Lower-middle Eocene benthic foraminifera from the Fortuna Section (Betic Cordillera, southeastern Spain)

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ABSTRACT: Benthic foraminifera were studied as part of an investigation of the Fortuna Section (Betic Cordillera, Southeastern Spain), undertaken to document a candidate section for the Global Stratotype Section and Point (GSSP) for the base of the Lutetian Stage (Ypresian/Lutetian boundary). Benthic foraminiferal assemblages in this section are mostly dominated by calcareous taxa (~50-96%) and by infaunal morphotypes (~55-88%). The most abundant calcareous taxa are *Globobulimina* species, *Aragonia aragonensis*, *Cibicidoides* species, *Osangularia dominicana*, and various *Lenticulina* species. The most common agglutinated species are *Clavulinoides angularis*, *Gaudryina arenata*, and *Thalmannammina subturbinata. Globobulimina* species, *A. aragonensis*, and *C. angularis* show strong fluctuations in relative abundances, with a pronounced peak in the relative abundances of *Globobulimina* species and *Aragonia aragonensis,* and low species richness across the Ypresian/Lutetian boundary. The occurrence of several peaks in abundance of *Globobulimina* species suggests that food supply to the benthos fluctuated, and the single peak in abundance of *A. aragonensis* across the Ypresian/Lutetian boundary might be indicative of a hyperthermal event. Paleodepths inferred from the assemblages range from lower upper bathyal for the lower part of the section to sublitoral for its upper part, and there is no evidence for a sea-level fall at the Ypresian/Lutetian boundary.

We selected 82 out of 175 benthic foraminiferal taxa for detailed taxonomic description, based on their relative abundances and/or paleoecological or paleobathymetrical importance.

INTRODUCTION

Benthic foraminifera are one of the most abundant, diverse, and widely distributed groups of marine organisms in deep-water environments, and have a rich fossil record. Fossil benthic foraminiferal assemblages have been used extensively for reconstruction of paleoenvironmental parameters, including water depth, delivery of organic carbon to the sea floor (hence, primary productivity in the overlying surface waters), and oxygenation of bottom and pore waters (e.g., reviews by van der Zwaan et al. 1999; Murray 2001; Gooday 2003). Such reconstructions are hindered by the fact that relatively little is known about the biology of Recent foraminifera, especially deep-sea forms. A few decades ago, assemblages were interpreted mainly in terms of physico-chemical properties of deep-sea water masses (e.g., Streeter 1973; Lohmann 1978; Schnitker 1974, 1979), but presently most authors consider various aspects of the flux of organic matter (total amount, quality and seasonality) from the sea surface as more important determinants of faunal assemblages in most open ocean environments (e.g., Gooday 1994, 2003; Jorissen et al. 1995, 1998; Loubere 1998; Gooday and Rathburn 1999; Loubere and Fariduddin 1999; Den Dulk et al. 2000; Fontanier et al. 2002). There is still discussion regarding the importance of oxygen levels in bottom or pore waters, with few researchers arguing that oxygenation is a controlling variable at relatively high levels, i.e., above 1.5ml/L (e.g., Kaiho 1994a, 1999).

Even with incomplete knowledge of the ecology of deep-sea benthic foraminifera, their assemblages have been used extensively to reconstruct paleoenvironments, including those in the Paleogene, the early part of the Cenozoic. Major global environmental changes characterized this overall warm period in earth history, which started at ~ 65 Ma with the major environmental disturbance caused by the impact of an asteroid, which has been linked to the mass extinction at the Cretaceous/Paleogene boundary (K/Pg). During this mass extinction benthic foraminifera did not suffer significant extinction (e.g., Boersma 1978; Lipps and Hickman 1982; Alegret et al. 2001; Culver 2003; Alegret and Thomas 2005), in stark contrast with the massive coeval extinction of planktic foraminifera and calcareous nannoplankton (e.g., Kaiho 1994b).

Deep-sea benthic foraminifera suffered a mass extinction about 10 myr after the beginning of the Paleogene, during a short (~ 100 kyr) period of extreme global warming just after the Paleocene/Eocene boundary, the so-called Paleocene-Eocene Thermal Maximum (PETM) (e.g., Beckmann 1960; Proto Decima and DeBiase 1975; Schnitker 1979; Tjalsma and Lohmann 1983; Thomas 1998). The PETM occurred during the warmest part of the Cenozoic, the late Paleocene through early Eocene, which time interval encompasses the Early Eocene Climate Optimum (EECO; Shipboard Scientific Party ODP Leg 208, 2004) and the Ypresian/Lutetian (Y/L) boundary (Miller et al. 1987; Zachos et al. 2001; Thomas 2003).

During the time interval from the late Paleocene through the early Eocene several "hyperthermals" events similar to, but not as pronounced as the PETM, appear to have occurred, with the latest of these events possibly occurring at the Y/L boundary (Thomas and Zachos 2000; Thomas et al. 2000; Cramer et al. 2003; Lourens et al. 2005; Shipboard Scientific Party ODP Leg 208, 2004). Such hyperthermal events were defined as intervals

of low latitudinal sea surface temperature gradients and extremely high global temperatures, possibly caused by high atmospheric greenhouse gas levels, stemming from dissociation of methane hydrates at the sea floor (Dickens et al. 1995; Dickens et al. 1997; Thomas 2003). There is considerable debate whether such events could have been triggered by orbital forcing of the climate system (Lourens et al. 2005; Cramer et al. 2003).

Partial recovery of deep-sea benthic foraminiferal faunas in the early through middle Eocene was followed by a period of gradual but important faunal turnover starting at the end of the middle Eocene and continuing into the earliest Oligocene, a time of long-term global cooling (Miller et al. 1987; Zachos et al. 2001). During this long-term cooling ice sheets became established on the Antarctic continent, and planktic as well as benthic foraminiferal assemblages underwent major restructuring (Thomas 1990, 1992a, b; Thomas et al. 2000; Kuhnt et al. 2002).

A solid taxonomy is essential to use benthic foraminiferal assemblages in such paleoenvironmental analysis, but there is no general international agreement on the taxonomy of the extremely diverse Paleogene benthic foraminifera. Different species names are commonly used for morphologically identical forms, and recent reviews do not fully solve this problem (van Morkhoven et al. 1986; Bolli et al. 1994; Holbourn et al., 2005). During the last decades, the research on deep-water benthic foraminifera has focused more on paleobiogeography and paleoenvironment, rather than on biostratigraphy and taxonomy, and this work is one of the few recent taxonomic revisions of Paleogene benthic foraminifera (e.g., Alegret and Thomas 2001: Katz et al. 2003; Holbourn et al. 2005).

Foraminiferal taxonomy, with few exceptions, started with early descriptive studies in the natural history tradition of the 19th century (e.g., d'Orbigny 1826, 1839, 1846; Brady 1884). Many taxonomic studies were published in applied micropaleontology (oil industry), e.g. by Cushman and his co-authors who carried out important taxonomic work during the second quarter of the 20th century, mainly in the Caribbean region, the Gulf Coastal region of the United States and Mexico, with fewer studies in Europe (Paris and Vienna Basins). For the Paleogene, many studies by Cushman and co-workers are available (see reference list), in addition to studies by Cole (1927, 1928), Nuttall (1928, 1930, 1932), Toulmin (1941), Bermúdez (1949), Beckmann (1954), Renz (1948), and Kaasschieter (1961).

Late Cretaceous and early Tertiary deep-water species generally have a wide to cosmopolitan geographic distribution, and long stratigraphic ranges (e.g., Tjalsma and Lohmann 1983; Thomas 1990). The widespread occurrence in space and time of many taxa made it possible to use information on faunas in the classic taxonomic studies cited above, in the absence of detailed studies on benthic foraminifera from the Paleogene and specifically the Eocene of the Betic Cordillera, the area of this study (e.g., Colom 1954; Márquez 1975, 1979, 1983).

We present a detailed taxonomic study of benthic foraminifera from the Ypresian-Lutetian (Y-L) transition in the Fortuna section in the Betic Cordillera. We compared our material with type specimens deposited at the Smithsonian Institution, Washington D.C., in order to help clarify the taxonomic confusion in literature.

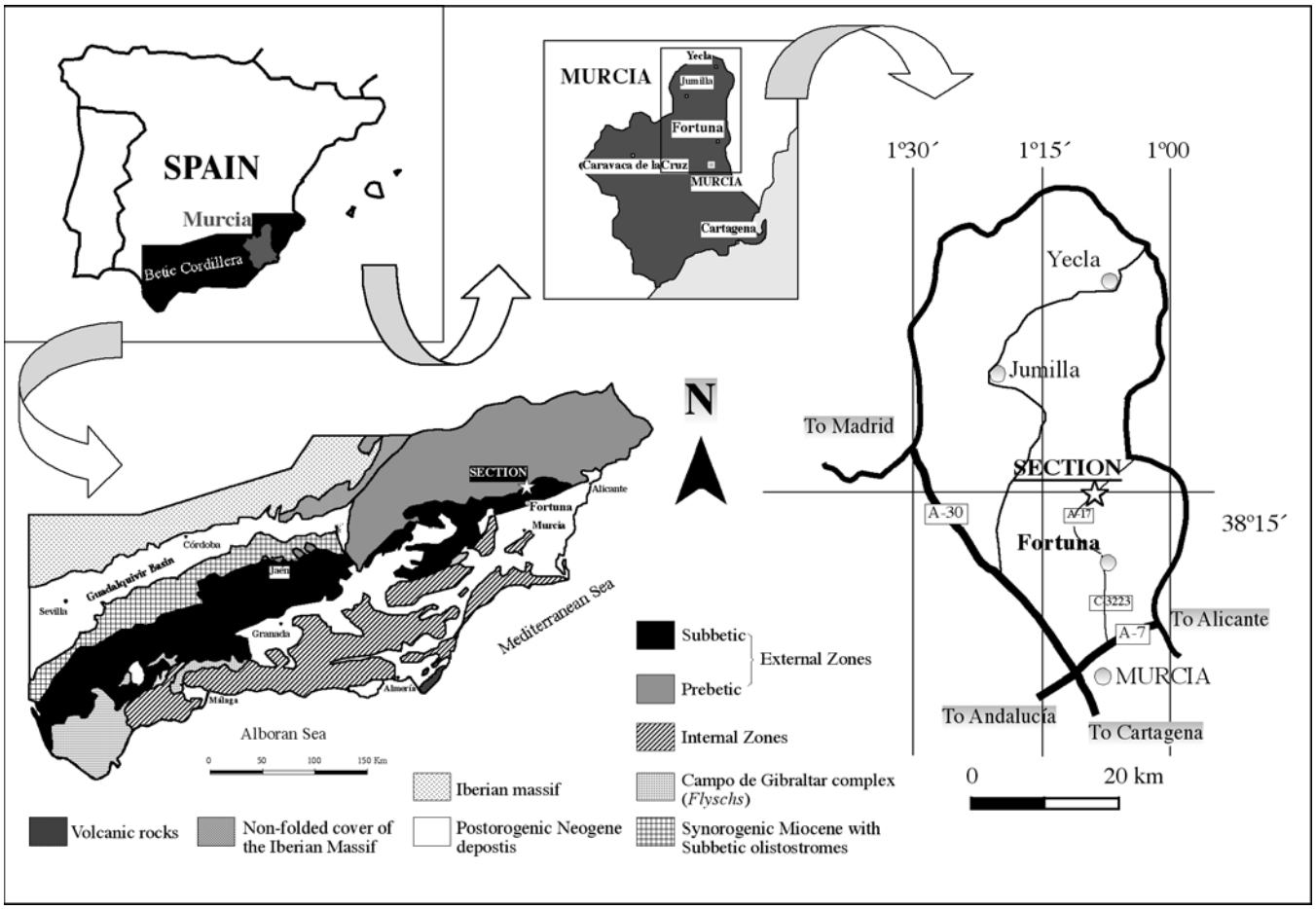
MATERIAL AND METHODS

One of the international working groups of the International Subcommission of Paleogene Stratigraphy is searching for a suitable section to define the Global Stratotype Section and Point (GSSP) for the base of the Lutetian Stage, i.e., the Ypresian/Lutetian Boundary. The Y/L Boundary corresponds to the lower/middle Eocene boundary, and must be defined in a region near the location of the base of the Lutetian Stratotype (France). Several countries (France, Italy, Morocco, Israel, Cuba, and Spain) have been visited by the working group in search of a suitable section, and many sections have been studied in order to delineate a bundle of successive events across the Y/L boundary. One of these sections is the Fortuna section, which according to preliminary studies has potential to be nominated as GSSP of the Y/L boundary (Gonzalvo et al 2001; Gonzalvo and Molina 2003; Ortiz and Molina 2003; Mancheño et al. 2003).

The Fortuna section is located in the Murcia Region, Betic Cordillera (Southeastern Spain). The outcrop is about 10 km North of Fortuna village, along the northern slope of road A-17, between Fuente Blanca and Peña de la Zafra, 200m NE from La Rauda ravine (text-fig. 1), at UTM coordinates 621376 to 623376, taken on the Fortuna map (892), scale 1:50.000.

The lower-middle Eocene sediments are rich in planktic microfossils and fully marine. The facies is transitional between those in the External Subbetic and the Internal Prebetic, in the meridional Prebetic of the Betic Cordillera (Vera 2004). The section is located in the periclinal closure of the La Garapacha anticline. The lower-middle Eocene sediments consist of marls in the lowermost 20m of the section. Upsection there are 10m of limestones (between 20 and 30m in the section). Above 30m in the section there are marls, with interbedded marly limestone and calcarenite layers; conglomerates are interbedded in the limestones (text-fig. 2).The biostratigraphy of the lower-middle Eocene in the Fortuna section is based on planktic foraminifera and calcareous nannofossils (Gonzalvo and Molina 1998; Gonzalvo et al. 2001). These authors recognized the Ypresian *Acarinina pentacamerata* Zone and the *Subbotina boweri* and *Truncorotaloides praetopilensis* planktic foraminiferal Subzones as well as the Lutetian *Hantkenina nuttalli* and *Globigerapsis kugleri* Zones and the *H. nuttalli*, *Globigerapsis subconglobata*, and *G. kugleri* Subzones (text-fig. 2). The Y/L boundary was placed just below sample For 13, characterized by the first occurrence of *Hantkenina* at the base of P10 (Berggren et al. 1995). Calcareous nannofossils studies were carried out by von Salis (Molina et al. in press), who recognized Subzones NP14b, NP15a, NP15b, and NP16 (Martini 1971). Stable isotopic analyses were performed on whole-rock samples and the benthic foraminiferal taxa *Cibicidoides hadjibulakensis* and *Lenticulina* spp. and clay mineralogical studies were performed by Schmitz and Mancheño (Molina et al. in press).

Benthic foraminifera were studied in 33 samples, taken at about 1m intervals in the lowermost and upper parts of the Fortuna section, and at about 50cm intervals closer to the Y/L boundary (text-fig. 2). The marly limestone unit was not used in the micropaleontological studies because of the difficulty in extracting the fauna. Samples were disaggregated in water to which diluted H_2O_2 (10%) was added, and washed through a 100µm sieve. Samples were cleaned repeatedly in an ultrasonic bath. The final cleaned residue was dried in an oven at a temperature below 50ºC. Quantitative analyses were based on representative splits of about 300 specimens of the >100µm fraction,



TEXT-FIGURE 1
Location and geological setting of the Fortuna section (Betic Cordillera, southeastern Spain).

obtained with an Otto microsplitter. Rare species were searched for in the remaining residue. All samples contained sufficient specimens for study, except for sample For 31, which was barren of both calcareous and agglutinated forms.

The preservation of benthic foraminifera varies from sample to sample, but in most samples is adequate to detect diagnostic morphological features. In samples For 11,3 to For 13,5, however, benthic foraminifera are small and less well preserved, resulting in loss of ornamentation (e.g., broken spines, keels, flaps), breakage of rectilinear specimens and of last chambers in spiral tests, calcite overgrowths on test surfaces (sugary appearance as described by Bignot 1998), and deformation (compression) of thin-walled, globose specimens such as *Globobulimina* spp.

The best preserved and most representative specimens were selected and coated with Au for Scanning Electron Micrography. All figured specimens are deposited at Department of Earth Sciences, Area of Paleontology, University of Zaragoza, Spain.

PALEOBATHYMETRY

Benthic foraminiferal assemblages have been traditionally used as paleobathymetric proxies (e.g., Bandy 1960; Murray 1973, 1991; Boltovskoy 1978). We base our paleobathymetric inferences on the occurrences and relative abundances of depth-dependent species, on their upper depth limits (Bandy 1960; van Morkhoven et al. 1986), on comparisons between fossil and Recent assemblages, and on comparisons with benthic foraminiferal assemblages at DSDP and ODP sites where paleodepths can be derived independently by back-tracking (e.g., Tjalsma and Lohmann 1983; van Morkhoven et al. 1986; Katz et al. 2003). Text-figure 3 documents the upper-depth limits and some of the most commonly observed bathymetric distributions of selected benthic foraminiferal taxa present in the Fortuna section. We have included references to all sources of information in the numbered references in the figure caption. Authors not always agree on paleodepth assignments, and we evaluated information in various sources in order to present the most probable bathymetric assignment possible with available data.

We used information on species depth distributions as reported from the Eocene, but also from the Paleocene to Oligocene (e.g., Katz et al. 2003; Speijer 1994), and from Recent assemblages (e.g., Murray 1991). In addition to information on taxa occurring in typical faunas from the Paleocene Midway and Velasco Formations, and from the Eocene Jackson-Clairborne (sublitoral) and Barbados (bathyal-abyssal) Formations (van Morkhoven et al. 1986), we included information on a well-described sublitoral Eocene fauna from Belgium (Kaasschieter 1961).

We use the following bathymetric zones, according to the most widely used zonal system as published by van Morkhoven et al.

(1986): sublitoral (<200m), upper bathyal (200-600m), middle bathyal (600-1000m), lower bathyal (1000-2000m), abyssal (>2000m).

The sublitoral "Midway-type fauna" and the bathyal to abyssal "Velasco-type fauna" correspond to Paleocene faunas described from around the North Atlantic and Tethys Oceans in land sections, as well as in DSDP-ODP drill sites (Berggren 1972; Berggren and Aubert 1975; Schnitker 1979). Mixed Midway and Velasco-type faunas are found in upper bathyal settings (e.g., Alegret et al. 2001; Speijer 1995; Widmark and Speijer 1997).

The lower Eocene Aragon Formation in Mexico contains Midway-type species (Nuttall 1930), some of which are present in the Fortuna section, mainly in its lower part, such as *Lenticulina rotulata*, *Loxostomoides applini*, and *Pullenia quinqueloba*. Other Midway-type species in the Fortuna section are *Anomalinoides acutus*, *Clavulinoides angularis*, *Lenticulina turbinata*, *Siphogenerinoides eleganta*, and *Osangularia plummerae* (Plummer 1926; Berggren and Aubert 1975; Alegret and Thomas 2001). These species are not abundant, with the exception of *C. angularis*, which is very abundant (up to 24.6%) in some samples. Species described from the deep-bathyal Velasco Formation, such as *Bulimina trinitatensis* and *Nuttallides trümpyi*, with an upper depth limit of 500-700 m, never reach more than a few % relative abundance in the Fortuna section.

Various *Lenticulina* species are common in the lower part of the Fortuna section, suggesting upper-middle bathyal depths (200-1000m) (e.g., Murray 1991; Bignot 1998). *Cibicidoides* species can assist in distinguishing between bathyal and abyssal depths (Katz et al. 2003), and in the Fortuna section, *Cibicidoides eocaenus* is the most abundant *Cibicidoides* species. This was primarily a bathyal species in the Eocene (van Morkhoven et al. 1986), and common at middle bathyal to lower abyssal depths in the early Oligocene (Katz et al. 2003). *Cibicidoides grimsdalei* was primarily a lower bathyal and abyssal taxon (van Morkhoven et al. 1986; Katz et al. 2003); this species is very rare in the Fortuna section. *Cibicidoides dutemplei* is found in outer sublitoral and upper bathyal deposits (Kaasschieter 1961; van Morkhoven et al. 1986), and shows strong fluctuations in relative abundance from very rare to abundant in the Fortuna section.

Among the most abundant taxa in the Fortuna section are species of *Globobulimina* (text-fig. 2), which in the present oceans occur over a very wide depth range, from sublitoral through abyssal depths (e.g., Murray 1991). *Aragonia aragonensis* is very abundant in samples For 11,3 through For 13 (text-fig. 2). Van Morkhoven et al. (1986) assigned an upper depth limit of ~1000m to this species, but Grünig and Herb (1980) interpreted water depths of about 600-1000m for a part of the upper Eocene Possagno section in Italy where this species is common. Upper bathyal depths of occurrence for *Aragonia aragonensis* are also quoted by Bignot (1998), Speijer (1994), and Browning et al. (1997).

In the Fortuna section the planktic/benthic (P/B) ratio varies between 61 and 94%, indicating open ocean conditions. The lowest value (sample For 12) may not reflect a decrease in depth of deposition, because no other changes in relative abundances suggest that such a change occurred, but might be caused by high benthic foraminiferal productivity (see below).

