3280m
2 *Buliminella* sp.1, 2890m
3-4 *Uvigerina* aff. *carapitana*, 2890m, 2840m
5 *Uvigerina spinulosa*, 3050m
6-8 *Uvigerina hispida*, 2920m, 3090m, 2840m
9 *Uvigerina* aff. *carapitana*, 2840m
10-12 *Uvigerina macrocarinata*, 3100m, 2920m, 3070m

PLATE 19
(page 555)
Scale bar = 200µm (unless indicated)

1-2 *Uvigerina mantaensis*, 3420m, 3070m
3 *Uvigerina* aff. *mediterranea*, 3130m
4 *Uvigerina proboscidea*, 3050m
5 *Fursekoina bramlettei*, 3160m
6 *Neugeborina longiscata*, 3050m
7 *Siphonodosaria* aff. *abyssorum*, 2920m
8 *Stilostomella adolphina*, 3050m
9-11 *Stilostomella subspinosa*, 2840m, 3190m, 3070m
12-15 *Valvulineria pseudotumeyensis*, 2890m, 2810m, 2810m, 2980m


1a
1b
2
3
4a
4b
5
6
7
8
9
10a
10b
10c
11
12
13
14
100 µm


1
2a
2b
3a
3b
50 µm
4a
4b
5
6a
6b
7
8a
8b
8c
9
10
11
12
100 µm

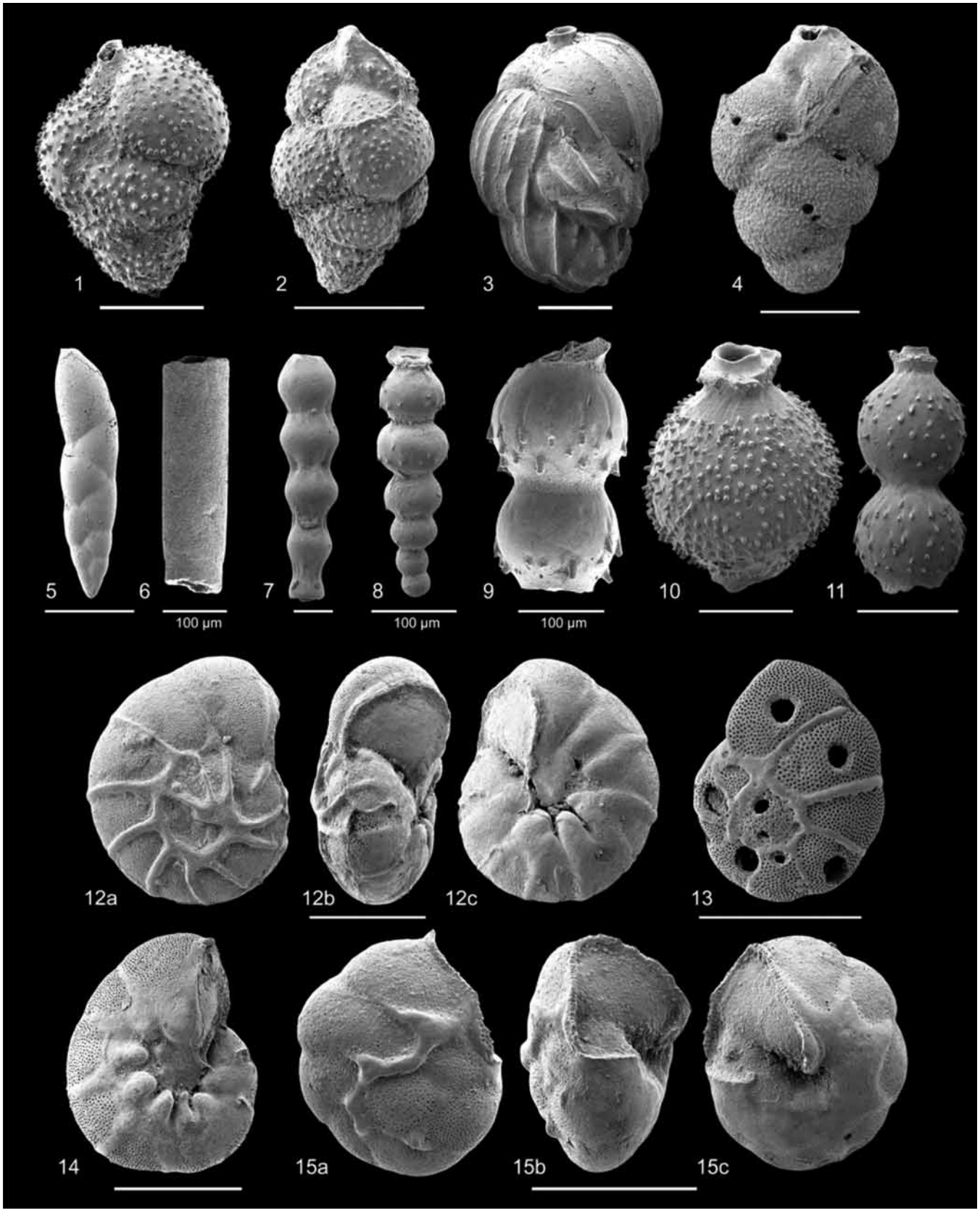

1
2
3
4
5
6
7
8
9
10
11
100 µm
100 µm
100 µm
12a
12b
12c
13
14
15a
15b
15c

PLATE 20
(page 557)
Scale bar = 200µm (unless indicated)

1-2 *Neoeponides campester*, 2890m, 2910m

3 *Sphaeroidina bulloides*, 3070m

4-5 *Cibicidoides crebbsi*, 2890m, 3050m

PLATE 21
(page 558)
Scale bar = 200µm (unless indicated)

1 *Cibicidoides dohmi*, 3120m

2 *Cibicidoides grimsdalei*, 2900m

3 *Cibicidoides dohmi*, 3210m

4 *Cibicidoides guazumalensis*, 3000m

5 *Cibicidoides havanensis*, 2900m

PLATE 22
(page 559)
Scale bar = 200µm (unless indicated)