We therefore suggest that the preponderant evidence indicates that samples For 1 through For 19,5 (the lower part of the section) were deposited at depths close to the upper-middle bathyal boundary (~600m), in agreement with the observed planktic foraminiferal percentages (e.g., van der Zwaan et al. 1990). Samples For 12,5-13,5 contain rare and abraded specimens of *Pararotalia audouini*, an inner sublitoral species (Murray 1991), which we consider to be allochthonous, having been transported downslope. Some *Asterigerina* specimens, a genus that presently mainly occurs epiphytically, could likewise have been transported downslope. The upper part of the Fortuna section (samples For 33 and For 35) are separated from the lower part by several meters of limestones with common macrofauna, abundant in sublitoral deposits. This upper part contains more common and better preserved *P. audouini*, as well as specimens of *Asterigerina brencei* and *A. fimbriata*, and thus may have been deposited at sublitoral depths (<200m). In conclusion, we found no evidence for the major sea-level fall, which has been described as occurring at the first appearance of *Hantkenina* spp., at the Y/L boundary, but a local or regional regression occurred higher in the section (Molina et al. in press).

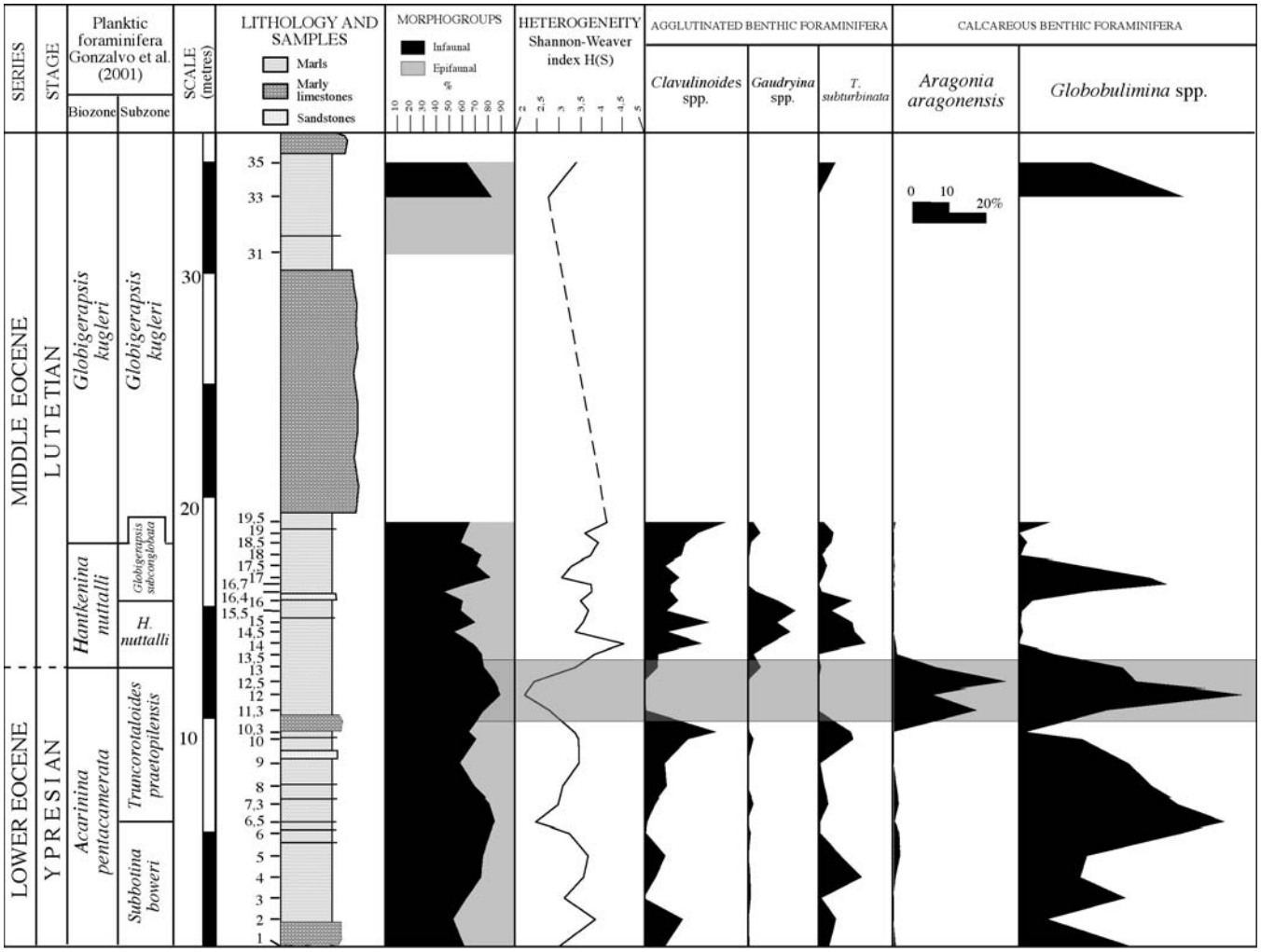
PALEOECOLOGY AND PALEOENVIRONMENTAL TURNOVER ACROSS THE Y/L TRANSITION

In order to evaluate faunal diversity, we calculated the simple species and genus numbers, and the H(S) Shannon-Weaver information function (text-fig. 2). The assemblages are generally highly diverse, with ~50 to 65 species, and ~30 to 40 genera present in most samples. Generally, assemblages contain a few dominant species and many rare species, as do most deep-sea foraminiferal assemblages. Our species richness values are similar to those observed for bathyal to abyssal faunas of the same age at other locations (e.g., Thomas 1990). The more conspicuous exceptions are samples For 12 and For 12,5, which contain only 33 and 38 species, and 28 and 29 genera, respectively. In the Fortuna section, the H(S) indices vary between 2.21 and 4.44 in samples For 12 and For 14, respectively.

Benthic foraminiferal assemblages are largely dominated by calcareous taxa, making up about 50%-95% of the total fauna. The most common calcareous taxa include *Globobulimina* species, *G. ovata* being the most abundant taxon while *Aragonia aragonensis*, *Cibicidoides* species, including *C. eocaenus*, *Osangularia dominicana*, and various *Lenticulina* species, e.g., *L. cultrata* are also abundant in at least some samples. The most common agglutinated species are *Clavulinoides angularis*, *Gaudryina arenata*, and *Thalmannammina subturbinata*. All these common taxa show strong fluctuations in relative abundance.

We assigned microhabitat preferences, based on test-shape (morphogroups) (e.g., Jones and Charnock 1985; Corliss and Chen 1988) and compared fossil with Recent assemblages (e.g., Mackensen et al. 1995). Many authors argue that the relative abundance of specimens belonging to infaunal species is positively correlated with the organic carbon flux to the sea floor (e.g., Corliss and Chen 1988; Jorissen et al. 1995; Mackensen et al. 2000). In our samples, infaunal morphogroups (55-85% of the assemblages) generally dominate over epifaunal morphogroups, with the exception of sample For 16,4, where infaunal morphogroups make up 45,5% of the assemblages (text-fig. 2).

The relative abundances of infaunal and epifaunal species (text-fig. 2) fluctuate strongly in the Fortuna section, mainly because of the strong fluctuations in the relative abundance of



TEXT-FIGURE 2
Lithology and stratigraphy of the Fortuna sectionwith location of samples and relative abundances of the most abundant benthic foraminiferal species. The grey area corresponds to extent of the possible "hyperthermal event" at the Ypresian/Lutetian boundary. *T. subturbinata= Thalmannammina subturbinata.*

Globobulimina spp., generally classified as a deep-dwelling infaunal species (e.g., Fontanier et al. 2002; Gooday 2003). A high relative abundance of these taxa in the present oceans is typical for areas with a high flux of organic matter to the sea floor, and possibly associated low oxygen conditions in bottom or pore waters (e.g. Bernhard and Sen Gupta 1999; Gooday and Rathburn 1999; van der Zwaan et al. 1999; Schmiedl et al. 2003).

In the Fortuna section, there are several intervals with low species richness, high relative abundances of *Globobulimina* spp. (peak abundance 69.1%), low relative abundances of various agglutinated taxa and of the epifaunal taxa *Cibicidoides* spp. and *Osangularia* spp., and scarce planktic foraminifera (text-fig. 2). We interpret these variations in the benthic foraminiferal assemblages as representing fluctuations in primary productivity. The lower relative abundance of planktic foraminifera could be interpreted as indicative of shallower water depths, but could also indicate higher productivity (e.g., Berger and Diester-Haass 1988). Clay mineral assemblages deposited during this time interval indicate humid conditions (Molina et al. in press), thus possibly high run-off from land, supplying nutrients. We do not consider these assemblages with high relative abundances of *Globobulimina* spp. as indicative of extremely eutrophic, anoxic to dysoxic conditions, because epifaunal taxa remain present and the sediments are light-colored and do not appear to have high organic carbon concentrations.

The Y/L boundary is located within one of the intervals (samples For 11,3 – For 13) with high abundances of *Globobulimina* spp. This interval is unusual because it is the only one in the Fortuna section which also has a high relative abundance of *Aragonia aragonensis* (up to ~35%), a species that is rare or absent in our other samples. Bulk $\delta^{13}C$ values show a negative excursion in this interval (Molina et al. in press). *Aragonia aragonensis* is extinct, and its ecology is not known. This species shows peaks in relative abundance at several deep-ocean sites in the lowermost Eocene, just after the benthic foraminiferal extinction at the end of the Paleocene (Thomas 1990;

Thomas et al. 2000; Thomas and Zachos 2000; Thomas 2003). It has been speculated to be an opportunistic species, by comparison of its abundance patterns with those of ostracod species in the lowermost Eocene (Steineck and Thomas 1996). Methane dissociation in the oceans at the end of the Paleocene might have triggered increased chemosynthetic activity, and high abundance of "bloom species" such as *A. aragonensis* could indicate presence of a chemosynthetic bacterial food supply (Thomas 2003). Such an increased food supply from bacteria could be present for benthic foraminiferal faunas far away from the actual locations of gas hydrate dissociation: bacterial oxidation of methane in hydrothermal plumes in the present oceans contributes an amount of organic carbon up to 150% that of the organic matter reaching the depth of the plume from the surface in the northeast Pacific (de Angelis et al. 1993). Such methane plumes might also have been generated during dissociation of methane hydrates, and may have supported benthic foraminifera living on bacteria (Dickens 2000).

Recently, evidence has started to accumulate that there may have been more than one occurrence of methane dissociation during the late Paleocene and early Eocene, as shown by the occurrence of multiple, so-called hyperthermal events (Thomas and Zachos 2000; Shipboard Scientific Party ODP Leg 208 2004; Cramer et al. 2003, Lourens et al. 2005). The Y/L boundary has been mentioned as the possible time of such a hyperthermal event (Thomas and Zachos 2000). Our data from the Fortuna section show a peak abundance of *A. aragonensis* at the Y/L boundary, and tentatively support that there might have been a hyperthermal event at the Y/L boundary.

CONCLUSIONS

This paper contains a detailed taxonomic study of the benthic foraminifera across the Ypresian-Lutetian transition in the Betic Cordillera (Spain) in the Fortuna section, which provides an important record of lower-middle Eocene benthic foraminiferal faunas from lower upper-middle bathyal paleodepths in the lower part of the section, to sublitoral for its upper part. We focused specifically on the revision and comparison of the main species of *Anomalinoides*, *Cibicidoides*, *Globobulimina*, and *Lenticulina*.

This quantitative study enabled us to define several intervals during which surface productivity was high, as based on the relative abundance of the most abundant calcareous taxon, *Globobulimina* spp. One of these intervals includes the Ypresian/Lutetian boundary, and is the only one to show a peak in the abundance of the possibly opportunistic species *Aragonia aragonensis*, an almost complete absence of agglutinated foraminifera, and low species richness. We suggest that this assemblage might indicate that a hyperthermal event, similar to that at the PETM but less intense, occurred at the Y/L boundary.

TAXONOMY

In total, we identified 175 taxa. Not all specimens were identified to the species level; for example, species of *Lagena* and other unilocular genera were included in a group 'unilocular indet taxa'. We selected 82 benthic foraminiferal taxa of these 175 for description, based on their abundances and/or their paleoecological or paleobathymetrical importance. The taxa include both agglutinated (14) and calcareous (68) foraminifera; within each of these groups, taxa were arranged in alphabetical order. In general, we kept that order of description in the plates, but made a few exceptions in order to illustrate some species together within one plate (e.g., a plate with *Globobulimina* species).

We followed Loeblich and Tappan (1987) for generic assignments, and did not use more recent generic classifications for some groups of genera (e.g., Loeblich and Tappan 1994; Sen Gupta 1999; Hayward 2002) in order to prevent inconsistencies, although we did use specific assignments in Hayward et al. (2002). Our identifications at the species level are based principally on Tjalsma and Lohmann (1983), van Morkhoven et al. (1986), and Bolli et al. (1994), as well as on various studies by Cushman and collaborators (see references). We checked all original species descriptions in the Ellis and Messina catalog (online version; http://www.micropress.org). For each species, we have quoted all references found that in our opinion are in agreement with our concept of the species. Specifically, we reviewed and revised *Globobulimina* species. We left two taxa in open nomenclature, *Pseudoclavulina* sp. A and *Angulogerina* sp. A.

We examined almost all primary types of the taxa that we recognized in the Smithsonian Institution, Washington D.C., and many secondary types. We also examined the syntypes of *Cibicidoides naranjoensis* in White's collection at the American Museum of Natural History. When the holotype, lectotype, and/or paratype(s) were examined, we quoted first the catalog number of the holotype or lectotype, then the paratype(s). In addition, we studied material in the collection of Fornasini (1895, 1901, 1901-1902) at the Dipartimento de Scienze della Terra e Geologico-Ambientale, Bologna (Italy).

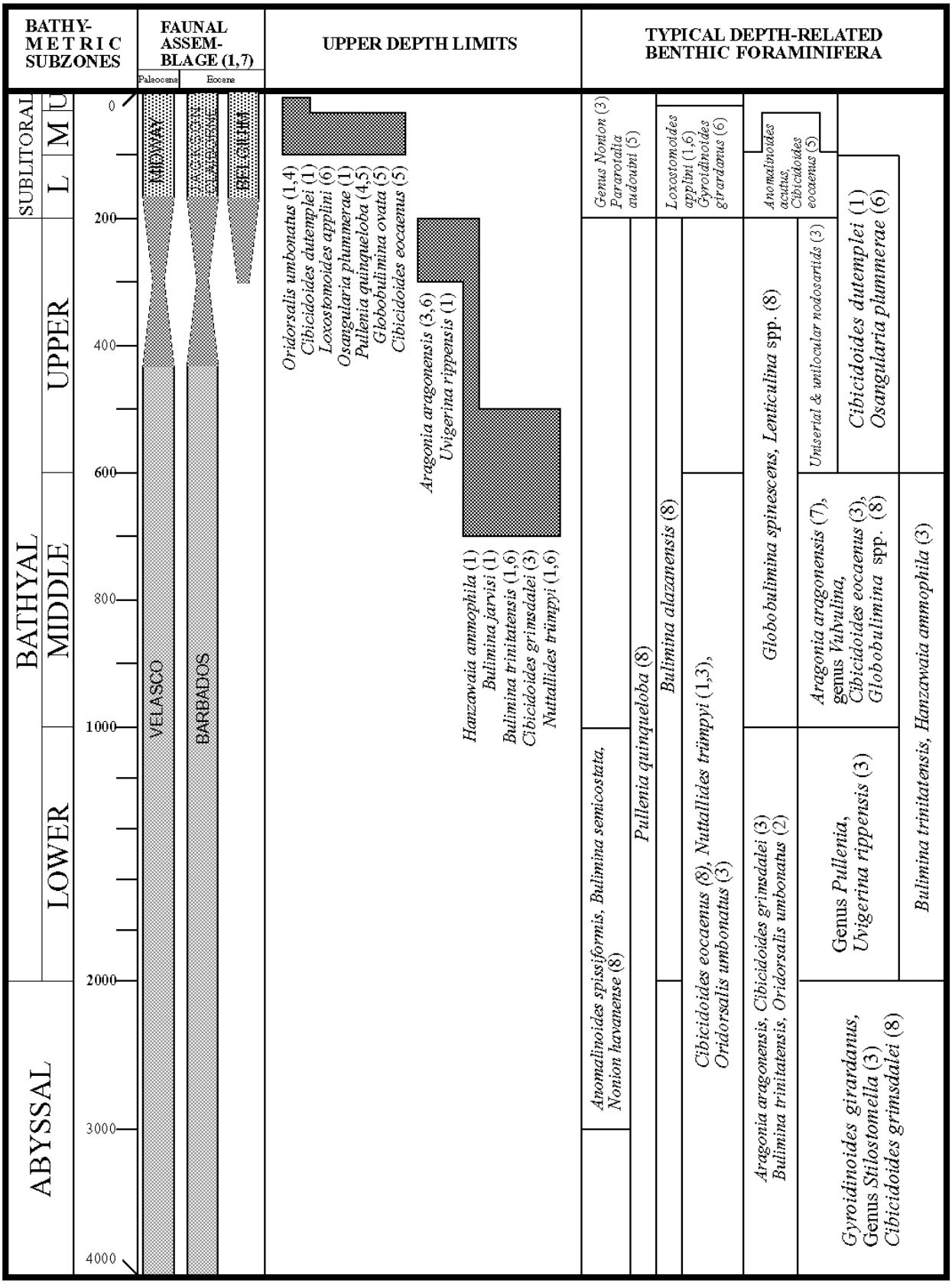
The occurrences and abundances of benthic foraminiferal species in the Fortuna section are shown in Table 1. The abundance is also listed in the description of each species, according to the following criteria: very abundant (>15%), abundant (5-15%), common (2-5%), rare (1-2%), very rare (<1%). These percentages refer to the abundance of each species in at least one sample, unless otherwise indicated.

Clavulinoides angularis (d'Orbigny) 1826

Plate 1, figures 1-5

Clavulina angularis d'ORBIGNY 1826, p. 268, pl. 12, fig. 7. – PLUMMER 1926, p. 70, pl. 3, figs. 4-5.
Clavulina guayabalensis COLE 1927, p. 13, pl. 1, fig. 11. – CUSHMAN 1937a, p. 127, pl. 18, figs. 10-12. – BANDY 1949, p. 62, pl. 4, fig. 4.
Clavulinoides jarvisi CUSHMAN 1936a, p. 23, pl. 3, fig. 18. – CUSHMAN 1937a, p. 135, pl. 19, figs. 3-5. – BERMÚDEZ 1949, p. 72, pl. 3, fig. 37, 38. – BECKER and DUSENBURY 1958, p. 9, pl. 1, fig. 5.
Clavulinoides tricarinatus LEROY 1941, p. 20, pl. 3, fig. 92, 93.
Pseudoclavulina tricarinata (LeRoy). – JONES 1994, p. 53, pl. 49, figs. 8-9.

Description: Test large, stout, elongate and tricarinate in its triserial, biserial and early uniserial stages, expanding rather rapidly through the short triserial portion of the test and only very gradually throughout the uniserial portion of the megalospheric form. Expanding rapidly and evenly throughout the entire development of the microspheric test, which has a more sharply pointed initial part of the test. Triangular in cross section, with the exception of the latter part of the uniserial part, which is rounded in large specimens with many uniserial chambers. Sides fairly parallel throughout, tapering at either end; slightly concave in the early part of the test. Chambers in the triserial portion somewhat indistinct. Uniserial chambers distinct, separated by distinct, depressed, curved sutures. In large



TEXT-FIGURE 3
Upper depth limit and common bathymetric distribution of selected benthic foraminifera from the Fortuna section, following: (1) van Morkhoven et al. (1986); (2) Tjalsma and Lohmann (1983); (3) Bignot (1998); (4) Boltovskoy (1978); (5) Browning et al. (1997); (6) Speijer (1994); (7) Kaasschieter (1961); (8) Katz et al. (2003).

individuals, the uniserial chambers become globular and separated by more clearly depressed sutures. Wall coarsely agglutinated, smoothly finished. Aperture terminal, rounded, with a slight, rounded, raised lip in the uniserial chambers.

Remarks: This species is abundant in many samples in the Fortuna section. In the literature, there are many different specific names for morphologically similar species, in our opinion because the morphological variability of the species has not been well described. Because we have abundant specimens of the species, we were able to evaluate whether this variability was continuous between specimens.

We compared the morphology of our specimens with that of the type specimens of several species, and we are of the opinion that several of these names are probably synonyms. For instance, according to Cole (1927), *Clavulinoides guayabalensis* Cole is close to *C. angularis* d'Orbigny, but differs in several respects; he does not describe in which respects the species differ. Cushman (1936a) did not include a differential analysis of *C. jarvisi* and *C. angularis*. The type of the latter does not have globular last chambers, but many specimens in our material that look very similar to the early stages of the large individuals with globular chambers also miss these chambers, either because they are broken off, or because the specimens are juveniles which have not yet formed them. We also find parts of tests consisting of globular chambers only. Cushman (1936a) described *C. jarvisi* as similar to *Clavulina indiscreta* Brady. We consider the latter to be a different species because of its much less distinct sutures and smoother surface; this species is not present in our material. *Clavulinoides tricarinatus* LeRoy may have slightly sharper triangular edges and slightly more concave sides, but these differences are small and can be seen as subjective. We consider *C. tricarinatus* LeRoy an invalid name (homonym), because d'Orbigny (1839) used the name *Clavulina tricarinata* for a different species. This species is said by d'Orbigny to be very close to his *Clavulina angulata*. D'Orbigny, however, did not describe a species *Clavulina angulata*. The type figure of *C. tricarinata* shows a species which resembles *C. angularis*, but d'Orbigny describes the former as having a toothplate. Our specimens lack a toothplate.