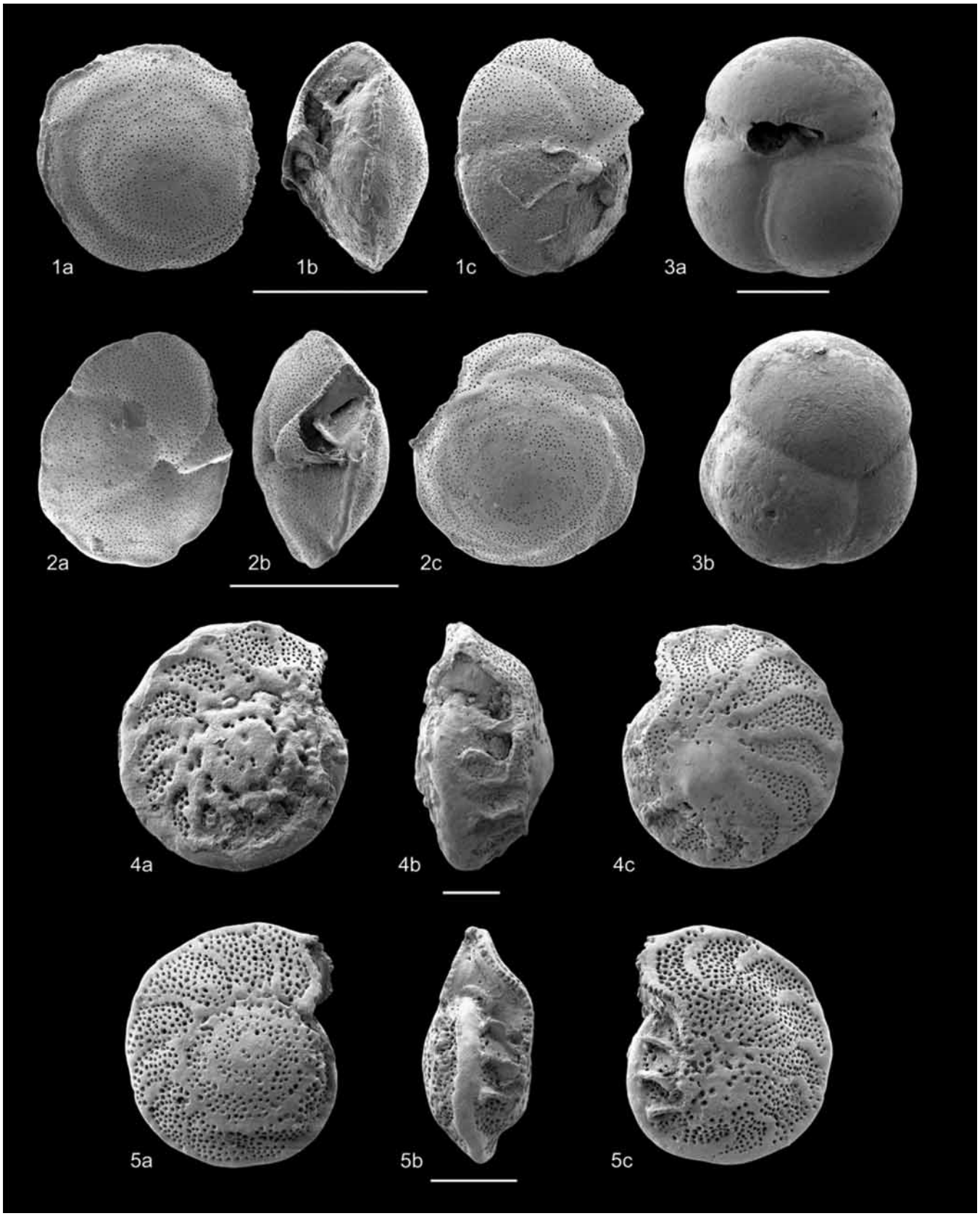
1 *Cibicidoides havanensis,* 3110m

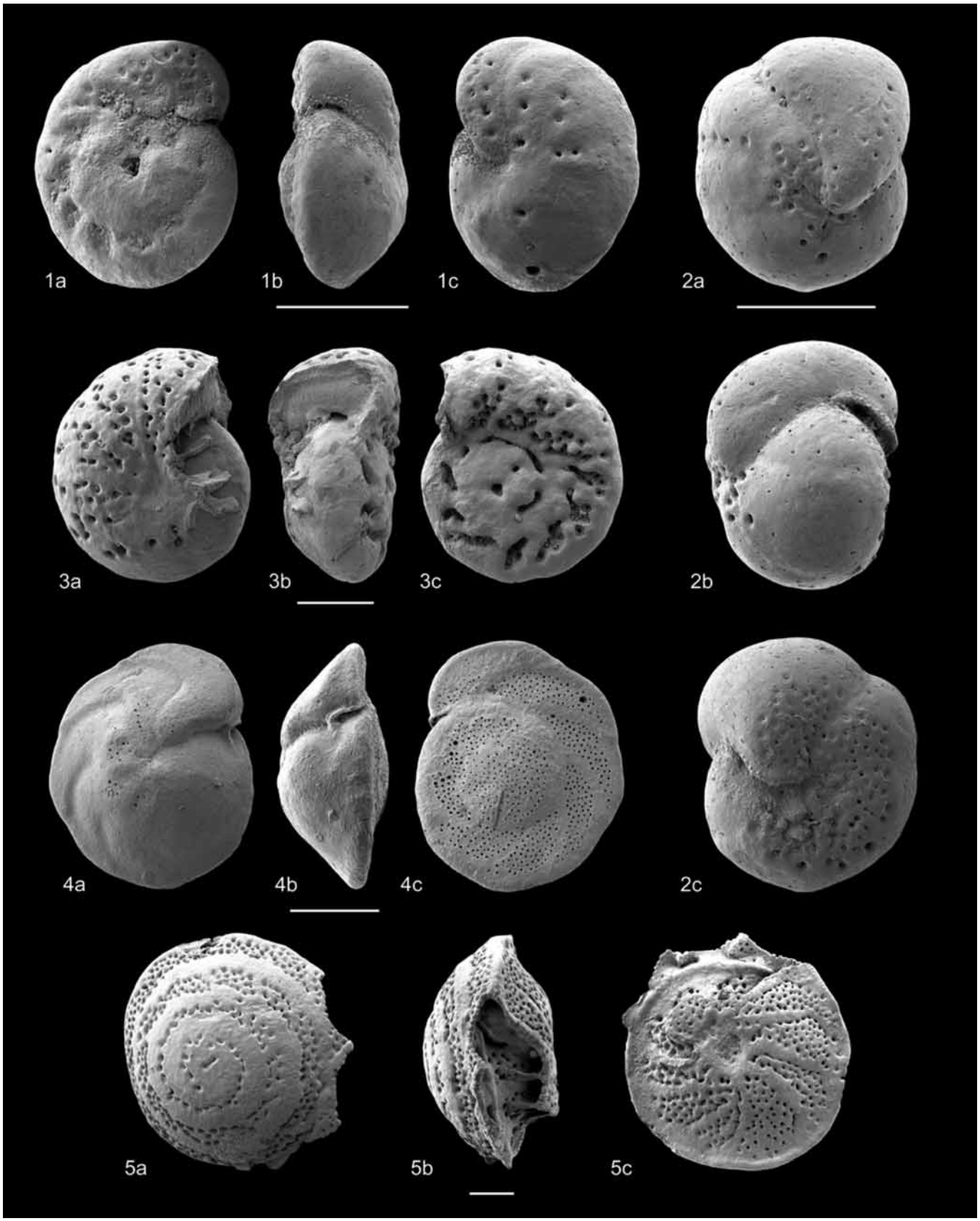
2-3 *Cibicidoides mundulus*, 3200m, 2900m

4 *Cibicidoides pachyderma*, 3050m

5 *Nonion* sp.1, 2840m

6 *Megastomella africana*, 2840m


1a
1b
1c
3a
2a
2b
2c
3b
4a
4b
4c
5a
5b
5c


1a
1b
1c
2a
3a
3b
3c
2b
4a
4b
4c
2c
5a
5b
5c

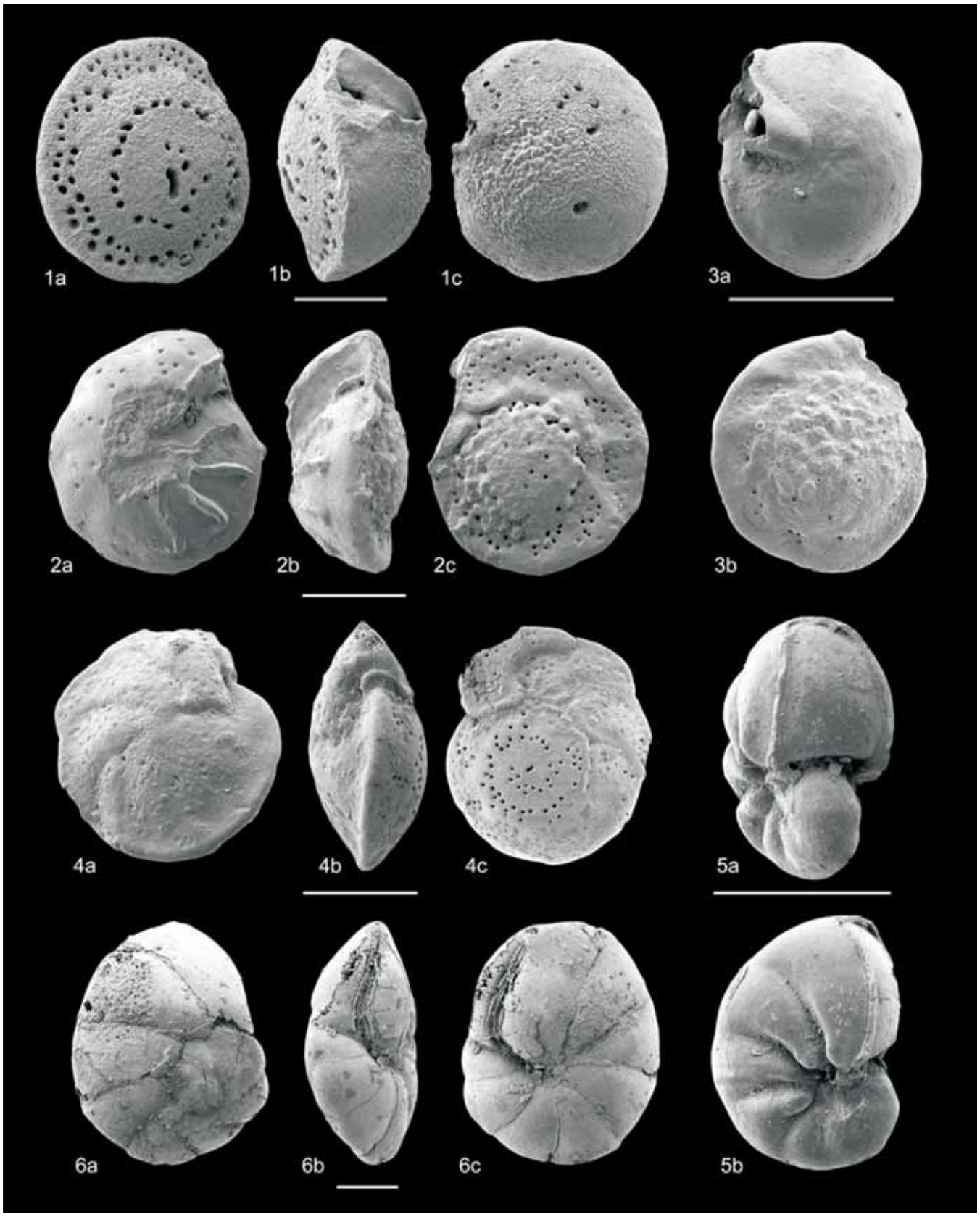

1a
1b
1c
3a
2a
2b
2c
3b
4a
4b
4c
5a
6a
6b
6c
5b

PLATE 23
(page 561)
Scale bar = 200µm (unless indicated)