We compared the holotype of *C. tricarinatus* LeRoy (USNM 257283), paratypes of *C. guayabalensis* (USNM 243181), and type material as well as other material of *C. jarvisi* (CC 20296, 20297, 62627) with our material, and with other material of *C. angularis,* and found all of these to be conspecific.

Occurrence: This species shows strong fluctuations in relative abundance in the Fortuna section, ranging from very rare to very abundant.

Genus ***Dorothia*** Plummer 1931

In the literature, different names have been used for what we consider to be probably juvenile and adult specimens of the same species.

Dorothia cylindracea Bermúdez 1963
Plate 1, figures 6, 7

Dorothia cylindracea BERMÚDEZ 1963, p. 26, pl. 2, figs.10, 11.
Dorothia beloides Hillebrandt. – BOLLI et al. 1994, p. 92, pl. 24, fig. 21 (not fig. 31) (non Hillebrandt).

Description: Test elongate, cylindrical, round in cross section with a somewhat pointed initial part. The trochospiral early stage is commonly shorter than the later biserial one. Biserial chambers more distinct and somewhat inflated, particularly the last two chambers. Characteristically, the sutures are clearly visible because of the dark color of the agglutinated material. Wall coarsely agglutinated. Aperture a high arc at the base of the apertural face, in some specimens bordered by a small lip.

Remarks: Bermúdez (1963) mentions that the aperture has a small lip, but we were not able to see it in all specimens. After checking the holotype and several paratypes at the Smithsonian Institution (USNM 208920, 208921, 208922), we consider our specimens to belong to *D. cylindracea* because of its strong resemblance in overall test and apertural shape; the lip is very small and difficult to see in the holotype and possibly not visible in many of our specimens because of poorer preservation.

We include in this species specimens that are smaller, elongate, somewhat conical in shape, which consist mainly of an early trochospiral stage followed by a triserial and/or short biserial part. The aperture is a slit at the base of the last chamber when the test is trochospiral and triserial, and a high arch at the base of the apertural face when the test ends biserially. We consider these specimens to be juvenile individuals of *Dorothia cylindracea* Bermúdez, with which they always co-occur. In our opinion the specimens figured as *D. cylindracea* by Bolli et al. (1994) do not belong to that species, but one specimen named *D. beloides* by these authors was included in the synonymy.

This species is distinguished from other *Dorothia* species by its cylindrical test shape.

Occurrence: The adult specimens are very rare to common, whereas the juvenile specimens are very rare to rare in the Fortuna section.

Genus ***Gaudryina*** d'Orbigny 1839

In the literature, several authors have used different names for what we consider to be juvenile and adult specimens of the same species.

Gaudryina abuillotensis Bermúdez 1949
Plate 1, figure 8

Gaudryina abuillotensis BERMÚDEZ 1949, p. 73, pl. 3, figs. 55, 56.

Description: Test elongate, initial part acute, pyramidal, triserial and markedly triangular in transverse section; margins angular. Test becomes biserial in later stages, quadrangular or slightly rounded in cross section, and almost circular in cross section in the final chambers; margins rounded to subacute. Sides nearly parallel in later stages of the test, sometimes slightly to moderately concave in the middle of the triserial portion of the test. Apertural end truncate. Chambers numerous, rather indistinct, especially those of the early portion, increasing gradually in size. Sutures indistinct, slightly depressed; the two last chambers separated by more depressed sutures. Wall agglutinated, smoothly finished. Aperture a simple slit at the inner margin of the last chamber.

Remarks: The holotype and paratype of *G. abuillotensis* (CC 62443, 62444) were examinated and found consistent with our material.

We have found several small, triserial, pyramidal specimens which we consider to be juvenile forms of *G. abuillotensis*.

TABLE 1
Benthic foraminiferal species counts in samples from Fortuna section. Described species are shown in boldface.

Taxa	FOR-1	FOR-2	FOR-3	FOR-4	FOR-5	FOR-6	FOR-6,5	FOR-7,3	FOR-8	FOR-9	FOR-10	FOR-10,3	FOR-11,3	FOR-12	FOR-12,5	FOR-13	FOR-13,5	FOR-14	FOR-14,5	FOR-15	FOR-15,5	FOR-16	FOR-16,4	FOR-16,7	FOR-17	FOR-17,5	FOR-18	FOR-18,5	FOR-19	FOR-19,5	FOR-33	FOR-35
Agglutinants indet.	4	4		1	4	2	3				4	1				2	3			3			8	3		1	2	1	6		5	4
Amphicoryna sp.																																1
Angulogerina muralis	3	9	2			2		2					1				8				1	1	1	4			3	6	1		1	4
***Angulogerina* sp. A**		1						1	3	5							4	2	3	3	11	3	4			1	4			3		
Angulogerina spp.		3	1							1														1							1
Anomalinoides acutus		2	1				2								1	2	3	1	7	3	4	6	2	5		3	2		1		4	4
Anomalinoides alazanensis				3	1								2						3	1		1	2	5	2	5	1	3	2	4	1	
Anomalinoides* cf. *capitatus	9	6		1	1	2	2	9	10	7	5	2							1	1	2											
Anomalinoides* cf. *cocoaensis				2														2	2	2	2	2	1		1		1	4		1		
Anomalinoides spissiformis		3		2	4	3		1			3	2	9		1		2		3	2	5	2	1		6	5	1	9	6	2		
Anomalinoides* cf. *spissiformis		1		4	3		1			2		2					1			2		1		1	1	2	1		1			
Anomalinoides spp.			1	1	2					2	1	1	1			4	1										2		2			1
Aragonia aragonensis	2			2	7	5	1	5	3				71	37	95	38	3	2						1		1				2		
Astacolus spp.				1																								1				
Astacolus toddae		4				1	1			1	1		1	1	1	2	1	1	4	2	1			1	1	2	2	3	1			
Asterigerina brencei																																18
Asterigerina fimbriata	3	8	16			1			2	17						3	2				3	1	20	2				4		1	6	
Asterigerina quadrata											1				1		1															
Bathysiphon spp.	1				1	1	3			1			1	3	5	7										1				1		
Bolivina nobilis						1								1	6	2	1	2	1	2	2		2	3	2	3	2	3			2	1
Bolivina spp.					1						1							1			2			1	1		3	6	1			4
Bolivinoides crenulata			1	1	2	3	2	1						2			10						2					13			15	1
Bolivinoides floridana						1																										
Bolivinoides obscurarta	3		2	1	1			1									6	1					1	2	1	1		7			4	
Bolivinoides spp.																					2						3				2	
Brizalina alata													1			1								2								
Brizalina carinata		1	11		2	2	1		1				1			2	10				1			1	4	1		12	2		9	
Brizalina spp.			3																		2						3					
Bulimina alazanensis		1	4			6		3		1							10	1							1			2			6	
Bulimina mexicana		4	1	1	4	1				1							1	1		1	1			2	1		4	3				4
Bulimina sp. juvenile form					1	1		3	2		1		2									1		1				1				
Bulimina spp.																	1	1														
Bulimina trinitatensis			1	4	1	1	1			4			1			2	2		3		2	2	3	2	1	4			1	6		
Bulimina semicostata	1		2			5	2	9			2					2					4	1		4			9	2	2			
Calcareous indet.		7	7		6	6	3	9	4	6	9	2		3	2	5	4	6	14	7	18	14	10	11			1	2	6	4		3
Cassidulina sp.																				1												
Cibicidoides* cf. *dutemplei		9	4	4	4					1	4	11				3	1	6	20	2	14	10							1	2		12
Cibicidoides eocaenus	13	3	1	1	8	6			9	1		1				1	1	4	4	5	6	5	18	7	1	1		12	8			
Cibicidoides grimsdalei																						1							1			
Cibicidoides hadjibulakensis	3	3	5	2	6	3	1	3	7	6	2	2	1		2	4	1	6	4	6	4	11	1	4	6	5	6	4	5	7	5	
Cibicidoides mexicanus																																1
Cibicidoides naranjoensis		2							2	2	2	3											3	1		1		9	10	5		
Cibicidoides proprius		3	3	7		3	2	1	3	4	3		4	4	2		4	3	1	6	6		2	4	2		1	3	1	4		9
***Cibicidoides proprius* juvenile form**	3	1	34		1		3	2	2	9							9	4				1	4			1	1	8				3
Cibicidoides sp. indet.			3		3		2				1					5	6		2										2	2		
Clavulinoides spp.	1											1																		2		
Clavulinoides angularis	16	22		11	11	1	3	8	15	11	32	60	2	1		9	5	43	17	46	14	20	18	13	21	17	29	35	37	60	1	
***Clavulinoides angularis* juvenile form**	3	10			7	1		3	6	7	3	7				3	7	8	5	20	7	11	3	10	9	2	5	8	8	9		
Coleites galeebi																							1					6				
Cribrostomoides spp.	2													1	4	1						1				5						
Dentalina spp.									1			1	1		1		3					2	1	2	2	1	2	4				
Dorothia cylindracea	3	8	1	10	5	3	3	8	4	3	4	6		2		2	1	5		11			2	2	3		4	3	4	6		
Dorothia cylindracea juvenile form		5				2		1	2	2				1		2	1	1		3		3	6				1	1				
Dorothia subglabra		3		1				2								3	1	4		6	1	1	4						1			
Eggerelloides palmerae																		1		2	1		1									
Ellipsoglandulina multicostata											1																					
Ellipsopleurostomella curta											1	1																				
Ellipsopolimorphina sp.																	2															
Fursenkoina dibollensis																					1									1		6
Fursenkoina spp.		1									2																					
Gaudryina abuillotensis																																7
Gaudryina arenata	11	15	1	29	19	2	2	10	6	2	28	31				1		37	28	31	13	25				1	1	5	13	5		
***Gaudryina arenata* juvenile form**				1														5				2						2				
Gaudryina concinna			2	10												2			6	4		4	3	1	4	7	3	7				
Gaudryina longa																																8
Glandulina sp.		1			1																											1
Globobulimina ovata	85	15	5	34	21	73	122	104	91	40	30	5	58	111	56	51	7		3	2	1		11	35	80	84	41	2	7		125	38
Globobulimina pacifica		2	62	4	13	9	5	3		1	9	1	9	9	19	6	21		1			3		10	26		4				1	7
Globobulimina pupoides	18	5	2	16	21	40	20	21	27	28	11	1	8	44	14	16								1	6	18	4				6	
Globobulimina pyrula		1	7	2	1	12	25	24		23				44	9	18	2									4					8	4
Globobulimina sp. indet.			14			7				2														12			3					6
Globobulimina spinescens	1	1	1		1	2			5															3	14	9	4				21	6

TABLE 1
Continued.

Taxa	FOR-1	FOR-2	FOR-3	FOR-4	FOR-5	FOR-6	FOR-6,5	FOR-7,3	FOR-8	FOR-9	FOR-10	FOR-10,3	FOR-11,3	FOR-12	FOR-12,5	FOR-13	FOR-13,5	FOR-14	FOR-14,5	FOR-15	FOR-15,5	FOR-16	FOR-16,4	FOR-16,7	FOR-17	FOR-17,5	FOR-18	FOR-18,5	FOR-19	FOR-19,5	FOR-33	FOR-35
Globulina problema			1	1	2				2			4				1				1	1			2		5					2	
Guttulina sp.	1											1												1								
Gyroidinoides girardanus		2		3	1							1	1		1	2	2		1			2	2	2		2	1	4		3		
Gyroidinoides spp.													7	3	6		2									1					3	
Hanzawaia ammophila			2				1		1	1		1					1			2	2	1	1	1	1	1	3		1	2		
Hanzawaia bundensis										1		1								1												
Hanzawaia cubensis										1								1	1		1		1	1				2		7		
Hanzawaia sp.	1									2													2	5			3	1		1	1	
Haplophragmoides spp.		2		1		1		1	1				3	3		1	1	3				2			1	4					2	
Hemirobulina sp.						1																										
Hopkinsina spp.	4							4	4	5		2	1																			
Hyperammina spp.														1																		
Karreriella sp.													1																1	1		
Karreriella sp. A				1													2	6	1	5	7	5	1	2	2	1	1		1			
Karrerulina sp.	2	2		3	4	5		3			4									2						3				1	
Laevidentulina elegans																																21
Laevidentalina spp.					1	1	2				3				1	1	3	2			3					1						
Lamarckina sp.			2				1			1											1			3	2	1		7	6			
Lenticulina clericii	3	3	2	4		1		3	8	4	2		1			3		5	1	3	1	2		3			1		5		4	
Lenticulina cultrata	12	11		10	9	3	6	6	5	2	11	10	7		6	7	3	5	10	9	4	5	11	5	8	9	6	3	8	4	5	8
Lenticulina helena		1																										2	1		1	
Lenticulina insulsa						1		1	1	1	1			1				5	3				2			2	5	5	1	2	1	
Lenticulina rotulata	4	1		2	1						3	6	3			2		2	4	1	1	1							2	1	2	
Lenticulina similis						1						1								2						1			1			
Lenticulina sp. indet	2			1		1		1				3						4	11	7	5		3		1	3		4	1	9		
Lenticulina sp. juvenile form				2		1		1			1	4					2	1						1			5	1				
Lenticulina sp., big keel				1							1									1	1		1	2						1	2	5
Lenticulina spp.			1						1		1					1	2			1												3
Lenticulina turbinata	2	9		2	3		1		2	1	7	7	1					3	7	1	4	6	1		1	5	1	8	4	3		
Lenticulina velascoensis			2	3								1												1								
Lenticulina williamsoni	4	1	3			1	1										1					1		2	1	1	2		2		2
Lenticulina yaguatensis	1	1	2	2	1	2	1	3	7	5					1				2	3	9	2	5	3	4	2	4	5	4			
Lobatula lobatula			7					1		2						4	1	1			1		8	10			3		1			4
Loxostomoides applini		1			1								3		1												1		1			
Marginulina sp. juvenile form						1			1	1								1						1			1			1		
Marginulina tuberculata								1		1													1			4				1		
Marssonella floridana	5	2			1	2		3	1	2		9	1	2		1	1			3	3	2	1	4	5	4		3	10	10		
Marssonella sp. juvenile form			1	2																												
Marssonella trinitatensis	1			5	3	2	1	1		2		2			1	1	3		12	6	3	3		1		7	3	10	7	8		
Nodosaria longiscata				1	1					2		1	1		1													1			1	
Nodosaria soluta																	1	1		5												
Nodosaria spp.																1	2															
Nonion affine				1																			1									5
Nonion havanense								3	1	1	1						1	2			1											
Nonionella sp.					1		1									1	1															
Nuttallides trümpyi				2	2		1	1		1		3	2	1				1						1			1				1	
Oridorsalis plummerae	1	1							2																		1					3
Oridorsalis umbonatus	12	6	2	3	2	1	1	2	1	2	4	1	2	1		1	1		7	3	7	9	6	4	5	5	6	6		6		
Osangularia dominicana	33	11		3		10	5	12	17	23	8	29	13	4	1	1		10	11	13	6	16	5	13	3	6		11	17	16	11	
Osangularia cf. *dominicana*		2									2		3	2	2																2	
Osangularia mexicana																		1														
Osangularia plummerae		3	1	4	6			1		2	1	4	1	1	2	2	10	13	13	8	7	10		2	1	6	1	5	2			7
Osangularia* cf. *plummerae		3	1						2	2		1	3					3		3	2	1	4				3			3		1
Parafrondicularia sp.													1																1			
Pararotalia audouini					1										1	4	3															14
Planulina cooperensis													1	1		1		1			1	1	3									
Planulina sp.				1																			1									
Planulina subteratissima	4	4					1	2	4	2		5	1			1			3		1	1	14		4		1		1	5		2
Pleurostomella velascoensis					1	2			4			1	1			1				1			1		1		9					
Polymorphina sp.												1					1															
Psammosphaera sp.						3				2				2																	1	
Pseudoclavulina sp. A					2				3	2	2	4		2	3				1			1	1	5	5		14	2		12		
Pseudoclavulina trinitatensis	7	1		3	4	3	3	3	1	3	10	15	3				3	2		5	3		3	2	1				7	4	1	
Pseudonodosaria mutabilis			1																											2		
Pullenia jarvisi					2			1		1	1	1						2		1						1		1				
Pullenia quinqueloba			1		1				1				2							2	1							1	1			
Pyramidulina latejugata							1				1	1						1											1			
Pyramidulina minor											2	1			1																	
Pyramidulina spp.				1	1	1	1	1	1	1	1					1		4		2			1	1	1		1	1	2	1	1	1
Quadrimorphina allomorphinoides			7		1						2	2	1	4	2	9	21								1						1	
Recurvoides spp.		1	2	2		1	1						1	2	2					1											2	
Reophax sp.																			1													

TABLE 1
Continued.

Taxa	FOR-1	FOR-2	FOR-3	FOR-4	FOR-5	FOR-6	FOR-6,5	FOR-7,3	FOR-8	FOR-9	FOR-10	FOR-10,3	FOR-11,3	FOR-12	FOR-12,5	FOR-13	FOR-13,5	FOR-14	FOR-14,5	FOR-15	FOR-15,5	FOR-16	FOR-16,4	FOR-16,7	FOR-17	FOR-17,5	FOR-18	FOR-18,5	FOR-19	FOR-19,5	FOR-33	FOR-35
Reussella oberhurgensis	2	3		1	2				2		1				1		5	2			3		1	2		5	2	2				1
Rhabdammina spp.	1	1	1				1										2	1														
Rhizammina spp.	1	2		2					1					3	1			1			1	2				2	3					
Saccammina spp.									1																	1						
Saracenaria italica																	2			1	2		1		1	1	1					
Saracenaria spp.														1														1			1	
Sigmoilopsis sp.	1			2	1	1		1	1	1	1	2			1	2			1		4	3	1			1	2	2		1	2	1
Siphogenerinoides eleganta	2	1				1	1		1	1		1				1	1									1	2		4			
Siphogenerinoides kugleri	2	1	1			10	15	1		5	2												1		1		1				8	
Siphonodosaria annulifera	6	2		6	3	2		2	4	1	3	6	1	1	2	2	8	5	2	3	4	3	7	9	3	3	6	4	8	3	8	18
Siphonodosaria pomuligera				1		1				1	4						5	5	6	6	2	5	4	3	3	4	17	14	6	6	1	
Siphouvigerina sp.																												4				
Spiroplectinella sp.												1																				
Spiroplectinella carinata		4	1	7	17	2			1								2	8	9	5	11	6	2	2		2	5	5	3	5	1	
Stilostomella alexanderi		1				1			1											1			1		1	1			1	2		
Stilostomella lepidula				2								9	2		1	1			1		1				2		1	2			1	
Stilostomella spp.					4												1					1		2		1		1		1		
Textularia agglutinans		1									1	1				1	2					1		1	2	1				2		2
Thalmannammina subturbinata	2	1	3	3	1	3		6			5	2				12	5	20	40	30	45	28	7				2	4	11	5		
Tritaxilina caperata					2			2			3					1					1			1								
Tritaxilina caperata juvenile form				1				1																		1						
Unilocular species	1	4	21	1	3	3	7	3		2	1	5	27	1	14	13	16	1	2	1	2	1	1		6	2	3	5		1	1	1
Uniserial indet									1		1	1	1				1	1		1				1				1	1			1
Uvigerina hispida																		1		1			1								17	
Uvigerina pigmea		2	2	32	10	7		1	7		2	4	5	1		2	3	1	12	6	3	12	9	2	4	1	3	1		9		3
Uvigerina rippensis		8	11	9	16		7	3	2			4	1		1	3	2	3			6	25	1	8	7		2		2	7		5
Uvigerina spp.								1									1	1														
Vaginulinopsis nudicostata										1		1							1													
Vaginulinopsis sp.												1																			1	
Valvulineria cf. haitiana	3	4					1		1		2							1		1			2	3		1	2	4				
Vulvulina advena				9	2					1	1	1						6	6	5	10	2	3	8	1	1	5	10	15	12	5	9

Occurrence: This species is common in the uppermost sample (For 35), with adult and juvenile specimens co-occurring.

Gaudryina arenata (Cushman) 1936
Plate 1, figures 9-10

Dorothia arenata CUSHMAN 1936a, p. 32, pl. 5, fig. 11. – CUSHMAN 1937b, p. 101, pl. 11, fig. 9.
Karreriella danica (Franke). – KAASSCHIETER 1961, p. 143, pl. 1, fig. 25.
Gaudryina cf. *laevigata* Franke. – TJALSMA and LOHMANN 1983, p. 31, pl. 8, fig. 3-5.

Description: Test short and stout, rounded to oval in cross section, tapering, with blunt base, laterally slightly compressed. Chambers triserially to biserially arranged, somewhat inflated, particularly the last few chambers; sutures depressed, slightly oblique. Wall very coarsely agglutinated, especially in early chambers. Aperture a high, domed arch at the base of the apertural face, or in large specimens within the lower part of the apertural face.

Remarks: We studied the holotype and several paratypes of *G. arenata* (CC 20919, 20920, 209210, 1310) which largely agree with our concept of the species.