1-3 *Planulina renzi*, 2840m, 3120m, 3200m

4 *Melonis pompilioides*, 2940m

5 *Pullenia bulloides*, 2980m

6 *Oridorsalis umbonatus*, 3410m

PLATE 24
(page 562)
Scale bar = 200µm (unless indicated)

1-2 *Oridorsalis umbonatus*, 3060m, 2920m

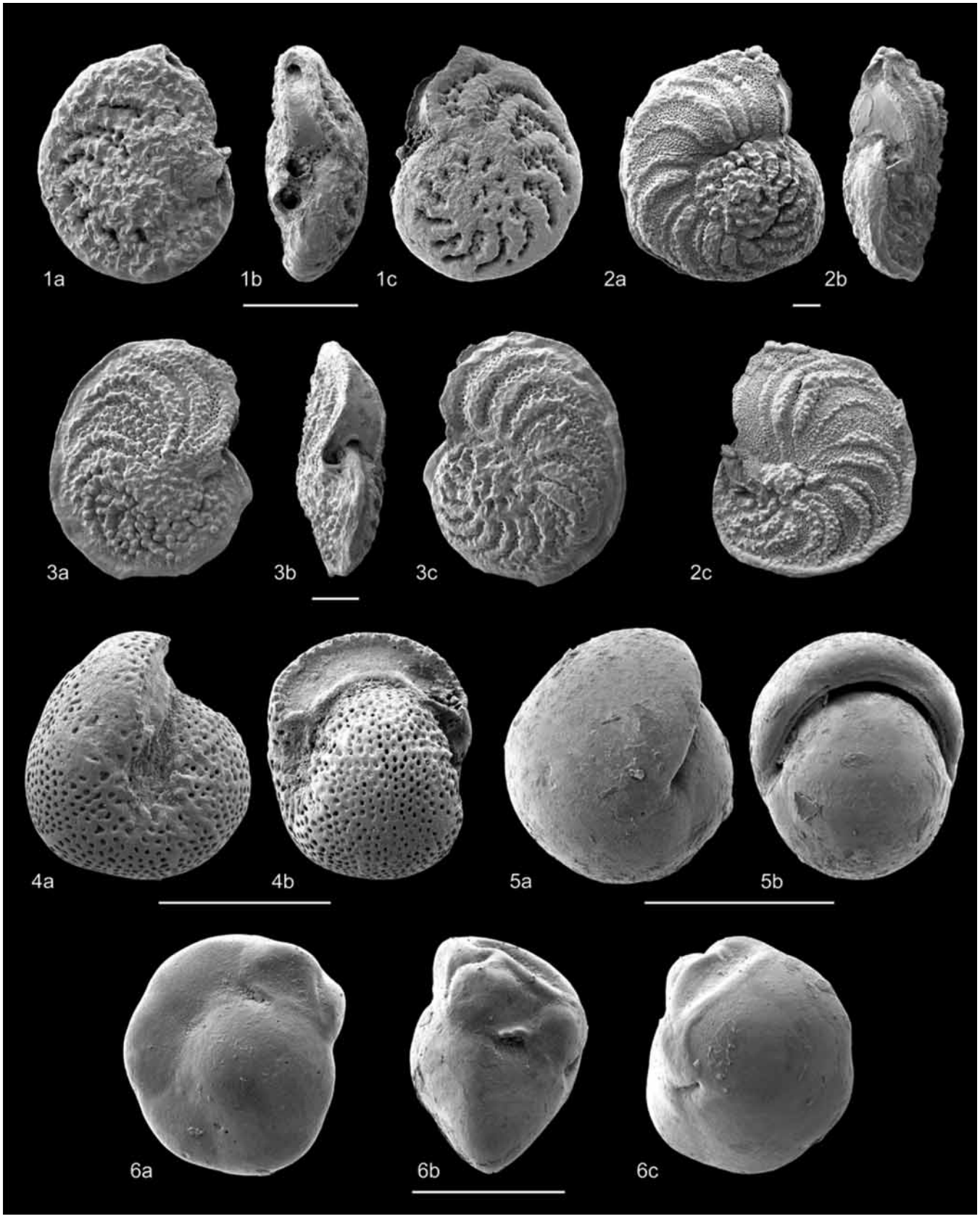
3 *Gyroidinoides altiformis*, 3050m

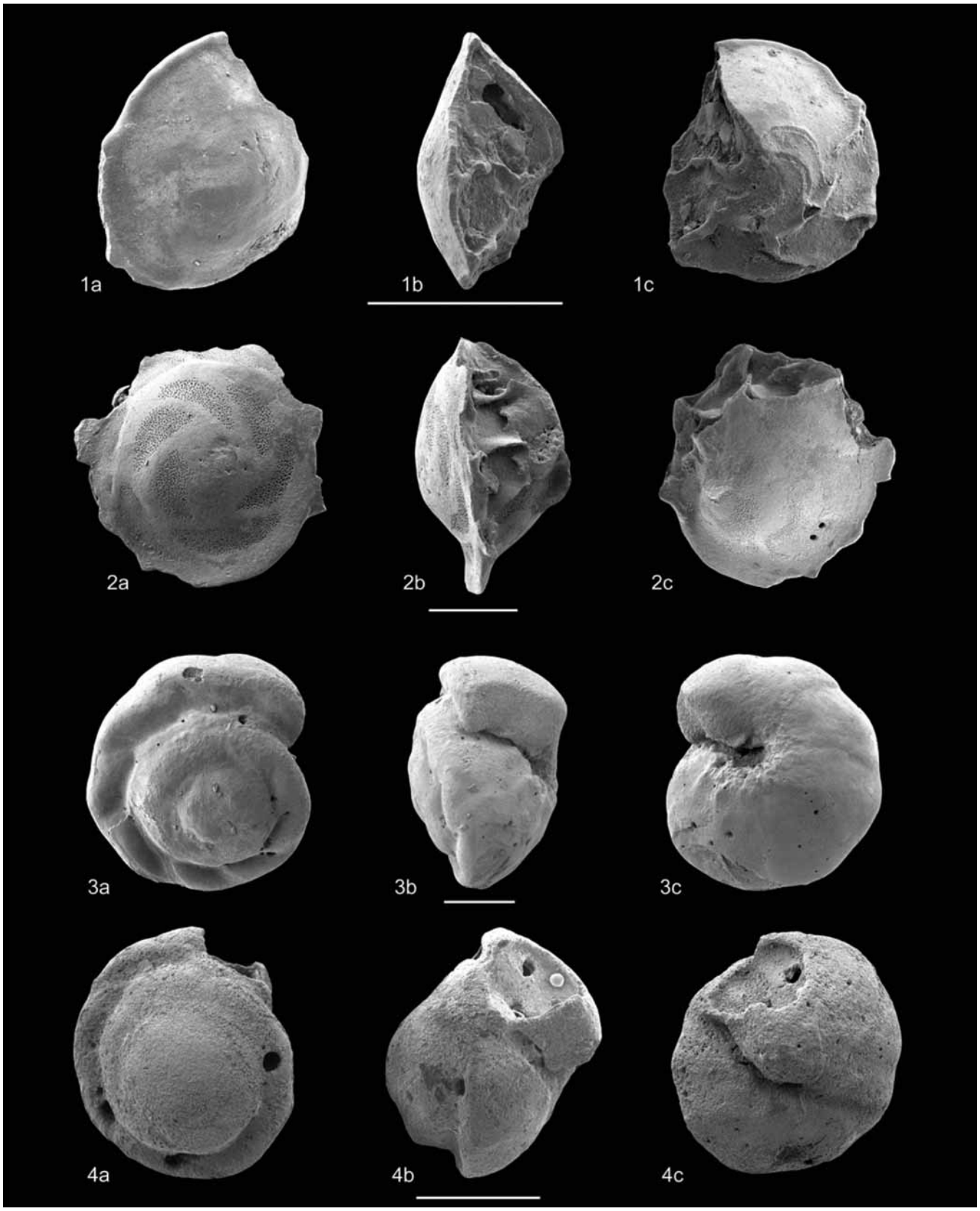
4 *Gyroidinoides altispira*, 3190m

PLATE 25
(page 563)
Scale bar = 200µm (unless indicated)

1-2 *Gyroidinoides soldanii*, 2900m, 2900m

3-4 *Gyroidina orbicularis*, 2810m, 3080m


1a
1b
1c
2a
2b
3a
3b
3c
2c
4a
4b
5a
5b
6a
6b
6c


1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c

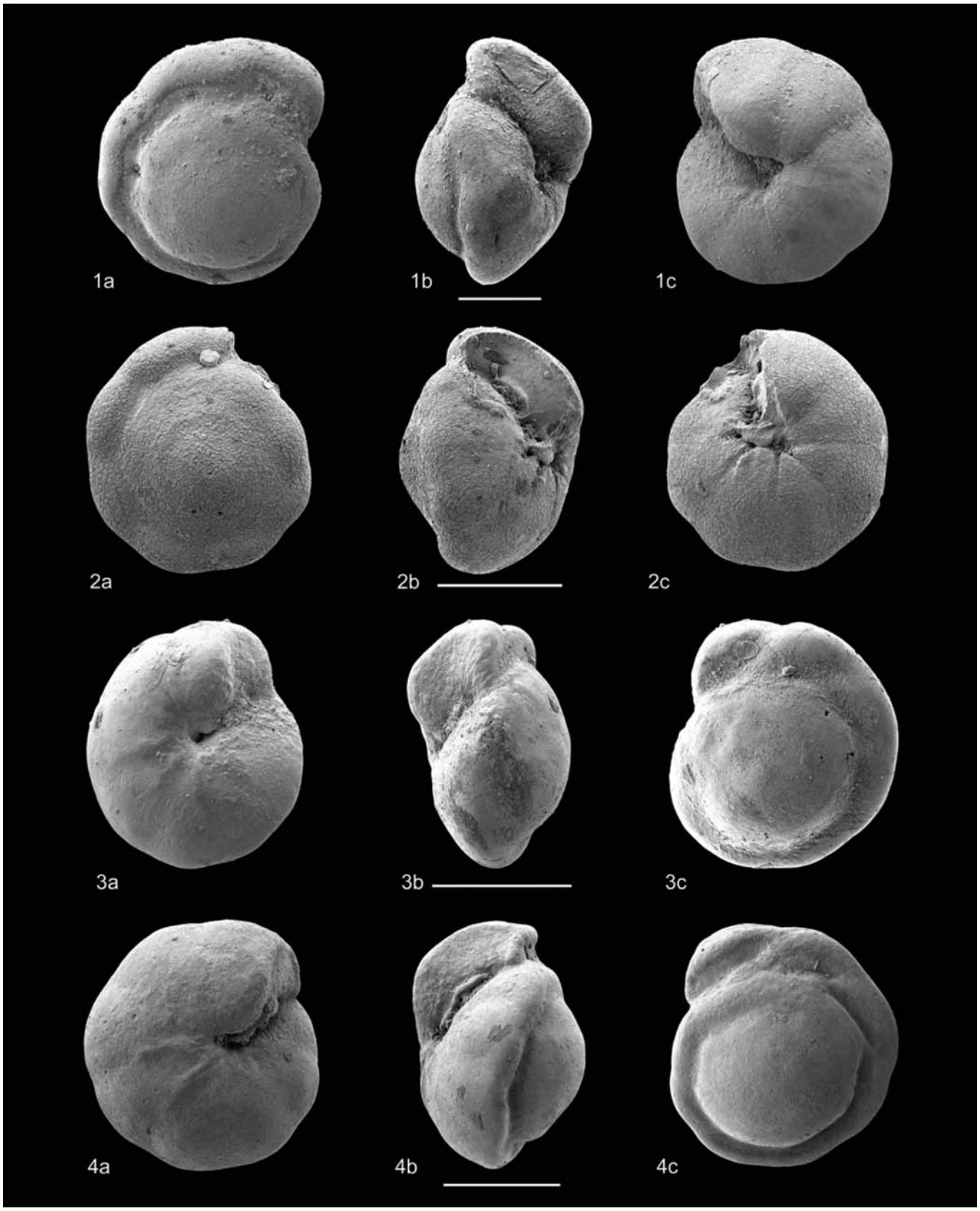

1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c

PLATE 26
(page 565)
Scale bar = 200µm (unless indicated)