Cushman (1936a) assigned this species to the genus *Dorothia*. According to Loeblich and Tappan (1987) *Dorothia* has a low, arched aperture at the base of the apertural face. All our specimens, as well as the type material, have a clearly visible, highly arched aperture, not a low arched one. Loeblich and Tappan (1987) state that *Gaudryina* usually has a low aperture, but may have an 'upward spur' on the aperture. The genus *Plectina* has a round aperture, which does not touch the base of the apertural face. In our specimens, the aperture is in contact with the base of the apertural face in most specimens, but in some (usually large) specimens it may be somewhat above the base of the apertural face. We thus decided to assign the species to the genus *Gaudryina* as defined by Loeblich and Tappan (1987).

This species resembles *Gaudryina frankei* Brotzen, but differs by its much more rounded and less angular initial portion, which is particularly coarsely agglutinated, more so in its earlier chambers than in its last chambers. We consider that the specimens named *Gaudryina* cf. *laevigata* Franke by Tjalsma and Lohmann (1983) are *Gaudryina arenata*, because they lack the characteristically truncated chamber margins of *G. Laevigata*.

We also observed juvenile specimens, which are small and consist of coarsely agglutinated triserial chambers.

Occurrence: *G. arenata* is the most common *Gaudryina* species in the Fortuna section, with fluctuating relative abundances from very rare to abundant.

Gaudryina concinna (Reuss) 1846
Plate 1, figures 11-12

Textularia concinna REUSS 1846, p. 109, pl. 24, fig. 54. – CUSHMAN and JARVIS 1928, p. 91, pl. 13, fig. 1. – CUSHMAN and JARVIS 1932, p. 15, pl. 4, figs. 1, 2.
Dorothia concinna (Reuss). – CUSHMAN 1937b, p. 75, pl. 8, figs. 8-10.

Description: Test elongate, slightly tapering towards the base, somewhat laterally compressed; periphery lobulate. Chambers distinct, inflated, relatively broad and low, increasing gradually

in size as added. Sutures distinct, depressed, horizontal to downward slanting. Wall agglutinated, somewhat roughened. Aperture a high arch at the base of the last chamber.

Remarks: We examinated several plesiotypes of *G. concinna* collected by Cushman (1937b) (CC 20771, USNM 379529), which largely agree with our material.

This species can be distinguished from other *Gaudryina* species by its laterally compressed, and somewhat roughened test. The chambers are distinctly sub-rectangular due to this compression.

G. arenata differs from *G. concinna* by its bigger, more coarsely agglutinated test.

Occurrence: Very rare to common in the Fortuna section.

Gaudryina longa Bermúdez 1949
Plate 1, figures 13, 14

Gaudryina longa BERMÚDEZ 1949, p. 76, pl. 3, figs. 71, 72.

Description: Test large, elongate. Early portion of the test is triserial, with flat sides and blunt edges. In later stages becoming biserial, with the sides nearly parallel and somewhat lobulate. Laterally slightly to moderately compressed. Triserial chambers somewhat indistinct, biserial chambers distinct, inflated, separated by depressed sutures. Biserial portion with one to four pairs of chambers of uniform size. Wall agglutinated, smoothly finished. Aperture a high arch at the inner margin of the last chamber.

Remarks: The holotype and paratype of this species (CC 62687, 62688) were examined at the Smithsonian Institution. They are larger, with somewhat more inflated chambers than our specimens, but they are clearly consistent with our material.

We found some small specimens, which consist of an early triserial stage and a later biserial one, with greatest width close to the apertural end. We consider these specimens to be juvenile individuals of *G. longa*.

G. longa is easily differentiated from other *Gaudryina* species by its elongate and laterally compressed test.

Occurrence: Both juvenile and adult specimens are present only in sample For 35, where they are common.

Marssonella floridana Applin and Jordan 1945
Plate 1, figures 15-16

Marssonella oxycona (Reuss) var. *floridana* APPLIN and JORDAN 1945, p. 135.
Gaudryina trochoides Marsson. – WHITE 1928b, p. 314, pl. 42, fig. 11 (non Marsson).
Gaudryina oxycona (Reuss). – CUSHMAN and JARVIS 1932, p. 18, pl. 5, fig. 1 (not fig. 2).
Marssonella oxycona (Reuss). – CUSHMAN 1937b, p. 56, pl. 6, fig. 9.

Description: "Test small, conical, tapering rapidly from the subacute initial part of the test; early chambers triserial, adult chambers biserial; chambers distinct, not inflated, increasing rather rapidly in size as added; sutures very broad, distinctly marked, either flush or slightly raised above surface, especially in later chambers; walls very finely arenaceous, smoothly finished; aperture a broad, slit-like opening at inner margin of last-formed chamber, centrally enlarged by a small, circular indentation." (Applin and Jordan 1945).

Remarks: See *Marssonella trinitatensis*.

Occurrence: This species is very rare to common in the Fortuna section.

Marssonella trinitatensis Cushman and Renz 1946
Plate 1, figure 17

Marssonella oxycona (Reuss) var. *trinitatensis* CUSHMAN and RENZ 1946, p. 22, pl. 2, fig. 29.
Gaudryina oxycona (Reuss). – CUSHMAN and JARVIS 1932, p. 18, pl. 5, fig. 2 (not fig. 1).
Marssonella oxycona (Reuss). – CUSHMAN 1937b, p. 56, pl. 6, fig. 10.
Marssonella oxycona trinitatensis Cushman and Renz. – BOLLI et al. 1994, p. 94, pl. 25, figs. 3, 4.

Description: Test elongate, tapering from the initial portion, nearly circular in cross section. Early portion triserially arranged, conical, later biserial portion with parallel sides. Chambers low, distinct, separated by depressed sutures, particularly those of the biserial portion. Wall agglutinated, smoothly finished. Aperture a high arch at the inner margin of the last chamber. Terminal face concave.

Remarks: Cushman and Renz (1946) state that *Marssonella oxycona* (Reuss) var. *trinitatensis* may represent a separate species. The highly arched aperture, acute first part of the test, depressed sutures and a concave apertural face are the main characteristics to differentiate *M. trinitatensis* from *Marssonella oxycona* and from other *Marssonella* species.We consider it a separate species after studying the holotype and paratype of *M. trinitatensis* (CC 15302, 46550). Although we did not observe a deep re-entrant as part of the aperture, we consider that this might be the result of imperfect preservation.

We consider *M. oxycona* var. *floridana* to be a separate species, after studying its holotype at the Smithsonian Institution (MO 559699). The limbate sutures, somewhat raised, and the less conical shape of the test, narrowed at the last chambers, makes it possible to differentiate *M. floridana* from other *Marssonella* species. Some specimens intermediate in morphology between *M. floridana* and *M. trinitatensis* occur in the Fortuna section.

Occurrence: This species is very rare to common in the Fortuna section.

Pseudoclavulina sp. A
Plate 2, figure 1

Tritaxia sp. TJALSMA and LOHMANN 1983, pl. 8, fig. 11.

Description: Test elongate, early triserial portion bluntly triangular in cross-section, followed by a uniserial, rounded portion. Triserial chambers indistinct, later uniserial ones faintly distinct and inflated, separated by depressed sutures. Wall agglutinated, very roughly finished, making chamber distinction difficult. Aperture terminal, rounded, with a distinct tubular neck.

Remarks: These specimens are characterized by their rough, coarsely agglutinated test, and long triserial part with indistinct chambers.

Occurrence: Very rare to common in the Fortuna section.

Pseudoclavulina trinitatensis Cushman and Renz 1948
Plate 2, figures 2, 3

Pseudoclavulina trinitatensis CUSHMAN and RENZ 1948, p. 13, pl. 3, fig. 5. – BOLLI et al. 1994, p. 97, pl. 25, fig. 29; p. 330, pl. 62, fig. 13.

Pseudoclavulina maqfiensis LEROY 1953, p. 44, pl. 2, fig. 16, 17.

Description: Test elongate, slender, with an initial triserial stage, which is rounded to bluntly triangular in cross-section. This initial stage is followed by a short and indistinct biserial stage and a much longer uniserial stage, which is rounded in cross section and commonly broken. Chambers of the triserial stage are indistinct; biserial and uniserial chambers rounded, rather inflated, separated by distinct, depressed sutures. Wall agglutinated with a slightly roughened finish. Aperture terminal, rounded, on a short neck.

Remarks: According to Bolli et al. (1994), the uniserial chambers are commonly slightly collapsed, which results in the presence of a horizontal rim around the chamber. We have observed these in some specimens, but less markedly than in the specimens illustrated by Bolli et al. (1994).

In the type figures, *Pseudoclavulina globulifera* seems to have a triserial section that is more triangular in cross section than that of *P. trinitatensis*, although both species are said to have indistinct chambers in this part of the test. Ten Dam and Sigal did not include a differential analysis with *P. trinitatensis*.

We examined the holotype of *P. maqfiensis* (CC 58022), which shows a somewhat acute, triangular triserial part, as short as in our material, and a globular last chamber versus a pyriform one in *P. trinitatensis* (CC 57064, 57065). We think that these differences are small, and we agree with Bolli et al. (1994) that *P. maqfiensis* is a junior synonym of *P. trinitatensis*.

In our material, some specimens are smaller, have a smoother finish of the test, and the triserial part of the test is slightly more rounded and less triangular in cross-section, with more distinct chambers (pl. 2, fig. 3). The two slightly different morphotypes always co-occur in our samples, and we tentatively consider them as both belonging to *P. trinitatensis*.

P. trinitatensis is easily distinguished from other species by its short triserial part, constricted uniserial sutures and small number of uniserial chambers.

Occurrence: Very rare to common in the Fortuna section.

Spiroplectinella carinata (d'Orbigny) 1846
Plate 2, figures 4-5

Textularia carinata d'ORBIGNY 1846, p. 247, lám. 14, fig. 32-34.
Spiroplecta wrighti? SILVESTRI 1903, p. 59, pl. 1-6.

Description: Test elongate, compressed, thickest in the middle, periphery acute with a well-developed keel in adult specimens bearing occasional projections. Sub-rhomboidal in apertural view. Initial part of the test pointed; subrounded when planispiral stage is large. Later chambers biserial, distinct, broad and low, enlarging rapidly. Sutures distinct, wide, conspicuously raised, generally straight and oblique, but slightly curved next to the median axis of test, forming an angle with it. Wall agglutinated, smoothly finished. Aperture a low, rather broad arch, at the inner margin of the final chamber.

Remarks: Specimens referred to this taxon show variability in outline, degree of tapering and keel development, the latter probably due to variability in preservation. The specimens with a best developed planispiral early stages show a less triangular test, with the edges almost parallel in the biserial stage. We observed adult specimens with a well developed keel, with projections (pl. 2, fig. 4). Other specimens do not show a keel but have an acute periphery (pl. 2, fig. 5). The latter show less raised sutures, so they may be included in *Spiroplectinella wrighti* (Silvestri), although this species may include badly preserved specimens, in which case it could be synonymous with *S. carinata*.

Occurrence: *S. carinata* is very rare to common in the Fortuna section.

Thalmannammina subturbinata (Grzybowski) 1898
Plate 2, figure 6

Haplophragmiuim subturbinatum GRZYBOWSKI 1898, p. 280, pl. 10, fig. 23.
Thalmannammina subturbinata (Grzybowski) 1898. – BOLLI et al. 1994, p. 80, pl. 21, figs. 19, 20. – RÖGL 1995, p. 257, pl. 1, figs. 24-26; text-figs. 10-13.

Description: Test subglobular, with tight, streptospiral coiling. Early chambers indistinct, last 3-4 chambers globular to elongate or ovate, separated by slight to moderately depressed, straight sutures. Wall coarsely agglutinated, with a slightly rough finish. Aperture a low arch to a slit at the inner margin of the last chamber.

Remarks: Many of our specimens are somewhat flattened, and the aperture is not clearly visible.

Occurrence: Very rare to abundant, the latter in samples For 14-For 16.

Tritaxilina caperata (Brady) 1881
Plate 2, figures 7-8

Valvulina (Clavulina) caperata BRADY 1881, p. 54, pl. 49, figs. 1-7.
Tritaxilina caperata (Brady) . – CUSHMAN 1937b, p. 158, pl. 19, figs. 7-12. – JONES 1994, p. 53, pl. 49, figs. 1-7. – SZAREK 2001, p. 98, pl. 10, fig. 20.

Description: Test elongate, subcylindrical to fusiform, with pointed to tapering initial part, nearly circular in cross section. Early stage is high trochospiral, followed by a relatively large triserial portion, becoming biserial to almost uniserial in the last chambers. Diameter largest at about the mid-point of the length of the test. Periphery sub-rounded to sub-acute in the early portion of the test, rounded later on. Triserial chambers are broad and low, separated by characteristically depressed, limbate sutures. Last triserial chambers commonly slightly to moderately inflated; biserial chambers slightly inflated and separated by depressed sutures but without the external limbate lines. Wall agglutinated, smoothly finished. Aperture terminal, at the base of the last chamber, moving to a central position as the last chambers are becoming almost uniserial.

Remarks: This species is easy to recognize because of the characteristic wavy suture patterns.

Occurrence: Very rare in the Fortuna section.

Vulvulina advena Cushman 1926
Plate 2, figures 9-12

Vulvulina advena CUSHMAN 1926, p. 32, pl. 4, fig. 9. – COLE 1928, p. 206 (6), pl. 1, fig. 24; pl. 3, fig. 17.
Vulvulina colei CUSHMAN 1932, p. 84, pl. 10, figs. 21, 22. – BERMÚDEZ 1949, p. 55, pl. 1, figs. 62, 63. – LEROY 1953, p. 54, pl. 8, fig. 23. – BOLLI et al. 1994, p. 84, pl. 22, fig. 13.

Description: Test elongate, earliest chambers spiral in some (microspheric) individuals, followed by broad and low, biserially arranged chambers; only in the largest specimens the biserial stage is followed by a uniserial one. The test is usually broadest at an early stage in ontogeny, just before the end of the biserial stage. Initial part of test slightly to moderately pointed because of the presence of an early planispiral stage, with the sides nearly parallel in the biserial stage, or narrowing somewhat. Margins moderately angled. Chambers distinct, the planispiral and biserial ones broad and low, much curved, projecting downward, with the lower angles of the test sometimes slightly projecting or even spinose; later chambers uniserial, sub-rectangular in adult (well-developed) specimens. Sutures distinct, those of the uniserial part somewhat more depressed than those in earlier stages. Wall agglutinated, smoothly finished. Aperture a low arch at the base of the apertural face of the last-formed chamber in the early stages, in the adult becoming terminal, elongate, elliptical.

Remarks: There are biserial morphotypes (pl. 2, fig. 9) characterized by having a broadest final portion close to the final part of the test; these may be juvenile specimens, which have not reached the uniserial stage of development. The finish of their walls is somewhat rougher than in larger specimens, and sutures are slightly raised. Some specimens have short spinose projections (pl. 2, fig. 12).

There is considerable confusion in the literature regarding species in the genus *Vulvulina*, so we examined the type material of several of these at the Smithsonian Institution. We compared the holotypes and several paratypes of *V. advena* (MO 354134), *V. colei* (CC 25694, 16866, 9515), and *V. spinosa* (CC 901, 902, 903, 16874).

As Cushman (1932) states *V. spinosa* "is particularly marked by spinose projections which not only occur on the biserial portion, but also in the later uniserial chambers", but in the type description of *V. advena* he states that this species shows "each angle of the chambers with a short spinose projection, even those of the uniserial portion". Traditionally, those specimens with spinose projections have been included in *V. spinosa*. However, in the type material of each of those species at the Smithsonian Institution, there was at least one specimen with spinose projections. In our opinion, the presence or absence of spinose projections is not a good character to differentiate species, as it seems to be highly dependent on the state of preservation.

According to its type description, *V. spinosa* is distinct from *V. advena*, but Cushman doesn´t say in which aspects; the holotype of *V. colei* seems to be less well preserved than those of the other two species. The holotype of *V. spinosa* is somewhat stouter and laterally more compressed, less smooth, and shows more somewhat depressed sutures than that of *V. advena*. Cushman (1932) states that *V. colei* is distinctive by "showing its primitive character in having the spiral portion not included in the following biserial one", but the initial planispiral coil is a characteristic of the genus *Vulvulina,* at least in the microspheric generation, thus this can not be used to distinguish species. The holotype of *V. colei* is smooth with the greatest width near the inital part of the test, sutures distinct but not raised, and slightly depressed. This species differs from *V. advena* and *V. spinosa* by having uniserial chambers separated by straight to slightly curved sutures, and in showing the greatest breadth near the initial, not near the apertural part of the test.

We compared biserial morphotypes of *V. spinosa* and *V. colei*, which are quite difficult to distinguish. We looked at several paratypes, and the differences between the holotypes of the three species described above could not be observed in the paratypes, which overlap strongly in morphology. We therefore consider *V. advena* and *V. colei* as synonyms, and we incluide in *V. spinosa* specimens with numerous spinose projections, depressed uniserial and biserial sutures, and a rough surface. *Vulvulina pennatula* (Batsch) 1791 is another species similar to *V. advena*, and may well be a synonym, in which case the species name would become *V. pennatula*. The species appears to be characterized by raised sutures, lacks spines, and has a rough test, but it is not clear whether some of these characters result from poor preservation. Since we do not have access to the type material of *V. pennatula*, we cannot be sure that this is a synonym, and have left this question open. We also studied the type material of *V. mexicana*, which resembles *V. advena*, but has a smoother wall and less encompassing chambers.

Occurrence: Very rare to common, especially present in the last samples of the lower part of the Fortuna section and in the upper part.

Angulogerina muralis (Terquem) 1882
Plate 2, figures 13-14

Uvigerina muralis TERQUEM 1882, p. 119, pl. 12, figs. 26-29.
Angulogerina muralis (Terquem). – CUSHMAN and EDWARDS 1937, p. 55, pl. 8. figs. 3-5. – KAASSCHIETER 1961, p. 199, pl. 10, figs. 3, 4. – BIGNOT 1962, p. 166, pl. 2, figs. 11-14.

Description: Test elongate, ovate, sometimes tapering, greatest width at about 2/3 of the pointed initial part of the test; nearly triangular in cross section, periphery sub-angular. Loosely triserial with overhanging, somewhat inflated, distinct chambers, conspicuously excavated at the base, specially the last ones; sutures distinct, depressed. Wall calcareous, smooth, finely perforate. Aperture terminal, with a neck bordered by a slight lip, usually broken.

Remarks: We examined abundant material at the Smithsonian Institution as well as 3 plesiotypes (CC 23741 and 23742) described by Cushman and Edwards (1937). These largely agree with our material and also show variability in the outline of the test, from sub-parallel to tapering; in the degree of roundness of the chambers, from sub-acute to rounded. If the chambers are more rounded, the sutures are usually less depressed, and the test is more tapered. Sometimes the last chamber(s) are irregular, umbrella-shaped.

This species is easily distinguished from other *Angulogerina* species by the irregular chamber shape.

Occurrence: This species is very rare to common throughout the section.

Angulogerina sp. A
Plate 2, figure 15

Description: Test elongate, fusiform, about 2-2^1/$_2$ times as long as broad, greatest width close to the middle part of the test; sub-triangular in apertural view, periphery roughly rounded. Chambers triserially arranged, distinct, compact, slightly inflated. Sutures distinct, depressed. Wall calcareous, finely perforate. Aperture terminal, with a short neck, usually broken.

Occurrence: These specimens are very rare to rare throughout the section.

Genus ***Anomalinoides*** Brotzen 1942

This genus includes almost planispiral to low trochospiral taxa, commonly classified within other genera, such as *Anomalina*, *Cibicides*, *Cibicidoides* or *Planulina*.

Anomalinoides acutus (Plummer) 1926
Plate 3, figures 1-2

Anomalina ammonoides (Reuss) var. *acuta* PLUMMER 1926, p. 149, pl. 10, figs. 2a-c; BROTZEN 1948, p. 87, pl. 14, fig. 2.
Anomalina acuta Plummer 1926. – TOULMIN 1941, p. 608, pl. 82, fig. 9, 10. – KAASSCHIETER 1961, p. 216, pl. 12, fig. 12; pl. 13, fig. 4.
Anomalinoides acuta (Plummer). – OLSSON 1960, p. 51, pl. 11, fig. 4, 5.
Anomalinoides acutus (Plummer). – BERMÚDEZ 1963, p. 16, pl. 6, figs. 7-9. – ALEGRET and THOMAS 2001, p. 277, pl. 1, fig. 9.
Falsoplanulina acuta (Plummer). – BOLLI et al. 1994, p. 149, pl. 40, fig. 18-20.

Description: Test trochospiral, compressed, moderately biconvex to plano-convex. Sub-circular in outline; peripheral margin sub-acute. Chambers narrow, numerous, about 12 to 17 in the last whorl. Ventral sutures distinct, limbate, thickening towards the inner edge, surrounding a thick, raised spiral of shell material. Dorsal sutures distinct, curved, limbate, becoming slightly depressed in the later part of the whorl. Dorsal side with a distinct umbonal boss. Wall calcareous, perforate. Aperture a low arch at the periphery extending onto the ventral side towards the umbilicus.

Remarks: We examined much material referred to *A. acutus* at the Smithsonian Institution. Some specimens didn´t appear to belong to this species, but most show the typical compressed test, numerous chambers and the distinct ornamentation of the ventral side. The specimens most similar to ours were those from the Soldado formation, Trinidad (Eocene, Midway) (Cushman and Renz 1942) (CC 38213, 38270).

We observed some specimens which resemble *A. acutus* on the ventral side, but have a distinct concave dorsal side. We consider these to belong to a different species (see *Anomalinoides* cf. *cocoaensis*).

Occurrence: *Anomalinoides acutus* is very rare in the lowermost samples of the lower part of the Fortuna section, and very rare to common in the rest of the section.

Anomalinoides alazanensis **(**Nuttall) 1932
Plate 3, figure 3

Anomalina alazanensis NUTTALL 1932, p. 31, pl. 8, figs. 5-7.
Anomalinoides cf. *alazanensis* (Nuttall). – TJALSMA 1983, p. 739, pl. 5, fig. 3.
Cibicidoides alazanensis (Nuttall). – VAN MORKHOVEN et al. 1986, p. 201, pl. 68, figs.1-2.
Anomalinoides alazanensis (Nuttall). – BOLLI et al. 1994, p. 373, pl. 59, figs. 5-9; pl. 79, fig. 20.

Description: Test trochospiral biconvex, somewhat compressed, periphery sub-rounded. Umbilical and dorsal sides semi-involute, slightly depressed in the middle of the test. About 13 chambers in the last-formed whorl, slightly inflated. Sutures flush to depressed the last one(s), curved, slightly limbate. Wall calcareous, coarsely perforate on both sides. Aperture an interiomarginal slit at the base of the final chamber, extending to the dorsal side.

Remarks: We studied the holotype and paratypes of *A. alazanensis* (CC 16460, 16461, 16462) at the Smithsonian Institution. Although the types show more chambers on average, with 16 chambers in the holotype, and slightly more limbate and raised sutures, they largely agree with our material.

These specimens are distinguished from *A. spissiformis* by their less rounded periphery, less involute umbilical side, more involute dorsal side, and more curved sutures.

Occurrence: These specimens are very rare to rare in the Fortuna section.

Anomalinoides cf. ***A. capitatus*** (Gümbel) 1868
Plate 3, figure 6

Rotalia capitata GÜMBEL 1868, p. 653, pl. 2, fig. 92.

Description: Test trochospiral, involute, biconvex; peripheral margin broadly rounded. Ventral side with 9 to 12 chambers in the last whorl, the last ones inflated; umbilicus depressed. Ventral sutures curved and characteristically raised, except the ones between the last few chambers, which are generally depressed. Dorsally less involute; dorsal sutures flush with the surface or even raised except the ones between the last chambers, which are depressed. Wall calcareous, coarsely perforate. Aperture an interiomarginal curved slit at the base of the last chamber.

Remarks: The specimens included in this species are similar to *A. capitatus* because of the raised sutures and coarsely perforate surface. However, the perforation is present over all of the surface of *A.* cf. *A. capitatus* whereas *A. capitus* shows some imperforated parts. Besides, *A. capitatus* has fewer chambers, a less rounded periphery, and is less laterally compressed. These specimens are distinguished from other *Anomalinoides* species by their symmetrical biconvex test, broadly rounded periphery and coarsely perforate test.

Occurrence: This species is very rare to common in the Fortuna section.

Anomalinoides cf. ***A. cocoaensis*** (Cushman) 1928
Plate 3, figures 4-5

Anomalina cocoaensis CUSHMAN 1928, p. 75, pl. 10, figs. 4a-c. – CUSHMAN 1935, p. 51, pl. 21, fig. 13.

Remarks: The specimens included here are similar to *A. acutus* as seen on the ventral side, but differ because they have a distinct, concave dorsal side, somewhat less perforate, with slightly oblique dorsal sutures, whereas *A. acutus* is biconvex.

These specimens are concavo-convex, with a peripheral margin sub-acute. The oblique dorsal sutures are distinct but not raised. The concave dorsal side has a distinct umbilical boss.

We checked the holotype and several paratypes of *A. cocoaensis* (CC. 104101, 37486, 37487, 37488, 22336). The ventral side of *A. cocoaensis* is almost the same as that in *A. Acutus,* but the test is thicker in peripheral view. *A. cocoaensis* has a more rounded periphery, and a concave dorsal side with limbate, oblique sutures. One of the paratypes (CC 22336) (Cushman 1935) and more specimens described by this author (CC 37489, 37490, 37491) are thinner than the holotype, and did not show raised dorsal sutures. These specimens are similar to our specimens; one slide is labeled 'not typical *A. cocoaensis'*.

Intermediate forms between *A. acutus* and *A. cocoaensis* were found in the material checked at the Smithsonian Institution. We include these specimens in *A.* cf. *cocoaensis* in order to stress the similarity of these two species.

Occurrence: These specimens are very rare to rare in the Fortuna section.

Anomalinoides spissiformis (Cushman and Stainforth) 1945
Plate 3, figure 7

Anomalina alazanensis Nuttall, var. *spissiformis* CUSHMAN and STAINFORTH 1945, p. 71, pl. 14, fig. 5. – CUSHMAN and RENZ 1948, p. 41, pl. 8, figs. 15, 16. – BECKMANN 1954, p. 399, pl. 26, fig. 14. – BOLLI et al. 1994, p. 373, pl. 59, figs. 10-12.
Anomalinoides spissiformis (Cushman and Stainforth). – MACKENSEN and BERGGREN 1992, p. 620, pl. 5, figs. 11-14.

Description: Test trochospiral plano-convex, flattened, periphery rounded. Ventral side involute, closely coiled, convex, with 11-13 chambers visible in the last whorl. Dorsal side almost evolute, nearly flat, with two visible whorls. Sutures gently curved, the last ones slightly depressed. Wall calcareous, coarsely perforate. Aperture an interiomarginal slit, extending from near the umbilicus towards the dorsal side, along the inner margin of the last whorl.

Remarks: We studied the holotype and paratypes of *A. spissiformis* (CC 43987, 43988). They show a somewhat less evolute dorsal side, but largely agree with our specimens.

This species is distinguished by its numerous chambers, and lack of any ornamentation.

Occurrence: Very rare to common in the Fortuna section.

Anomalinoides cf. ***A. spissiformis*** (Cushman and Stainforth) 1945
Plate 3, figure 8

Anomalina alazanensis var. *spissiformis* CUSHMAN and STAINFORTH 1945, p. 71, pl. 14, fig. 5. – CUSHMAN and STAINFORTH 1951, p. 162, pl. 28, fig. 6.

Remarks: These specimens are very similar to those figured by Cushman and Stainforth (1951) from the Eocene of Coastal Ecuador. These authors stated these to be rare specimens, which closely resemble the types of *A. spissiformis*, but they didn´t say in which aspects they differ. They are very smooth and more finely perforate than *A. spissiformis*. They are also bigger and thicker in cross section than typical *A. spissiformis*, and have a deeper umbilicus.

Occurrence: These specimens are very rare to rare in the Fortuna section.

Aragonia aragonensis (Nuttall) 1930
Plate 4, figures 1-3

Textularia aragonensis NUTTALL 1930, p. 280, pl. 23, fig. 6.
Bolivina capdevilensis CUSHMAN and BERMÚDEZ 1937, p. 14, pl. 1, figs. 49-50.
Aragonia zelandica FINLAY 1939c, p. 319, pl. 27, figs. 68, 69.
Bolivina semireticulata LEROY 1953, p. 20, pl. 8, fig. 26.
Bolivinoides compresssa OLSSON 1960, p. 30, pl. 4, fig. 20, 21.
Aragonia capdevilensis (Cushman and Bermúdez). – TJALSMA and LOHMANN 1983, p. 23, pl. 11, fig. 3.
Aragonia semireticulata (Leroy). – TJALSMA and LOHMANN 1983, p. 23, pl. 11, fig. 1.
Aragonia aragonensis (Nuttall). – TJALSMA and LOHMANN 1983, p. 23, pl. 11, fig. 2. – PROTO DECIMA and DE BIASE 1975, p. 94, pl. 2, fig. 7. – VAN MORKHOVEN et al. 1986, p. 308, pl. 101A, figs. 1-3; pl. 101B, figs. 1-4; pl. 101C, figs. 1-3. – BOLLI et al. 1994, p. 130, pl. 35, fig. 5.

Description: Test compressed, sub-rhombohedral, slightly longer than broad, greatest width near midpoint at base of last-formed chambers; initial end tapering. Greatest thickness at the center of the test, thinning towards the slightly carinate periphery. Chambers biserially arranged, low and broad, arched, not inflated, enlarging rapidly in size as added. Sutures distinct, straight to slightly curved, strongly oblique, characteristically limbate with occasional short straight projections extending onto the chamber surface. Wall calcareous, no pores visible. Aperture a small, low arch at the base of the last chamber.

Remarks: At the Smithsonian Insititution we studied the holotypes and paratypes of *A. aragonensis* (Nuttall) (CC 025691A and 25691) and *A. capdevilensis* (Cushman and Bermúdez) (CC 23388 and 23387), the holotypes of *A. semireticulata* (LeRoy) (CC 58037) and *A. compressa* (Olsson) (USNM 626458), the paratypes of *A. zelandica* Finlay (USNM 689067) and the material of van Morkhoven et al. (1986). We observed considerable variability in the degree of ornamentation in the material of Nuttall, van Morkhoven et al. (1986) and ours. This variability may in part be due to the state of preservation. The holotype of *A. capdevilensis* has narrower and less arched chambers than *A. aragonensis*. The holotype of *A. semireticulata* is more compressed than specimens of *A. aragonensis*. However, in agreement with van Morkhoven et al. (1986), we consider *A. capdevilensis* and *A. semireticulata* synonyms of *A. aragonensis*. The holotype of *A. compressa* is not well preserved, more compressed than that of *A. aragonensis*, and it does not show the projections of the sutures; its last chambers extend beyond the peripheral edge as small ledges, which was also the case in the holotype of *A. capdevilensis*. Therefore, we tentatively propose that the holotype of *A. compressa* may be a poorly preserved specimen, making this species also a synonym of *A. aragonensis*. Finlay (1939c) described *A. zelandica* as closely related to *A. aragonensis*, but without the fine, raised projections between the sutural ridges. This difference is according to us a result of preservation, and we thus consider *A. zelandica* also as a junior synonym of *A. aragonensis*.

Occurrence: This species is abundant to very abundant in samples For 11,3-For 13.

Asterigerina brencei Haque 1960
Plate 4, figure 4

Asterigerina brencei HAQUE 1960, p. 33, pl. 2, fig. 3. – SETIAWAN 1983, p. 118, pl. 9, fig. 3.

Description: Test trochospiral, planoconvex; dorsal side flat or gently convex, evolute; ventral side high, conical, involute. Periphery angular with an imperforate keel. Chambers indistinct, seven or eight in the last whorl, gradually increasing in size as added, so that the outline is almost circular. Supplementary chambers very indistinct, visible in some specimens. Ventral sutures flush, fairly curved, somewhat depressed between the last few chambers; dorsal sutures distinct, curved, limbate. Wall calcareous, granulate, especially in the apertural face, finely perforate. Aperture interiomarginal, a narrow ventral slit.

Remarks: "This species is distinguished by the peripheral prolongation of the chambers on the ventral side" (Haque 1960). We have found remains only of the spines, probably because the spines were broken.

Occurrence: This species is only present in sample For 35 (6.7%).

Asterigerina fimbriata Todd 1957
Plate 4, figures 5-6

Asterigerina fimbriata TODD 1957, p. 296, pl. 69, fig. 3.

Description: Test planoconvex, dorsal side strongly flatted, ventral side sharply conical to very slightly domed with a prominent boss in the center; periphery sub-acute, with an imperforate keel, nearly circular in outline. Chambers indistinct, about eight in the last whorl, increasing gradually in size and rather uniform in shape; supplementary chambers elongate, visible in few specimens only. Ventral sutures straight and radial; dorsal sutures oblique, straight to gently curved, spiral suture strongly limbate. Wall calcareous, perforate, nearly smooth except for a roughened area just in front of the aperture on the ventral side. Aperture a narrow, elongate slit on the ventral margin of the last formed chamber.

Remarks: We examined the holotype (USNM 623799) at the Smithsonian Institution. Specimens from our material are very similar to the holotype, but have a more prominent boss although it varies strongly in size. The keel is also not so fimbriate and more pronounced, but this may be due to preservation.

A. fimbriata and *A. brencei* are both planoconvex but *A. fimbriata* differs from *A. brencei* by its distinct ventral boss, straight sutures, less acute keel, and by the lack of projections on the keel.

Occurrence: Very rare to abundant in the Fortuna section.

Bolivina nobilis Hantken 1875
Plate 4, figures 7-8

Bolivina nobilis HANTKEN 1875, p. 65, pl. 15, fig. 4. – CUSHMAN 1937c, p. 51, pl. 7, figs. 1-4. – MATHELIN and SZTRÀKOS 1993, p. 78, pl. 32, fig. 9.
Bolivina cf. *nobilis* Hantken. – SZTRÀKOS 2000, p. 165, pl. 12, fig. 13.

Description: Test elongate, about 4 times as long as broad, tapering, slightly compressed. Periphery rounded to sub-acute, somewhat lobulate, especially for the last chambers. Chambers distinct, increasing rather regularly in size, both in width and height, the last ones faintly inflated. Sutures distinct, oblique, more depressed in later chambers. Wall calcareous, distinctly perforate, with numerous fine longitudinal costae covering the earlier chambers. Aperture loop-shaped, reaching the inner margin of the last chamber.

Remarks: Our material is somewhat less compressed than the figured type specimen. We examined several plesiotypes of *Bolivina nobilis* at the Smithsonian Institution (CC 21748, 21749, 21750), which include the specimens figured as # 2-4 by Cushman (1937c). Our material agrees well with the specimens in figures 2-4 and with several of the plesiotypes. *B. nobilis* is related to *B. pulchra* Le Calvez 1950, but *B. pulchra* differs mainly by lacking costae, which are clearly present in our specimens.

Some specimens show a change in direction of growth at a point about in the middle of the test.

Occurrence: Very rare in the lowest part of the section, and rare to common in the rest of section.

Bolivinoides crenulata (Cushman) 1936
Plate 4, figures 9-10

Bolivina crenulata CUSHMAN 1936a, p. 50, pl. 7, fig. 13. – CUSHMAN 1937c, p. 53, pl. 6, figs. 33, 34. – CUSHMAN 1951, p. 43, pl. 12, figs. 14 (not fig. 13). – KAASSCHIETER 1961, p. 194, pl. 9, figs. 15-17. – MATHELIN and SZTRÀKOS 1993, p. 78, pl. 32, fig. 7 (not fig. 6).

Description: Test tapering, biserial, greatest width near apertural part of the test. Periphery sub-acute, test thickening rapidly at the middle part of the test towards the apertural end, sub-rhomboidal in apertural view. Chambers broad and low, increasing gradually in size as added; separated by gently distinct and oblique sutures. These sutures are crenulate, showing re-entrants arranged in longitudinal rows parallel to longitudinal ridges. Wall calcareous, finely perforate. Aperture an elongate narrow loop at the last chamber.

Remarks: There are many species which resemble *B. crenulata* as to its characteristic ornamentation with rows and ridges. We examined the holotype and paratypes of *B. crenulata* (CC 21497-21450), *Bolivina floridana* Cushman 1918 (USNM 325334, CC 977), *Bolivina obscuranta* Cushman 1936a (CC 21879, 21880), *Bolivina plicatella* Cushman 1930 (USNM 371074, CC 10916), and *B. plicatella* var. *mera* Cushman and Ponton 1932b (CC 16320, 18470). Our material cannot be distinguished from the type material of *B. crenulata*. *B. floridana* is more elongate and rounded in apertural view, and it has less pronounced crenulations. *B. obscuranta* has more chambers, with more oblique and distinct sutures. The type specimens of *B. plicatella* are small and not well preserved, but we think that this species and specifically its variety *B. plicatella mera*, could be synonyms of *B. crenulata*, as also suspected by others (Cushman 1937c; Kaasschieter 1961). We keep the name of *B. crenulata* because it is more descriptive of the species.

B. crenulata is distinguished by its tapering, stout test, its sub-rhomboidal cross section, and the crenulated sutures.

Occurrence: This species is very rare to common in the Fortuna section.

Brizalina carinata (Terquem) 1882
Plate 4, figure 11

Bolivina carinata TERQUEM 1882, p. 148, pl. 15, fig. 19. – CUSHMAN 1937c, p. 46, pl. 6, figs. 14-16. – TODD 1957, pl. 66, fig. 12. – KAASSCHIETER 1961, p. 193, pl. 9, figs. 12-14.

Description: Test elongate, compressed, tapering to somewhat sub-rounded. Maximum width and thickness near apertural part of the test; usually thickest along the lowest part of the median axis, as a slight ridge. Periphery keeled, oval in apertural view. Chambers increase in size fairly rapidly. Sutures distinct, limbate, strongly oblique, becoming depressed towards the apertural part of the test, sometimes meeting in the center of the test in small, triangular areas of clear shell material. Wall calcareous, finely perforate, surface smooth. Aperture loop-shaped, extending up from the base of the last chamber.

Remarks: We examined several plesiotypes of *B. carinata*, figures # 15 and 16 of Cushman (1937c) (CC 5326 and 22061) and figure # 12 of Todd (1957) (USNM 623778). They are in good agreement with our material. This species is distinguished by its keeled periphery.

Occurrence: This species is very rare to common in the Fortuna section.

Bulimina alazanensis Cushman 1927
Plate 4, figures 12, 13

Bulimina alazanensis CUSHMAN 1927c, p. 161, pl. 25, fig. 4. – PARKER and BERMÚDEZ 1937, p. 514, pl. 58, fig. 5. – CUSHMAN and PARKER 1947, p. 103, pl. 24, figs. 14-16. – CUSHMAN and RENZ 1948, p. 25, pl. 5, figs. 14, 15. – BERMÚDEZ 1949, p. 180, pl. 12, fig. 1. – TJALSMA 1983, pl. 1, fig. 4-5. – TJALSMA and LOHMANN 1983, p. 24, pl. 14, fig. 4. – KATZ and MILLER 1987, p. 306, pl. 1, fig. 7. – MILLER and KATZ 1987a, p. 279, pl. 3, fig. 12, 13. – MILLER and KATZ 1987b, p. 124, pl. 2, fig. 7. – MÜLLER-MERZ and OBERHÄNSLI 1991, p. 156, pl. 2, fig. 5. – KUHNT et al. 2002, p. 138, pl. 6, fig. 18.
Bulimina dominicana BERMÚDEZ 1949, p. 181, pl. 12, fig. 4.

Description: Test elongate, rounded triangular in outline and in cross section, tapering towards the sub-acute initial part of the test; maximum width near the sub-rounded to obliquely truncate apertural end. Chambers indistinct in the earlier portion of the test, last chambers slightly inflated, increasing rather rapidly in size as added. Sutures indistinct. Wall ornamented with fine, elevated, conspicuous, longitudinal costae usually extending to the base of the last whorl. Wall calcareous, punctate except for the costae. Aperture elongate, loop-shaped, extending up the apertural face from the base of the last chamber.

Remarks: The holotype of *B. alazanensis* is lost (MO 369307), so we analysed several topotypes (CC 51870, 58963) and one paratype described by Bermúdez (1949) (CC 63043). Our specimens are somewhat more elongate, their costae slightly less prominent. We also examined the holotype and paratypes of *B. dominicana* (CC 62764, 62765). Bermúdez (1949) stated that *B. dominicana* resembles *B. sculptilis* Cushman 1923, from which it differs by being shorter, and in having more regular, more blunt costae. It differs from *B. bleeckeri* Hedberg 1937 by having raised, continuous, longitudinal costae. After looking at the type material, we think that *B. dominicana* is a junior synonym of *B. alazanensis* since the only difference is the smaller size of *B. alazanensis*.

This species differs from other species of *Bulimina* by being triangular and truncate in outline, with longitudinal and continuous costae, and no distinct chambers.

Occurrence: Very rare to common in the Fortuna section.

Bulimina semicostata Nuttall 1930
Plate 4, figure 14

Bulimina semicostata NUTTALL 1930, p. 285, pl. 23, figs. 15, 16. – PARKER and BERMÚDEZ 1937, p. 513, pl. 58, fig. 3. – CUSHMAN and PARKER 1947, p. 93, pl. 21, figs. 28-29. – TJALSMA and LOHMANN 1983, p. 25, pl. 13, figs. 1-3. – VAN MORKHOVEN et al. 1986, p. 279, pl. 93, figs. 1-5. – KATZ and MILLER 1991, pl. 3, fig. 2-3. – BOLLI et al. 1994, p. 136, pl. 36, fig. 23.
Bulimina jarvisi CUSHMAN and PARKER 1936, p. 39, pl. 7, fig. 1. – PARKER and BERMÚDEZ 1937, p. 513, pl. 58, fig. 2. – AGIP S.p.A. 1982, pl. 27, figs. 7. – TJALSMA and LOHMANN 1983, p.25, pl. 13, figs. 4-5. – VAN MORKHOVEN et al. 1986, p. 184, pl. 62, figs. 1-5. – MILLER and KATZ 1987b, p. 125, pl. 2, fig. 6.
Bulimina semicostata Nuttall/*Bulimina jarvisi* Cushman and Parker. – MÜLLER-MERZ and OBERHÄNSLI 1991, p.157, pl. 2, figs. 10, 11.
Bulimina tuxpamensis Cole. – KUHNT et al. 2002, p.140, pl.6, figs. 16, 17.

Description: *B. jarvisi*: "Test large, more than twice as long as broad, tapering throughout; chambers numerous, 6-7 whorls, inflated; sutures distinct, depressed; wall of the lower one-half to two-thirds of the test covered with fine, irregular costae, the upper half very coarsely perforate, giving the surface a very rough appearance; aperture loop-shaped with a slight lip" (Cushman and Parker 1936).