1 *Gyroidina umbonata*, 2840m
2 *Hanzawaia* sp.1, 2900m
3-4 *Hanzawaia mantaensis*, 3050m, 2910m
5 *Ammonia* cf. *parkinsoniana*, 3130m
6 *Ammonia* sp., 3130m

PLATE 27
(page 566)
Scale bar = 200µm (unless indicated)

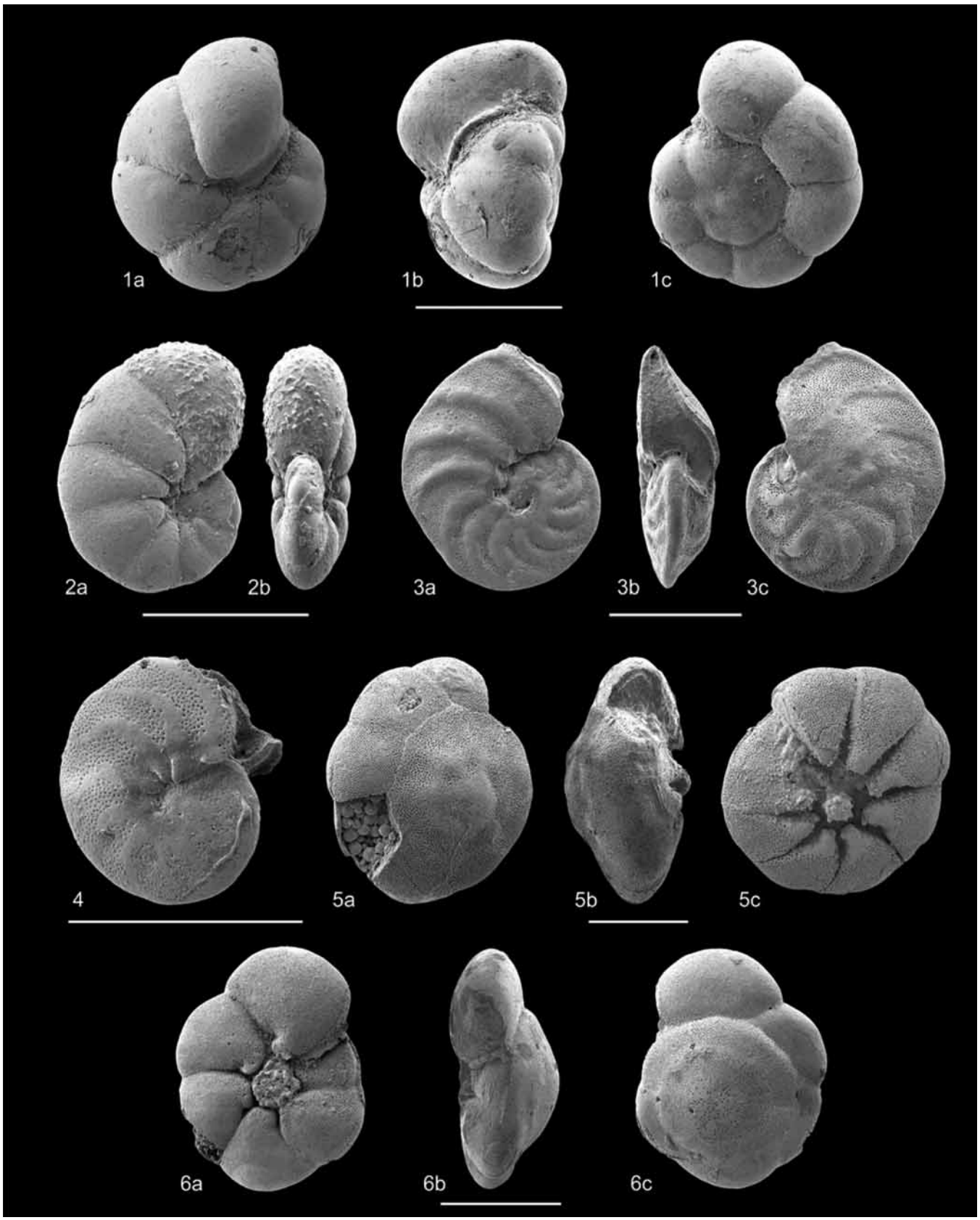
1 *Catapsydrax unicavus*, 3210m
2 *Globigerinoides sacculifer*, 3120m
3 *Globigerinoides immaturus*, 3010m
4 *Globigerinoides trilobus*, 2890m
5 *Globigerinoides bisphericus*, 2840m
6 *Praeorbulina sicana*, 3040m
7 *Praeorbulina glomerosa glomerosa*, 2890m
8 *Globigerinoides bisphericus*, 2890m