B. semicostata: "Test cylindrical, elongate, tapering to a blunt point at the initial end, rounded at the apertural end. The last three or four chambers are smooth, sutures depressed, narrow, distinct. Earlier chambers indistinct, covered with fine irregular, only slightly elevated longitudinal costae. Aperture short, straight" (Nuttall 1930).

Remarks: After examining the holotype and paratypes of *B. jarvisi* (CC 23128, 58942) as well as the type material of *B. semicostata* (CC 59481, 59482) and a paratype of Cushman and Parker (1947) (fig. 29) (CC 51871), we agree with Tjalsma and Lohmann (1983) in considering that "*B. jarvisi* is slenderer in appearance than *B. semicostata* Nuttall, the chambers are more strongly inflated, the early part of the test is less distinctly triangular in cross section and the costae are much finer"; besides, *B. jarvisi* is more elongate and more porose, except for the somewhat larger imperforate area around the aperture . Even though these differences exist, the two species are very difficult to distinguish, as many authors have noticed (e.g., Tjalsma and Lohmann 1983; van Morkhoven et al. 1986; Müller-Merz and Oberhänsli 1991). We also studied the material documented by van Morkhoven et al. 1986, three specimens of *B. jarvisi* (R/C# 62) and two of *B. semicostata* (R/C# 93), confirming the similarity of the two taxa, but "*B. jarvisi* has the longer test and its greatest diameter is at a point approximately two thirds of the distance from the initial end to the final chamber". We decided not to separate the two species, because our material contains only few specimens and we cannot evaluate the morphological variability.

We observed in some but not all of the paratypes of both *B. jarvisi* and *B. semicostata* re-entrants in the sutures of the last chambers. We have observed this in material of the middle-upper Eocene, but not in the specimens from the Fortuna section.

Occurrence: These specimens are very rare to common, the latter only in sample For 18.

Bulimina mexicana Cushman 1922
Plate 4, figures 15, 16

Bulimina striata? d'ORBIGNY 1826, p. 269. – GUÉRIN-MÉNEVILLE 1843, p. 9, pl. 2, figs. 16, 16a.
Bulimina costata? d'ORBIGNY 1852, p. 194. – FORNASINI 1901, p. 174, pl. 1.
Bulimina inflata Seguenza var. *mexicana* CUSHMAN 1922a, p. 95, pl. 21, fig. 2.
Bulimina instabilis CUSHMAN and PARKER 1936, p. 44, pl. 8, fig. 3.
Bulimina bleeckeri HEDBERG 1937, p. 675, pl. 91, figs. 12, 13.
Bulimina striata d'Orbigny var. *mexicana* Cushman. – CUSHMAN and PARKER 1940, p. 15, pl. 3, fig. 9.
Bulimina mexicana Cushman. – VAN MORKHOVEN et al. 1986, p. 59, pl. 19, figs. 1-4. – SZAREK 2001, p. 129, pl. 17, fig. 20. – HOLBOURN et al. 2005.

Description: Test elongate, slightly to distinctly tapering, sub-rounded apertural part of the test. Initial chambers indistinct, later ones inflated; sutures indistinct, except for those between the last few chambers, depressed, horizontal and straight. Test ornamented by distinct, longitudinal costae, from the initial part of the test to the base of the chambers in the last whorl, in some specimens extending from the base of the chambers as short, blunt spines. Wall calcareous, smooth and finely perfo-

rate between the costae and the upper part of last three chambers. Aperture loop-shaped, extending up from the base of the last chamber.

Remarks: Considering the remarks of van Morkhoven et al. (1986) about *B. mexicana*, we examined the holotype and one paratype of *B. bleeckeri* (CC 23596, 23597) and the holotype of *B. instabilis* (CC 23140), as well as the holotype and paratypes of *B. mexicana* (USNM 16402A, 16402) and the material of van Morkhoven et al. (1986) (R/C# 19). All the type material of *B. mexicana* shows very well developed costae extending downward as sharp spines. However, *B. bleeckeri* and *B. instabilis* show less distinct costae and spines, as we also observed in our material. In spite of these differences, the overall form of the test, the space between the costae, the average number of costae, and the fact that the costae do not reach the last chambers, are the same in all these taxa. Therefore we agree with van Morkhoven et al. (1986) in considering them synonyms. We also consider that *B. costata* d'Orbigny 1852 and *B. striata* d'Orbigny 1826 could possibly be synonyms, but cannot decide this at the present because we have not studied the type material. *Bulimina midwayensis* Cushman and Parker 1936, described from the Paleocene, may also be a synonym, although the latter may have re-entrants along the sutures; this species, however, also shows less distinct costae and more spines than our specimens. Similarly, *B. macilenta* shows relatively thin spines, which are not distinctly combined in costae. We searched the collection of specimens described by Fornasini (1901), but the specimens were missing, probably as a result of damage suffered during World War II.

This species can be distinguished by its conspicuous costae with spines, and inflated chambers.

Occurrence: This species is very rare to rare in the Fortuna section.

Bulimina trinitatensis Cushman and Jarvis 1928
Plate 4, figures 17, 18

Bulimina incisa CUSHMAN 1926, p. 592, pl. 17, fig. 9.
Bulimina trinitatensis CUSHMAN and JARVIS 1928, p. 102, pl. 14, fig. 12. – CUSHMAN and JARVIS 1932, p. 44, pl. 13, fig. 4. – BERMÚDEZ 1963, p. 20, pl. 3, figs. 11, 12. – TJALSMA and LOHMANN 1983, p. 7, pl. 3, figs. 3, 4; pl. 14, fig. 1. – VAN MORKHOVEN et al. 1986, p. 299, pl. 98A, figs. 1-2; pl. 98B, figs. 1-4. – MILLER and KATZ 1987a, p. 280, pl. 3, fig. 10-11. – THOMAS 1990, p. 589, pl. 2, fig. 7. – NOMURA 1991, p. 21, pl. 1, fig. 10. – BOLLI et al. 1994, p. 136, pl. 36, figs. 28, 29. – SPEIJER 1994, p. 154, pl. 2, fig. 3. – WIDMARK 1997, p. 40, pl. 15, figs. C-D. – ALEGRET and THOMAS 2001, p. 279, pl. 2, figs. 12-15. – HOLBOURN et al. 2005.

Description: "Test somewhat longer than broad, rounded in transverse section, chambers distinct with the lower border extended into an overhanging plate which is marked on the upper side by an irregular network of reticulate areas, the outer angles ending in short spines; aperture elongate, comma-shaped, the apertural face smooth." (Cushman and Jarvis 1928).

Remarks: The holotype of *B. trinitatensis* (CC 9682) and several paratypes (CC 9697, 15414, 15415, 15422) figured by Cushman and Parker (1947), and Cushman and Jarvis (1932), were examined at the Smithsonian Institution. The distinct ridges at the base of the chambers and the overlapping of the chambers over the sutures are the main distinctive features of *B. trinitatensis* (Alegret and Thomas 2001). In our specimens the ridges, spines, and the ornamented surface are usually slightly eroded, as also seen in the type material of *B. trinitatensis*. It is thus possible that several species are created to include differently preserved *B. trinitatensis* specimens. Alegret and Thomas (2001) established that *B. incisa* may well be a synonym of *B. trinitatensis*, and after examining the holotype of *B. incisa* (CC 5157) we agree with this opinion.

Occurrence: *Bulimina trinitatensis* is very rare to common, the latter in sample For 19,5.

Genus ***Cibicidoides*** Saidova 1975

The taxonomy of this genus as well as of various species within the genus, overall characterized by almost biconvex tests, is plagued by confusion, mainly due to the fact that these taxa vary in morphology. For this reason, we describe the differences between all species of *Cibicidoides* present in our material. These species have been previously included in other genera, such as *Anomalina*, *Anomalinoides*, *Gavelinella*, *Heterolepa*, *Planulina*, *Rotalia*, *Rotalina,* or *Truncatulina*.

Cibicidoides cf. ***C. dutemplei*** (d'Orbigny) 1846
Plate 5, figure 1

Rotalina dutemplei d'Orbigny 1846, p. 157, pl. 8, fig. 19-21.

Description: Test trochospiral, unequally biconvex; sub-circular outline, subacute periphery. Dorsal side evolute, moderate to gently convex, less convex than ventral side, with the last-formed whorl somewhat flat to depressed. Ventral side convex, 12-14 chambers visible on the last whorl, uniform in shape, converging on the umbo and forming a small central boss; sutures flush to slightly depressed, especially in the last few chambers; ventral sutures curved, dorsal ones tangential. Spiral suture limbate and somewhat raised. Wall calcareous, coarsely perforate on both sides, except for the imperforate periphery. Aperture an interiomarginal slit extending from the umbilical side towards the dorsal side along the spiral suture.

Remarks: We examined the material of *C. dutemplei* figured by van Morkhoven et al. (1986) (R/C# 35) at the Smithsonian Institution. There were five specimens that varied in the degree of convexity of the dorsal side. The main differences with our material are the lack of a central umbilical boss, showing a small umbilicus, fewer chambers, 8-10 as compared to 12-14 in our material, and the higher apertural face.

Occurrence: This species is rare to common in the Fortuna section.

Cibicidoides eocaenus (Gümbel) 1868
Plate 5, figure 2

Rotalia eocaena GÜMBEL 1868, p. 650, pl. 2, fig. 87.
Cibicides tuxpamensis COLE 1928, p. 219(19), pl. 1, figs. 2, 3; pl. 3, figs. 5, 6. – NUTTALL 1930, p. 291, pl. 25, figs. 2, 4.
Cibicides eocaenus (Gümbel). – BERMÚDEZ and GÁMEZ 1966, p. 228, pl. 2, figs. 7, 8.
Heterolepa eocaena (Gümbel). – SAPERSON and JANAL 1980, p. 404, pl. 2, fig. 3; pl. 5, fig. 9.
Cibicidoides tuxpamensis (Cole) 1928. – MILLER and KATZ 1987a, p. 285, pl. 6, fig. 7-9. – TJALSMA and LOHMANN 1983, p. 28, pl. 18, figs. 3-4; pl. 22, figs. 1-3.
Cibicides perlucida NUTTALL 1932, p. 33, pl. 8, figs. 10-12. – RENZ 1948, p. 129, pl. 11, fig. 9. – BERMÚDEZ 1949, p. 304, pl. 25, figs. 16-18. – BECKMANN 1954, p. 403, pl. 28, fig. 2.
Cibicidoides eocaenus (Gümbel). – VAN MORKHOVEN et al. 1986, p. 256, pl. 86A, figs, 1-4; pl. 86B, figs. 1-2; pl. 86C, figs. 1-3; pl. 86D, figs. 1-2. – MILLER and KATZ 1987b, p. 126, pl. 8, fig. 3. – NOMURA 1995, p. 291, pl. 1, fig. 4.

Cibicidoides perlucidus (Nuttall). – VAN MORKHOVEN et al. 1986, p. 260, pl. 86D, figs. 1-2.

Description: Test trochospiral, planoconvex to slightly biconvex, nearly circular in outline, periphery rounded to sub-acute. Dorsal side evolute, usually two whorls visible, flat to moderately convex, less convex than ventral side; spiral suture limbate, slightly raised. Umbilical side convex, with a distinct central plug; 7 to 10 chambers in the last whorl, slightly inflated. Dorsal and umbilical sutures pronounced, limbate, flush to depressed in the last few chambers, radial, slightly curved. Wall calcareous, conspicuously perforate, more coarsely so on the spiral side. Aperture a slit at the base of the last chamber, extending onto the dorsal side along the spiral suture.

Remarks: Van Morkhoven et al. (1986) examined topotypes of *C. tuxpamensis* and compared these with topotypes and other comparative material of *C. eocaenus*, and decided that they are conspecific, in agreement with Bermúdez and Gámez (1966) and Tjalsma and Lohmann (1983). We agree that these are synonyms after studying material of van Morkhoven et al. (1986) at the Smithsonian Institution (R/C# 86). The morphological variability in our specimens is similar to that described by van Morkhoven et al. (1986). These authors suggested that *C. perlucidus* could also be a junior synonym of *C. eocaenus* and proposed that *C. eocaenus-tuxpamensis* and *C. perlucidus* could have been ecophenotypes, mainly differing in the shape of the periphery. The periphery is rounded in *C. eocaenus-tuxpamensis* and more acute in *C. perlucidus*. We studied Nuttall's specimens (1932) (CC 16463, 16464), which were not differentiated into holotype and paratypes. Therefore van Morkhoven et al. (1986) proposed the specimen shown in figure # 10 of Nuttall (1932) as lectotype (CC 16463). The main differences between the type material of *C. perlucidus* and specimens of *C. eocaenus* are the more acute and more planoconvex test in the former species, even being nearly concave-convex in some specimens, and the smaller ventral boss. These specimens resemble some specimens that are included in *Osangularia dominicana* (Bermúdez) in overall shape, although the aperture is different. When specimens are not well preserved or the last chambers are broken off, the aperture cannot be clearly seen, and we distinguished them by the coarser perforate dorsal side of *C. eocaenus*, and the presence of oblique dorsal sutures and the typical rather thick calcite covering on the spiral side of *O. dominicana*.

Occurrence: Very rare to abundant in the Fortuna section.

Cibicidoides grimsdalei (Nuttall) 1930
Plate 5, figure 3

Cibicides grimsdalei NUTTALL 1930, p. 291, pl. 25, figs. 7, 8, 11. – CUSHMAN and RENZ 1948, p. 41, pl. 8, figs. 17-19.
Cibicidoides grimsdalei (Nuttall). – CUSHMAN and STONE 1949, p. 83, pl. 14, fig. 24. – BERMÚDEZ and GÁMEZ 1966, p. 228, pl. 2, figs. 9-11. – TJALSMA and LOHMANN 1983, p. 26, pl. 18, fig. 2; pl. 22, fig. 6 (not fig. 7). – VAN MORKHOVEN et al. 1986, p. 247, pl. 83A, figs. 1-3; pl. 83B, figs. 1-7. – MILLER and KATZ 1987b, p.126, pl. 8, fig. 1.

Description: Test trochospiral, highly domed, outline sub-circular, periphery sub-acute. Dorsal side strongly flatted, limbate sutures. Ventral side strongly convex, about 9 chambers visible, the last one of which may be somewhat inflated; ventral sutures limbate, somewhat raised, slightly curved. Wall calcareous, finely perforate on ventral side, distinctly and more coarsely perforate on dorsal side. Aperture a low arched slit at the base of the apertural face, slightly extending onto the dorsal side.

Remarks: We examined the type material of Nuttall (1930) (CC 59517, 59518, 59519, USNM 369263, 369264) and one specimen discussed by van Morkhoven et al. (1986) (R/C# 83). Nuttall did not designate a holotype, only paratypes. Thus, van Morkhoven et al. (1986) designated a lectotype (CC 59518), which corresponds to figure # 7 of Nuttall (1930). All paratypes are distinctively high-domed and coarsely perforate on the dorsal side.

Specimens studied by Tjalsma and Lohmann (1983) show a more rounded periphery, with a ventral side which is not always completely involute, so that some chambers of the previous whorl are visible through a transparent umbilical mass (pl. 22, fig. 7).

Occurrence: This species is very rare in the Fortuna section.

Cibicidoides hadjibulakensis Bykova 1954
Plate 5, figures 4-6

Cibicides (*Cibicidoides*) *hadjibulakensis* BYKOVA in Vasilenko, 1954, p. 177, pl. 31, fig. 5. – SAPERSON and JANAL 1980, p. 400, pl. 1, fig. 9.
Heterolepa libyca (LeRoy). – SAPERSON and JANAL 1980, p. 404, pl. 2, fig. 4 (non LeRoy).

Description: Test trochospiral, unequally biconvex to planoconvex, periphery acute, slightly keeled, outline somewhat lobulate. Dorsal side semi-evolute, $2^1/_2$ to 3 whorls visible, slightly convex; chambers distinct, separated by limbate, raised, curved, and oblique sutures. Spiral suture very distinct, limbated, conspicuously raised, sometimes beaded. There are raised ridges and knobs where spiral and septal sutures meet on the dorsal side. Ventral side involute, more convex than the dorsal one, conical to slightly domed; 9 to 11 chambers visible in the last whorl; ventral sutures somewhat raised, slightly curved, becoming more curved towards the periphery and more depressed in the last chambers; umbilicus covered by a small to medium boss. Wall calcareous, coarsely perforate on both sides. Aperture a peripheral slit with a lip, extending to the dorsal side.

Remarks: The specimens included in this species show variability in the degree of convexity of the test, specifically of the ventral side, and ornamentation. The largest specimens are more coarsely perforate and show a more convex ventral side, whereas the smallest show a more beaded spiral suture. *C. barnetti* is similar in overall shape to *C. hadjibulakensis* but the former has a depressed spiral suture.

Occurrence: Very rare to common in the Fortuna section.

Cibicidoides naranjoensis (White) 1928
Plate 5, figure 7

Cibicides naranjoensis WHITE 1928b, p. 298, pl. 41, fig. 1. – ALEGRET and THOMAS 2001, p. 281, pl. 4, fig. 1.

Description: Test large, nearly plano-convex to slightly biconvex; periphery sub-acute. Ventral side convex, 6-8 chambers in the last whorl, separated by distinct, slightly curved, and fairly oblique sutures. Ventral umbilicus covered by a very small boss. Dorsal side flat to moderately convex; dorsal chambers somewhat rectangular, separated by distinctly oblique sutures. Wall calcareous, smooth, finely perforate. Aperture a

interiomarginal slit extending from near the umbilicus to the periphery.

Remarks: We studied the syntypes in White's collection at the American Museum of Natural History, which largely agree with our material.

C. naranjoensis is similar to *C. eocaenus* but the former is flatter and has a more acute periphery.

Occcurrence: This species is very rare to common in the Fortuna section.

Cibicidoides proprius Brotzen 1948
Plate 5, figures 8-9

Cibicidoides proprius BROTZEN 1948, p. 78, pl. 12, figs. 3, 4. – KAASSCHIETER 1961, p. 222, pl. 13, fig. 9. – BOLLI et al. 1994, p. 148, pl. 39, figs. 28-30. – ALEGRET and THOMAS 2001, p. 281, pl. 4, figs. 2-4.
Cibicides libycus LEROY 1953, p. 24, pl. 5, fig. 1-3.

Description: "Test trochospiral, slightly biconvex to nearly planoconvex, periphery acute, outline somewhat lobulate. Dorsal side moderately convex to nearly flat with a distinct central plug, flat to slightly elevated. About 9 chambers in the last whorl, the last one may be inflated; ventral sutures curved, sinusoidal and depressed between the last chambers. Umbilical side convex, umbilicus covered by a small boss of translucent shell material. Aperture arched, at the base of the last chambers and extending shortly towards the umbilical side. Wall calcareous, smooth." The description of this species in Alegret and Thomas (2001) is overall in agreement with our specimens, except for the number of chambers in the last whorl, which was about 8 in Alegret and Thomas' (2001) material.

Remarks: This species shows strong variability in the degree of convexity of the spiral side, dependent upon the size of the specimen. Usually in juvenile forms the ventral side is more convex than the dorsal side, as in specimens from Alegret and Thomas (2001).

We examined the holotype of *C. libycus* (CC 58053) at the Smithsonian Institution. This differs from *C. proprius* mainly by being somewhat more finely perforate, and having a more depressed spiral suture. In our material we could not distinguish such specimens from specimens more typical of *C. proprius*, and we consider *C. libycus* a probable junior synonym, although we have not studied the type specimens of the former.

We designated as *C. proprius* juvenile forms (pl. 5, fig. 8) all small, strongly plano-convex specimens, but with a slightly distinct dorsal boss.

C. proprius differs from most other *Cibicidoides* species by the acute periphery, flat, biconvex test, and uniform dorsal boss. *C. hadjibulakensis* is similar in overall shape to C. *proprius*, but may be distinguished by its more irregular dorsal side and more pronounced ornamentation of the test. *C. grimsdalei* clearly differs from all other species by its high, domed shape. *C. eocaenus* is easily distinguished by its coarsely perforate dorsal side. *C. naranjoensis* is distinguished by its fairly flat dorsal side and distinct oblique dorsal sutures; and *C.* cf. *dutemplei* is distinguished from the other *Cibicidoides* taxa discussed by its numerous chambers in the last whorl.

Occurrence: This species is very rare to abundant in the Fortuna section.

Coleites galeebi Haque 1960
Plate 7, figures 1-2

Coleites galeebi HAQUE 1960, p. 32, pl. 5, fig. 8.

Description: Test trochospiral, almost equally biconvex, sub-circular to oval in plane view; periphery with a distinct, somewhat ragged keel. Chambers very indistinct, obscured by ornamentation, about six in the final whorl, separated by indistinct, curved sutures; last chambers may be uncoiling. Wall calcareous, strongly ornamented by a coarse reticulation obscuring the entire surface. Aperture a narrow slit on the ventral side, rather difficult to see.

Remarks: We included our specimens in the genus *Coleites*, being very close to the species *C. cancellatus*, except for the last chamber which is smooth in *C. cancellatus*, coarsely reticulate in our specimens. Our specimens strongly resemble *C. galeebi* in its type figure, but we have not been able to look at type material. Several specimens in our material show a more elongate and more strongly biconvex test (plate 7, fig. 1); we include these in *C. galeebi*, because we consider this to represent intraspecific variability.

Occurrence: These specimens are very rare to rare, only appearing in For 16,4 and For 18,5.

Fursenkoina dibollensis(Cushman and Applin) 1926
Plate 7, figure 3

Virgulina dibollensis CUSHMAN and APPLIN 1926, p. 168, pl. 7, fig. 7. – CUSHMAN 1935, p. 36, pl. 14, figs. 1-3. – CUSHMAN 1937c, p. 7, pl. 1, figs. 20, 22.

Description: Test elongate, slender, about $3^1/_2$-4 x as long as broad, periphery rounded, weakly compressed. Chambers high and narrow, slightly inflated, increasing rather rapidly in heigth as added, uniform in shape. Biserially arranged, slightly twisted about the test axis. Sutures distinct, depressed, strongly oblique. Wall calcareous, smooth, finely perforate. Aperture narrow, elongate, extending up into the face of the last chamber, usually not reaching the base of the last chamber.

Remarks: The holotype of *F. dibollensis* (CC 5393) closely resembles our material.

Occurrence: This species is rare in sample For 35.

Genus ***Globobulimina*** Cushman 1927

There is considerable taxonomic confusion in assigning specimens to the related genera *Globobulimina*, *Praeglobobulimina*, and *Protoglobobulimina*. These genera are mainly differentiated by apertural characters, since other characteristics including pore size and density, shape, or degree of chamber overlap are not of generic significance and variability is high within populations (Haynes 1954; Loeblich and Tappan 1987). Jones (1994) regarded the genus *Protoglobobulimina* as a junior synonym of *Praeglobobulimina*. Hofker (1951) and Haynes (1954) argued that *Praeglobobulimina* constituted a separate genus, but Papp and Schmid (1985) revised the material of d'Orbigny (1846), who originally defined many of the species that we recognized, and considered that the differences between *Praeglobobulimina* and *Bulimina* did not justify the distinction of these genera.

We considered the type species of the three genera: *Bulimina pyrula* d'Orbigny var. *spinescens* Brady 1884, the type species

of the genus *Praeglobobulimina* Hofker 1951; *Bulimina pupoides* d'Orbigny 1846, the type species of the genus *Protoglobobulimina* Hofker 1951, and *Globobulimina pacifica* Cushman 1927b, the type species of *Globobulimina* Cushman 1927b.

Apertural characters of our specimens are commonly not clearly visible because of the deformation of the more globose specimens, but specimens belonging to these morphological genera are extremely abundant in our samples, so that we can study the morphological variability within populations well. We concluded that the differences between these genera are insufficient to distinguish *Protoglobobulimina* and *Praeglobobulimina,* and placed all 5 species that we recognize in the genus *Globobulimina* because we consider them to be closely related.

Globobulimina ovata (d'Orbigny) 1846
Plate 6, figures 4-5

Bulimina ovata D'ORBIGNY 1846, p. 185, pl. 11, fig. 13, 14. – CUSHMAN 1922b, p. 92, pl. 16, fig. 4. – NUTTALL 1932, p. 19, pl. 2, fig. 8. – CUSHMAN and PONTON 1932a, p. 67, figs. 1-2. – CUSHMAN 1935, p. 35, pl. 13, figs. 15, 16. – CUSHMAN and PARKER 1937, p. 47, pl. 6, figs. 4, 5. – TOULMIN 1941, p. 597, pl. 80, fig. 26. – CUSHMAN and PARKER 1947, p. 106, pl. 25, figs. 8, 9. – CUSHMAN and STAINFORTH 1951, p. 151, pl. 26, fig. 44. – BECKMANN 1954, p. 366, pl. 21, fig. 12. – KAASSCHIETER 1961, p. 191, pl. 9, fig. 6.
Bulimina cf. *ovata* d'Orbigny. – CUSHMAN 1926, p. 591, pl. 17, fig. 8.
Bulimina pupoides d'Orbigny. – NUTTALL 1932, p. 19, pl. 2, fig. 9. – CUSHMAN and PARKER 1937, p. 47, pl. 2, fig. 3. – RENZ 1948, p. 122, pl. 6, fig. 11 (non d'Orbigny).
Bulimina cf. *pupoides* d'Orbigny. – PARKER and BERMÚDEZ 1937, p. 515, pl. 59, fig. 3 (not figs. 4-5) (non d'Orbigny).
Bulimina aff. *ovata* d'Orbigny. – BROTZEN 1948, p. 59, pl. 10, figs. 9, 10.
Praeglobobulimina ovata (d'Orbigny). – MURRAY and WRIGHT 1974, p. 120, pl. 6, figs. 16,17. – AGIP S.p.A. 1982, pl. 27, figs. 9. – JONES 1994, p. 54, pl. 50, fig. 13.
Bulimina pyrula d'Orbigny. – PAPP and SCHMID 1985, p. 69, pl. 62, figs. 2-4 (non d'Orbigny).

Description: Test elongate, slender, ovate to elliptical in side view, slightly tapering, apex broadly rounded in macrospheric forms and moderately pointed in microspheric forms, oval to circular in apertural view. Chambers numerous, elongate, distinct, with last chambers overlapping earlier ones and somewhat inflated. Sutures distinct, slightly to moderately depressed, oblique to the horizontal. The last whorl forms about two thirds of the test; maximum width is reached at about 2/3 of the test measured between apex and aperture. Wall calcareous, smooth, finely perforate. Aperture loop-shaped, sometimes with a lip and/or with a tooth.

Remarks: The three species described by d'Orbigny (1846), namely *Bulimina ovata, B. pupoides,* and *B. pyrula,* have been commonly confused in the literature because they are morphologically similar, and there is considerable morphological similarity between populations. We consider this group of morphological species as closely related to each other (possibly ecophenotypes), intermediate specimens occur, but we are of the opinion that most specimens can be attributed to one or other of these species. Comparing the type descriptions, we recognize 4 species along a transition from more typically *Bulimina*-shaped to extreme *Globobulimina*-shaped in this sequence: 1. *Globobulimina pupoides* (last chambers not encompassing, greatest width close to aperture, length>width) -> 2. *Globobulimina ovata* (last chambers encompassing, initial part of test visible, greatest width at about 2/3 of test length, length>width) -> 3. *Globobulimina pyrula* (chambers strongly encompassing, first chambers just visible, greatest width at about 1/3 of test or somewhat lower, length only slightly greater than or close to width) -> 4. *Globobulimina pacifica* (chambers very strongly encompassing, only last 2-3 chambers visible, strongly inflated, greatest width close to lowermost part of test, length about 1.5 times width). A 5th species is *Globobulimina spinescens,* which resembles *G. pyrula* but has numerous short, thin spines close to the base of the test. In our material specimens of the more globose species are commonly flattened, and details of the pores and commonly also the aperture can therefore not be observed.

Papp and Schmid (1985) studied the species and decided that *Globobulimina ovata* and *G. pupoides* were junior synonyms of *G. pyrula.* We disagree, and agree with several authors (e.g. Cushman and Parker 1937; Loeblich and Tappan 1987; Bolli et al. 1994) that these species can be distinguished as described above.

Occurrence: Globobulimina species show great fluctuations in abundance in the Fortuna section, with *G. ovata* being most abundant. This species is very rare (0%) to very abundant (up to 65.6%).

Globobulimina pacifica Cushman 1927
Plate 6, figures 8-11

Globobulimina pacifica CUSHMAN 1927b, p. 67, pl. 1, fig. 39. – JONES 1994, p. 54, pl. 50, figs. 7, 8, 10 (not fig. 9).
Globobulimina pacifica Cushman var. *curtata* WHITE 1956, p. 254, pl. 30, fig. 10.
Globobulimina pyrula (d'Orbigny). – AGIP S.p.A. 1982, pl. 28, figs. 3 (non d'Orbigny).

Description: Test elongate to sub-globular, about one and a half times as long as wide. Greatest width closes to lowermost part of test. Chambers distinct, inflated, elongate, very strongly encompassing, only last 2-3 visible. Sutures slightly depressed, almost vertical. Wall calcareous, smooth, finely perforate. Aperture loop-shaped with a slight border, not well visible in our specimens.

Remarks: Slide USNM 20285 at the Smithsonian contains the holotype of *G. pacifica* which is very similar to our specimens (pl. 6, fig. 10). In our opinion, the character that the last 2-3 chambers embrace all the earlier chambers is more important than the relation length/width; therefore, we include specimens less elongate than the holotype in this species. We also studied several varieties of this genus: *G. pacifica* var. *curtata* (holotype USNM 237496), var. *oregonensis* Cushman, Stewart and Stewart 1948 (holotype CC 48844, paratypes USNM 370096), and var. *scalprata* (holotype CC 44431, paratypes CC 44432). The variety *scalprata* differs by ornamentation of the test consisting of very fine, numerous, linear costae. We could not see this characteristic in any of its paratypes (4); we haven't observed this ornamentation in our material; thus, we cannot decide whether this is a separate species. White (1956) states that the variety *curtata* differs from *G. pacifica* by its shorter length and greater relative width. Such length/width variability is very common in our specimens (see pl. 6, fig. 8), so we think this may be ecophenotypic variability. The holotype of the variety *oregonensis* is very similar to that of *curtata*, with the exception that the three last chambers are not completely encompassing. Therefore, we include this variety in *G. pyrula* (see also *G. ovata)*.

Occurrence: This species is very rare to very abundant in the Fortuna section.

Globobulimina pupoides (d'Orbigny) 1846
Plate 6, figures 1-3

Bulimina pupoides D'ORBIGNY 1846, p. 185, pl. 11, fig. 11, 12. – CUSHMAN and PARKER 1937, p. 47, pl. 6, fig. 2. – CUSHMAN and PARKER 1947, p. 105, pl. 25, figs. 3-7. – CUSHMAN and RENZ 1948, p. 25, pl. 5, fig. 16.-BERMÚDEZ 1949, p. 183, pl. 11, fig. 67. – CUSHMAN and STONE 1949, p. 79, pl. 14, figs. 6, 7. – BERMÚDEZ 1963, p. 19, pl. 3, figs. 5, 6.
Bulimina cf. *pupoides* d'Orbigny. – PARKER and BERMÚDEZ 1937, p. 515, pl. 59, figs. 4-5 (not fig. 3).
Bulimina ovata d'Orbigny. – TOULMIN 1941, p. 597, pl. 80, fig. 25 (non d'Orbigny).
Bulimina pupoides d'Orbigny. – RENZ 1948, p. 122, pl.6, fig. 12.
Praeglobobulimina pupoides (D'Orbigny). – AGIP S.p.A. 1982, pl. 28, fig. 2. – JONES 1994, p. 55, pl. 50, figs. 14-15.
Bulimina pyrula d'Orbigny. – PAPP and SCHMID 1985, p. 69, pl. 62, figs. 5-7 (non d'Orbigny).

Description: Test elongate, tapering towards the initial part of the test; broadly rounded towards the aperture. Greatest width closes to aperture. Chambers distinctly inflated, the last ones not encompassing. Sutures distinct, somewhat depressed, sloping downward. Wall calcareous, smooth, perforate. Aperture loop-shaped.

Remarks: This species is somewhat more coarsely perforate than other *Globobulimina* species, especially in its earlier formed chambers. In a few specimens (pl. 6, fig. 3), we observed small spines at the base (see also *G. ovata)*.

Occurrence: This species is very rare to abundant in the Fortuna section.

Globobulimina pyrula (d'Orbigny) 1846
Plate 6, figures 6, 7

Bulimina pyrula D'ORBIGNY 1846, p. 184, pl. 11, fig. 9, 10. – CUHSMAN and PARKER 1937, p. 46, pl. 6, fig. 1. – CUSHMAN and PARKER 1947, p. 104, pl. 25, fig. 2. – PAPP and SCHMID 1985, p. 69, pl. 62, figs. 8-10.
Bulimina ovata d'Orbigny. – BERMÚDEZ 1949, p. 183, pl. 11, fig. 66 (non d'Orbigny).
Globobulimina pacifica Cushman. – BERMÚDEZ 1949, p. 185, pl. 12, fig. 14. – JONES 1994, p. 54, pl. 50, fig. 9 (non Cushman).
Bulimina pupoides d'Orbigny. – LEROY 1953, p. 22, pl. 8, fig. 21 (non d'Orbigny).
Bulimina pyrula d'Orbigny var. *perversa* CUSHMAN 1921, p. 163, text-figs. 2a-c.
Globobulimina pacifica Cushman var. *oregonensis* CUSHMAN, STEWART and STEWART 1948, p. 101, pl. 12, fig. 13.

Description: Test globular, length slightly greater than or equal to width of test; rounded initial end. Greatest width at about 1/3 of the height of the test or somewhat lower. Chambers distinct, slightly to moderately inflated, strongly encompassing, but earliest chambers just visible. Sutures distinct, depressed. Wall calcareous, smooth, finely perforate. Aperture loop-shaped.

Remarks: We observed some pyriform-shaped specimens, broadest at the base and tapering towards the apertural end, whose last chambers make up a greater portion of the test. Such specimens have been assigned to the varieties *G. pyrula* (d'Orbigny) var. *perversa* Cushman 1921 and *G. pacifica* Cushman var. *oregonenesis* Cushman, Stewart and Stewart 1948. After examining the holotypes and paratypes of these varieties (*oregonensis* CC 48844, USNM 370096; *perversa* USNM 14342, 14345a), we consider them to represent the same variety, and included them in *G. pyrula*.

Some specimens show short spines at the apex. d'Orbigny did not describe the occurrence of such spines, but Brady (1884) placed such specimens in *Bulimina pyrula* d'Orbigny var. *spinescens* Brady. We assigned such specimens to a separate species (see below) (see also *G. ovata)*.

Occurrence: This species is very rare to abundant in the Fortuna section.

Globobulimina spinescens (Brady) 1884
Plate 6, figure 12

Bulimina pyrula var. *spinescens* BRADY 1884, p. 400, pl. 50, figs. 11, 12.
Praeglobobulimina spinescens (Brady). – JONES 1994, p. 54, pl. 50, figs. 11, 12. – SZAREK 2001, p. 129, pl. 18, fig. 7, 8. – KATZ et al. 2003, p. 37, pl. 1, fig. 4.

Description: This species differs from *G. pyrula* (d'Orbigny) by the presence of numerous, small spines at the base of the test.

Remarks: We also observed spines in very few specimens of *G. pupoides*, so the presence of spines could be a characteristic of the genus, and an ecophenotypic variant of various species within that genus. We did not observe spines in any other species of the genus, however, and specimens with spines are most common in specimens with a morphology as *G. pyrula* (see also *G. ovata*).

Occurrence: This species is very rare to rare in the lower part of the Fortuna section and very rare to abundant in the rest of the Fortuna section.

Gyroidinoides girardanus (Reuss) 1851
Plate 7, figure 4

Rotalina girardana REUSS 1851, p. 73, pl. 5, fig. 34.
Gyroidina girardana (Reuss). – CUSHMAN and RENZ 1946, p. 44, pl. 7, fig. 20. – CUSHMAN and STONE 1949, p. 81, pl. 14, fig. 12. – CUSHMAN and STAINFORTH 1951, p. 158, pl. 27, fig. 24. – LEROY 1953, p. 35, pl. 5, fig. 10-12.
Gyroidinoides girardana (Reuss). – BECKMANN 1954, p. 382, pl. 23, fig. 23.
Gyroidinoides girardanus (Reuss). – SPEIJER 1994, p. 118, pl. 3, fig. 3. – ALEGRET and THOMAS 2001, p. 287, pl. 6, fig. 10.

Description: Test high trochospiral, planoconvex. Nearly circular in outline, periphery angular to sub-angular with a distinct angle at its dorsal edge. Apertural face somewhat concave. Dorsal side flattened, the last whorl slightly concave; ventral side convex with a deep open umbilicus. Chambers distinct, about 8 in the last whorl. Sutures somewhat depressed, nearly straight and radial. Test calcareous, smooth, perforate. Aperture a low interiomarginal slit extending from the umbilicus to the periphery.

Remarks: This species is easily distinguished from other *Gyroidinoides* species by its conspicuous concave apertural face and by the overhanging lower edges of the ventral chambers.

Occurrence: This species is very rare to rare in the Fortuna section .

Genus ***Hanzawaia*** Asano 1944

Species included in this genus have been classified alternatively in many different genera including *Anomalina*, *Boldia*, *Cibicides*, *Falsoplanulina*, *Florilus*, *Nautilus*, *Rotalia*, and *Truncatulina*. Some of them (*Florilus* and *Nautilus)* have been suggested to be synonyms of *Hanzawaia* (Loeblich and Tappan 1987). The genus is characterized by its thickened and strongly backwardly curved sutures, and umbilical apertural flaps.

Hanzawaia ammophila (Gümbel) 1868
Plate 7, figures 5-6

Rotalia ammophila GÜMBEL 1868, p. 652, pl. 2, fig. 90.
Cibicides cushmani NUTTALL 1930, p. 291, pl. 25, figs. 3, 5, 6. – CUSHMAN and RENZ 1948, p. 41, pl. 8, figs. 22, 23. – BERMÚDEZ 1949, p. 297, pl. 26, figs. 4-6. – CUSHMAN and STONE 1949, p. 83, pl. 14, fig. 26.
Hanzawaia cushmani (Nuttall). – TJALSMA and LOHMANN 1983, p. 32, pl. 17, fig. 1. – MACKENSEN and BERGGREN 1992, p. 620, pl. 3, figs. 1-4.
Hanzawaia ammophila (Gumbel). – SAPERSON and JANAL 1980, p. 401, pl. 5, figs. 1-3. – BERMÚDEZ and GÁMEZ 1966, p. 233, pl. 4, figs. 1-3. – VAN MORKHOVEN et al. 1986, p. 168, pl. 56, figs. 1-3. – MILLER and KATZ 1987a, p. 286, pl. 5, fig. 7-9. – MILLER and KATZ 1987b, p. 134, pl. 6, fig. 3.
Cibicidina cushmani (Nuttall). – BOLLI et al. 1994, p. 370, pl. 57, figs. 15,16.

Description: Test trochospiral, unequally biconvex to plano-convex, in plane view somewhat oval, periphery subacute. Dorsal side semi-evolute, flattened to slightly convex, with depressed umbilical area; one and a half whorl visible. Ventral side convex, involute; 9-11 narrow chambers in the last whorl, separated by limbate, raised, curved sutures. Wall calcareous, perforate between the sutures, non-perforate periphery. Aperture interiomarginal, extending onto the umbilicus, which is covered by umbilical flaps that are usually not well preserved.

Remarks: Hagn (1956) and Bermúdez and Gámez (1966) argued that *H. cushmani* (Nuttall) is a junior synonym of *H. ammophila* (Gümbel). Following Hagn (1956), and after examining topotypes and other comparative material of *Rotalia ammophila* Gümbel, van Morkhoven et al. (1986) agreed and considered *H. cushmani* to be a junior synonym o*f H. ammophila*. However, Tjalsma and Lohmann (1983) stated "*H. ammophila* shows a more rapidly uncoiling spire, which results in a flatter test than that in *H. cushmani"*. After looking at the type material of *H. cushmani* (CC 59514, 59513, USNM 369260, 369259) and at van Morkhoven et al.'s (1986) material (R/C# 56) we agree that *H. cushmani* is a junior synonym of *H. ammophila*.

Occurrence: *H. ammophila* is very rare to rare throughout the Fortuna section.

Hanzawaia bundensis (van Bellen) 1946
Plate 7, figure 7

Anomalina bundensis VAN BELLEN 1946, p. 73, pl. 11, fig. 1-3.

Description: Test trochospiral, periphery rounded to subacute. Dorsal side semi-evolute, flattened to slightly convex, central area somewhat depressed, consisting of two whorls. Ventral side involute, convex; about 9 distinct chambers visible; chambers somewhat inflated, especially the last one. Dorsal and ventral sutures curved, limbate and raised in earlier chambers, becoming depressed in last chambers. Wall calcareous, coarsely perforate. Aperture peripheral.

Remarks: Our specimens are very similar to *Hanzawaia bundensis* (van Bellen) 1946. We did not observe the peculiar dorsal side with raised ridges between the sutures, although the dorsal side is quite irregular in our specimens, probably due to preservation. These "pseudo-sutures" were not found in smaller specimens of the type material.

Occurrence: This species is very rare throughout the Fortuna section.

Hanzawaia cubensis (Cushman and Bermúdez) 1948
Plate 7, figure 8

Boldia cubensis CUSHMAN and BERMÚDEZ 1948, p. 74, pl. 11, figs. 15-16. – CUSHMAN 1951, p. 65, pl. 22, figs. 13-14.

Description: Test trochospiral, becoming nearly planispiral in the adult, periphery initially rounded, rapidly becoming conspicuously truncate. Both sides concave, but ventrally limited to the umbilical area; sub-circular in outline. Chambers distinct, 9-10 in the last whorl, gradually increasing in size as added, increasing more in height than in width. Ventral sutures distinct, slightly curved, nearly radial, somewhat limbate and raised in earlier chambers, depressed in later chambers. Wall calcareous, perforate. Aperture a low peripheral slit with a lip, extending onto the dorsal side.

Remarks: Our specimens have more chambers than those in the type description (6), but they have the same, very characteristic shape.

This species differs from others in the same genus by its conspicuously high and truncate transverse section. *H. bundensis* is the most coarser perforate *Hanzawaia* species in the section. *H. ammophila* is easily differentiated by its non-depressed, strongly curved sutures.

Occurrence: Very rare to common throughout the Fortuna section.