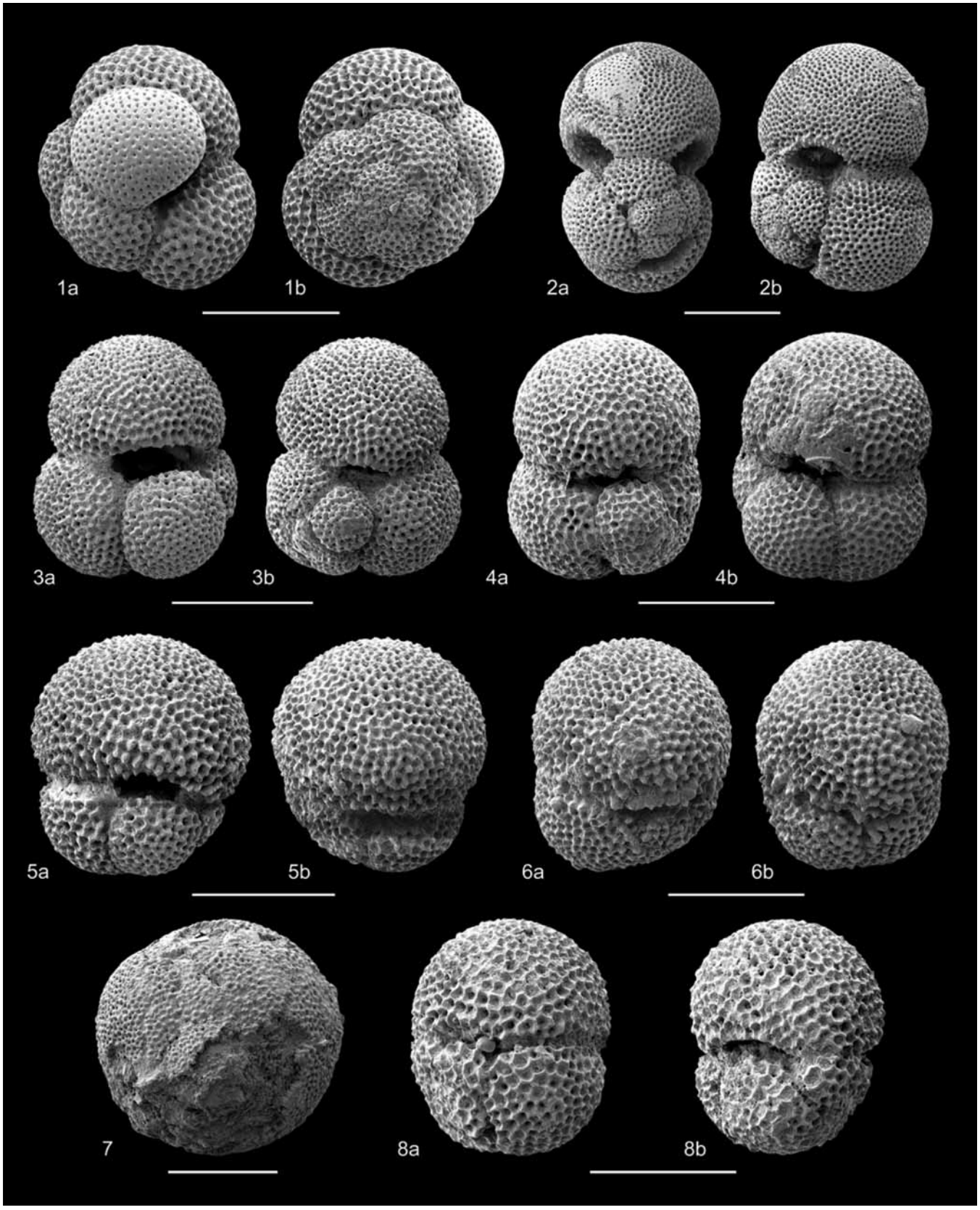
PLATE 28
(page 567)
Scale bar = 200µm (unless indicated)

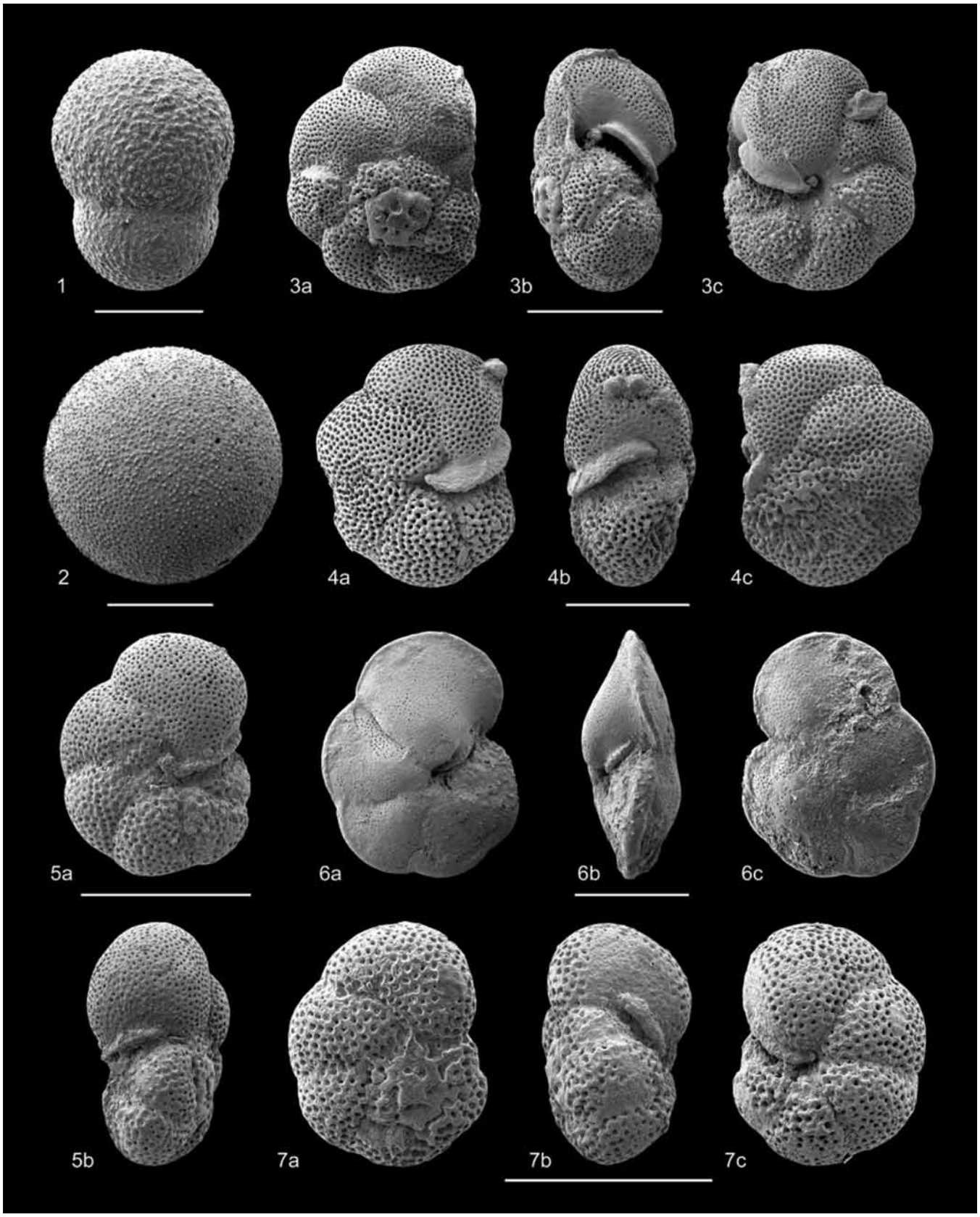
1 *Orbulina bilobata*, 2760m
2 *Orbulina universa*, 2800m
3-4 *Globorotalia peripheroronda*, 2920m, 3180m
5 *Globorotalia mayeri*, 3100m
6 *Globorotalia praemenardii*, 2930m
7 *Globorotalia* sp., 2840m

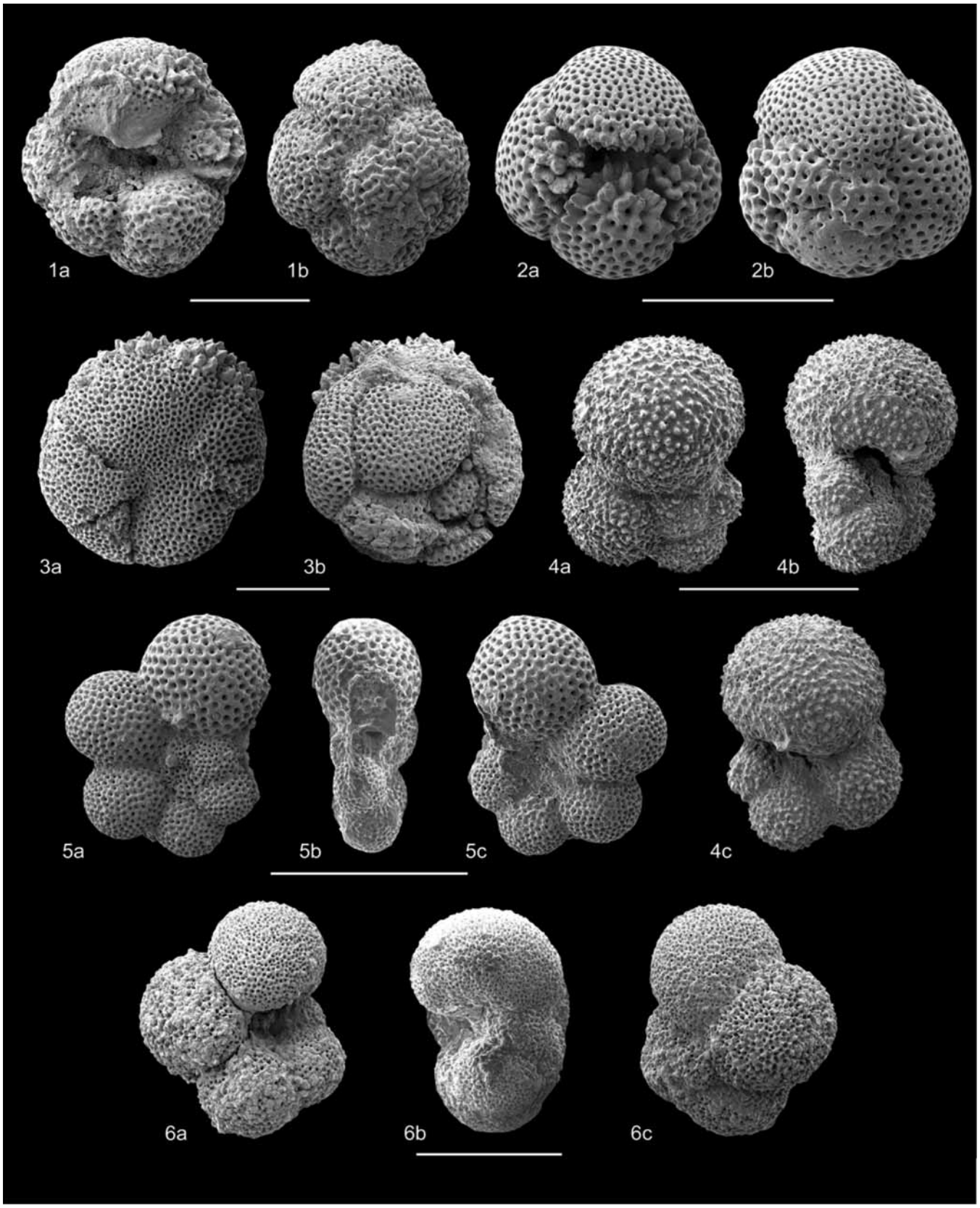
PLATE 29
(page 568)
Scale bar = 200µm (unless indicated)

1 *Globoquadrina dehiscens*, 3060m
2 *Globoquadrina venezuelana*, 2910m
3 *Dentoglobigerina altispira*, 2810m
4 *Globigerinella obesa*, 2890m
5 *Globorotaloides hexagona*, 3080m
6 *Globigerinella praesiphonifera*, 3120m


1a
1b
1c
2a
2b
3a
3b
3c
4
5a
5b
5c
6a
6b
6c


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
7
8a
8b


1
3a
3b
3c
2
4a
4b
4c
5a
6a
6b
6c
5b
7a
7b
7c


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
5c
4c
6a
6b
6c