Genus ***Laevidentalina*** Loeblich and Tappan 1986

In his taxonomic revision of elongate and uniserial benthic foraminifera, Hayward (2002) did not follow the generic distinction (Loeblich and Tappan 1987) between costate (*Dentalina*) and smooth (*Laevidentalina*) elongate, arcuate test forms. However, we follow Loeblich and Tappan (1987) since we have used their taxonomy for generic determinations.

Laevidentalina elegans (d'Orbigny) 1846
Plate 7, figure 9

Dentalina elegans d'ORBIGNY 1846, p. 45, pl. 1, figs. 52-56. – KAASSCHIETER 1961, p. 175, pl. 7, fig. 17. – PAPP and SCHMID 1985, p. 28, pl. 10, figs. 1-5.
Dentalina pauperata d'ORBIGNY 1846, p. 46, pl. 1, fig. 57, 58. – PAPP and SCHMID 1985, p. 28, pl. 10, figs. 6-8. – BERMÚDEZ 1949, p. 144, pl. 9, fig. 45.
Nodosaria pauperata (d'Orbigny). – PLUMMER 1926, p. 79, pl. 4, fig. 11.

Description: Test elongate, stout, uniserial, arcuate. Initial part of the test rounded with a slender spine. Chambers distinct, moderately long, increasing slightly in length as added, last ones faintly inflated. Sutures distinct, straight or nearly so, at right angles to the long axis of the test, flush to raised in the

early portion, becoming constricted in the last part of the test. Wall calcareous, perforate, smooth. Aperture terminal, radiate.

Remarks: d'Orbigny (1846) stated that *L. pauperata* differs from *Laevidentalina elegans* (d'Orbigny) 1846 in being stouter and shorter. Papp and Schmid (1985) considered *L. pauperata* as a junior synonym of *L. elegans*, arguing that the specimens considered by d'Orbigny as *L. pauperata* were juvenile forms of *L. elegans*. Other authors (e.g., Kaasschieter 1961) noted that the two species were very similar; we agree with Papp and Schmid (1985) and consider them synonyms.

Occurrence: This species is abundant in the uppermost studied sample, For 35.

Genus ***Lenticulina*** Lamarck 1804

This group of planispiral, lenticular, and biumbonate specimens has traditionally been included in the genera *Cristellaria* and *Robulus*, among others (see Loeblich and Tappan 1987). The taxonomy of this genus is usually difficult due to a lack of ornamentation and distinctive characteristics in many morphotypes. See discussion under *L. yaguatensis* for differential analysis between the various species that we recognized.

Lenticulina clericii (Fornasini) 1895
Plate 8, figure 1

Cristellaria clericii FORNASINI 1895, p. 1; FORNASINI 1901-1902, p. 65, pl. 17.
Robulus clericii (Fornasini). – CUSHMAN and RENZ 1947, p.11, pl. 3, fig. 1.
Robulus clericii (Fornasini) var. *acies* CUSHMAN and RENZ 1947, p. 11, pl. 3, fig. 2. – RENZ 1948, p. 84, pl. 12, figs. 17, 17a.
Robulus clericii (Fornasini) var. *carinata* MARKS 1951, p. 42, pl. 5, fig. 9.

Description: Test nearly sub-circular, planispiral, biconvex; periphery acute with a keel. 4 to 8 distinct chambers in the last whorl. Sutures limbate, curved, becoming much more curved towards the center, sometimes reaching the next suture and fusing with the small boss; central part of test elevated. Wall calcareous, smooth. Aperture at the periphery, radiate with slit.

Remarks: The varieties *Robulus clericii* (Fornasini) var. *acies* Cushman and Renz (1947) and *Robulus clericii* (Fornasini) var. *carinata* Marks (1951) differ from the original species by the size of the test and in having a keel. Our specimens vary considerably in size, but all have a keel to at least some extent. We think that Fornasini (1895) may not have observed the keel due to bad preservation and we include both varieties in the nominate species. We searched the collection of Fornasini, but did not find a slide labelled *Cristellaria clericii*; the slides in the collection do not refer to specific publications, and Fornasini did not number his slides. We did find a slide containing 2 specimens, which had originally been labelled '*Cristellaria rotulata* lam. sp.', on which had been written later 'no *rotulata, clericii*'. We do not know at what time the later note had been made, but these specimens resemble ours strongly; they do not have a pronounced keel, but do have an imperforate band.

Occurrence: *L. clericii* is very rare to common in the Fortuna section.

Lenticulina cultrata (Montfort) 1808
Plate 8, figures 2-3

Robulus cultratus MONTFORT 1808 p. 215.
Robulina cultrata d'ORBIGNY 1846, p. 96, pl. 4, figs. 10-13.
Lenticulina cultrata (Montfort). – PAPP and SCHMID 1985, p. 41, pl. 28, figs. 4-7.

Description: Test planispiral, closely coiled, biconvex, biumbonate; periphery keeled. 6-9 chambers in the last whorl, increasing gradually in size as added. Sutures distinct, curved, somewhat limbate, becoming tangential to the edge of the central boss. Boss distinct, slightly elevated. Wall calcareous, smooth. Aperture radiate, at the periphery.

Remarks: Our specimens vary in the degree of compression of the test.

Occurrence: Very rare to common, the most abundant *Lenticulina* species in our material.

Lenticulina insulsa (Cushman) 1947
Plate 8, figure 4

Cristellaria orbicularis PLUMMER 1926, p. 92, pl.7, fig. 1.
Robulus insulsus CUSHMAN 1947, p. 83, pl. 18, figs. 2-3.
Lenticulina insulsa (Cushman). – BOLLI et al. 1994, p. 108, pl. 28, figs. 19, 20.

Description: Test compressed, planispiral, closely coiled; periphery acute with a small, transparent keel. Chambers 6-7 in the last whorl, of uniform shape, increasing gradually in size as added. Sutures strongly curved, slightly raised or flush with the surface. Umbonal region of clear shell material present, slightly elevated. Wall calcareous, smooth; aperture radiate, peripheral, slightly projecting.

Remarks: We checked the holotype (CC 54269), which overall agrees with our material.

Occurrence: Very rare to rare in the Fortuna section.

Lenticulina rotulata (Lamarck) 1804
Plate 8, figure 5

Lenticulites rotulatus LAMARCK 1804, p. 188, pl. 62, fig. 11.
Cristellaria rotulata (Lamarck). – CUSHMAN 1926, p. 599, pl. 19, fig. 4. – PLUMMER 1926, p. 91, pl. 7, fig. 8.
Lenticulina rotulata (Lamarck). – CUSHMAN 1931, p. 37, pl. 5, fig. 1. – CUSHMAN 1946, p. 56, pl. 18, fig. 19; pl. 19, figs. 1-7. – AGIP S.p.A. 1982, pl. 10, figs. 6.

Description: Test planispiral, closely coiled, lenticular; periphery acute to subacute, with a distinct keel. About 9-12 chambers visible, increasing gradually in size as added and uniform in shape. Sutures distinct, non-depressed, somewhat limbate, rather curved, gently tangential to the elevated umbo. Wall calcareous, smooth. Aperture radiate, peripheral.

Occurrence: This species is very rare to rare in the Fortuna section.

Lenticulina turbinata (Plummer) 1926
Plate 8, figures 6-7

Cristellaria turbinata PLUMMER 1926, p. 93, pl. 7, fig. 4; pl. 13, fig. 2.
Robulus turbinatus (Plummer). – CUSHMAN and TODD 1946, p. 47, pl. 7, fig. 11. – CUSHMAN 1951, p.14, pl. 4, figs. 6-9. – OLSSON 1960, p. 10, pl. 2, fig. 2.

Description: Test planispiral, round, biconvex; peripheral margin sharp and extended into a fragile keel that is typically ragged. Chambers 7-8 in final whorl, narrow, smooth. Sutures strongly elevated and of about equal width from the large umbonal area to the periphery, very strongly curved. Wall calcareous. Aperture at apex of narrow septal face, radiate.

Remarks: Our specimens differ from the original description by having a somewhat less compressed test.

Occurrence: This species is very rare to common in the Fortuna section.

Lenticulina velascoensis White 1928
Plate 8, figure 8

Lenticulina velascoensis WHITE 1928a, p. 199, pl. 28, fig. 8. – CUSHMAN 1946, p. 57, pl. 19, fig. 8. – BOLLI et al. 1994, p. 111, pl. 29, figs. 22, 23. – ALEGRET and THOMAS 2001, p. 290, pl. 8, fig. 12.

Description: "Test flattened, lenticular, with depressed umbos of clear shell material, through which chambers of the inner whorls may be seen; usually about ten chambers to the last whorl; sutures flush, curved; periphery keeled, denticulate due to the breaking; aperture oval, obscurely radiate" (White 1928a).

Remarks: We compared our specimens to the type material of White (1928a) and consider them to belong to the same species.

Occurrence: Very rare to rare in the Fortuna section.

Lenticulina williamsoni (Reuss) 1862
Plate 8, figure 9

Cristellaria williamsoni REUSS 1862, p. 327, pl. 6, fig. 4.
Robulus williamsoni (Reuss). – CUSHMAN 1931, p. 37, pl. 5, fig. 2. – CUSHMAN and JARVIS 1932, p. 22, pl. 6, fig. 7. – CUSHMAN 1941, p. 61, pl. 16, figs. 1, 2. – CUSHMAN 1946, p. 54, pl. 18, figs. 2, 3. – CUSHMAN and RENZ 1946, p. 25, pl. 3, fig. 20.

Description: Test planispiral biconvex; peripheral margin acute, with a distinct keel. Few chambers, very slightly inflated, increasing gradually in size as added except for the last one(s), becoming much higher than wide. Sutures curved, slightly raised. Wall calcareous, smooth; aperture radiate with a slit at the upper end of the apertural face, conspicuously concave with raised edges.

Occurrence: Very rare to rare in the Fortuna section.

Lenticulina yaguatensis (Bermúdez) 1949
Plate 8, figure 10

Robulus yaguatensis BERMÚDEZ 1949, p. 132, pl. 7, figs. 29, 30.
Lenticulina sp. cf. *Lenticulina yaguatensis* Bermúdez. – KAASSCHIETER 1961, p. 173, pl. 7, figs. 8-9.

Description: Test biconvex, closely coiled, circular in plane view; peripheral margin acute, non-keeled or very slightly keeled. 7-8 chambers visible, increasing gradually in size as added. Sutures broadly curved, flush with the surface; early chambers visible through the transparent umbo. Wall calcareous, smooth. Apertural terminal, radiate.

Remarks: *Lenticulina yaguatensis* is very similar to *L. velascoensis* White (1928a): both species have a conspicuous, transparent umbonal region through which many of the previously formed chambers can be seen. They are differentiated because *L. yaguatensis* is strongly biconvex and has on average fewer chambers in the last whorl; the last chambers of *L. velascoensis* are slightly coiled and its periphery is sharply keeled. *L. williamsoni* is the *Lenticulina* species with fewest chambers, and the only species with rapid chambers growing. *L. rotulata* is the *Lenticulina* species with most chambers. *L. turbinata* differs from *L. insulsa* by its conspicuously ragged keel. Its strongly curved sutures differentiate *L. insulsa* from other species. *L. clericii* also shows strongly curved sutures but these are stongly curved near the umbo. When the sutures between subsequent chambers nearly touch each other, these specimens may be confused with *L. cultrata*, which has straight sutures, becoming tangential to the edge of the central boss.

Occurrence: Very rare to common in the Fortuna section.

Lobatula lobatula (Walker and Jacob) 1798
Plate 9, figures 1-2

Nautilus lobatulus WALKER and JACOB 1798, p. 20, pl. 3, fig. 71.
Cibicides lobatulus (Walker and Jacob). – CUSHMAN 1935, p. 52, pl. 22, figs. 4-6. – KAASSCHIETER 1961, p. 221, pl. 14, fig. 5.
Lobatula lobatula (Walker and Jacob). – LOEBLICH and TAPPAN 1987, p. 168, pl. 637, figs. 10-13. – MATHELIN and SZTRÀKOS 1993, p. 81, pl. 17, fig. 9.

Description: Test trochospiral, concavo-convex, irregularly shaped, conspicuously lobulate in plane view; periphery sub-acute, slightly keeled. Spiral side concave, evolute, somewhat variable in shape; sutures slightly depressed to flush with the surface, marked by an imperforate band of calcite. Umbilical side irregular; the number of chambers per whorl varies; chambers variable in shape; sutures depressed, nearly radial. Wall calcareous, coarsely perforate on both sides. Aperture a slit, extending from the periphery along the spiral suture.

Remarks: This species shows considerable morphological variability, possibly due to its epiphytic mode of life and attachment of the spiral side.

Rögl and Hanssen (1984) revised the material of Fichtel and Moll (1798), and considered *Nautilus tuberosus* as a probable synonym of *L. lobatula*. The former species, however, has an imperforate (or very finely perforate) spiral side, whereas our specimens and *L. lobatula* are coarsely perforate on both sides.

Occurrence: This species is very rare to rare, except for samples For 3, 16,4 and 16,7 where it is common.

Loxostomoides applini (Plummer) 1926
Plate 9, figure 3

Bolivina applini PLUMMER 1926, p. 69, pl. 4, fig. 1.
Bolivina applinae Plummer. – GALLOWAY and MORREY 1929, p. 35, pl. 5, fig. 9.
Loxostomum applinae (Plummer). – NUTTALL 1930, p. 285, pl. 24, figs. 4, 5. – CUSHMAN and TODD 1946, p. 60, pl. 10, fig. 22. – CUSHMAN and BERMÚDEZ 1948, p. 71, pl. 11, fig. 10. – BERMÚDEZ 1949, p. 196, pl. 12, fig. 52. – CUSHMAN 1951, p. 43, pl. 12, fig. 18. – LEROY 1953, p. 37, pl. 8, fig. 1. – BERMÚDEZ 1963, p. 37, pl. 3, figs. 18, 19. – BERMÚDEZ and GÁMEZ 1966, p. 234, pl. 4, figs. 15, 16.
Loxostoma applinae (Plummer). – CUSHMAN 1937c, p. 173, pl. 20, fig. 20.
Loxostomoides applinae (Plummer). – VAN MORKHOVEN et al. 1986, p. 327, pl. 106, figs. 1-3. – BOLLI et al. 1994, p. 128, pl. 34, figs. 26, 27. – SPEIJER 1994, p. 46, pl. 4, fig. 3; p. 109, pl. 1, fig. 11; p. 148, pl. 8, figs. 1, 2. – REVETS 1996, p. 10, pl. 5, figs. 5-8.

Description: Test elongate, somewhat compressed, sub-oval in cross-sectional view, tapering towards the initial part of the test which is faintly pointed; periphery rounded. Early portion more compressed, ornamented with fine, broken longitudinal striae extending upward several chambers. Sutures between initial chambers distinct, not depressed; sutures between later chambers depressed and conspicuously crenulate. Chambers

biserially arranged, later ones somewhat inflated, usually followed by several uniserial chambers in the later portion of the test, faintly cuneate in shape. Wall calcareous, perforate. Aperture terminal, rounded.

Remarks: The main characteristics of this species are the crenulation of sutures between the chambers, and the longitudinal somewhat discontinuous striae.

The species is cited as *L. applinae* by most authors, because it was named after Applin, who was female, giving the feminine genitive form *applinae* rather than the masculine form *applini*. The original author, however, called the species *B. applini*, and this grammatically incorrect name thus must be maintained.

Occurrence: This species is very rare to rare in the Fortuna section.

Nonion affine (Reuss) 1851
Plate 9, figure 4

Nonionina affinis REUSS 1851, p. 72, pl. 5, fig. 32.
Nonion affine (Reuss). – KAASSCHIETER 1961, p. 203, pl. 11, figs. 3, 4. – NOMURA 1995, p. 291, pl. 3, fig. 14.
Melonis affinis (Reuss). – PROTO DECIMA and DE BIASE 1975, p. 109, pl. 5, figs. 19-21. – KUHNT et al. 2002, p. 148, pl. 10, fig. 20, 21.

Description: Test planispiral, almost completely involute, compressed; periphery rounded, nearly circular and not lobulate in outline, conspicuously biumbilicate. Eight to eleven chambers in the last whorl, slightly distinct, separated by distinct, slightly curved sutures that are flush with the surface. Wall calcareous, smooth, finely perforate. Aperture a low interiomarginal and equatorial slit at the base of the high apertural face.

Remarks: We have examined the topotype and comparative material of *N. affine* (CC 25578, 43152, 46944) at the Smithsonian and found them to be somewhat more laterally compressed and with a slightly larger, pustulate umbilicus than our material. However, we consider these differences not so large that our specimens should be assigned to another species. Our specimens, the topotypes, and the holotype as described by Reuss have open umbilici.

Occurrence: This species is very rare to rare.

Nonion havanense Cushman and Bermúdez 1937
Plate 9, figures 5-6

Nonion havanense CUSHMAN and BERMÚDEZ 1937, p. 19, pl. 2, figs. 13, 14. – CUSHMAN and RENZ 1948, p. 22, pl. 5, fig. 4. – BECKMANN 1954, p. 363, pl. 21, fig. 1. – TJALSMA and LOHMANN 1983, p. 17, pl. 7, fig. 6. – WOOD et al. 1985, pl. 5, figs. 9-10. – MILLER and KATZ 1987a, p. 287, pl. 2, fig. 13-14. – MILLER and KATZ 1987b, p. 136, pl. 4, fig. 7. – BOLLI et al. 1994, p. 151, pl. 41, figs. 14, 15.
Nonion havanensis Cushman and Bermúdez. – NOMURA 1995, p. 291, pl. 3, fig. 10.

Description: Test strongly compressed laterally, completely involute on both sides, nearly circular in outline; periphery rounded, non-lobulate. 8-10 chambers increasing gradually in size as added. Sutures flush to very slightly depressed, gently curved. Wall calcareous, smooth, perforate. Aperture a low interiomarginal and equatorial slit extending towards the umbilicus.

Remarks: The holotype and paratype of *N. havanense* (CC 23417, 23418) largely agree with our material. Specimens referred to this taxon show variability in the degree of lateral compression.

N. havanense differs from *N. affine* by its more compressed test, lack of umbilical depression, and lower apertural face.

Occurrence: This species is very rare in the Fortuna section.

Nuttallides truempyi (Nuttall) 1930
Plate 9, figures 7-8

Eponides trümpyi NUTTALL 1930, p. 287, pl. 24, figs. 9, 13, 14.
Asterigerina crassaformis CUSHMAN and SIEGFUS 1935, p. 94, pl. 14, fig. 10. – CUSHMAN and STONE 1949, p. 82, pl. 14, fig. 16. – CUSHMAN and STAINFORTH 1951, p. 159, pl. 27, figs. 34, 35.
Nuttallides subtrümpyi FINLAY 1939a, p. 521.
Nuttallides trümpyi (Nuttall). – BECKMANN 1954, p. 384, pl. 24, figs. 2-3. – BELFORD 1958, p. 94, pl. 18, figs. 1-13. – AGIP S.p.A. 1982, pl. 40, fig. 9.
Nuttallides truempyi (Nuttall). – TJALSMA and LOHMANN 1983, p. 17, pl. 6, fig. 4; pl. 17, figs. 4, 5; pl. 21, figs. 1-4. – WOOD et al. 1985, pl. 5, figs. 1-3. – VAN MORKHOVEN et al. 1986, p. 288, pl. 96A, figs. 1-4; pl. 96B, figs. 1-3; pl. 96C, figs. 1-4. – MÜLLER-MERZ and OBERHÄNSLI 1991, p. 167, pl. 3, fig. 21. – NOMURA 1991, p. 22, pl. 2, fig. 7. – MACKENSEN and BERGGREN 1992, p. 621, pl. 4, fig. 4-6. – NOMURA 1995, p. 291, pl. 3, fig. 1. – BOLLI et al. 1994, p. 370, pl. 58, figs. 2, 3. – SPEIJER 1994, p. 158, pl. 2, fig. 1. – WIDMARK 1997, p. 52, pl. 22, figs. G-I. – BIGNOT 1998, p. 436, pl. 4, figs. 1, 2. – ALEGRET and THOMAS 2001, p. 291, pl. 9, figs. 1-2.
Nuttallides crassaformis (Cushman and Siegfus). – BOLLI et al. 1994, p. 370, pl. 58, fig. 1.

Description: Test trochospiral, unequally biconvex, dorsal side flattened to slightly convex; ventral side strongly convex. Circular in plane view, periphery imperforate, rounded to sub-acute. Dorsal side evolute, 3 or 4 whorls visible; dorsal chambers distinct, long and narrow, sutures flush, curved and oblique. Ventral side involute, 7 to 9 ventral chambers visible in the last whorl, increasing gradually in size as added; ventral sutures distinct, radial, slightly depressed, with a distinct sub-angular sinuosity at approximately 1/3 of the distance between umbilicus and periphery, with a distinct boss of clear shell material, flattened to somewhat rounded. Wall calcareous, perforate on both sides, with the exception of the flange and boss. Aperture interiomarginal, a slit extending from the boss to the periphery, bordered by a slender lip.

Remarks: We examined the types of Nuttall (1930) (CC 59491, 59492, 59493), who did not designate a holotype among several type specimens. Van Morkhoven et al. (1986) designated as lectotype for the species (CC 59492), the specimen figured as # 13 by Nuttall. The specimen figured by Loeblich and Tappan (1987) is that lectotype. The latter figure, however, does not show a marked sub-angular sinuosity of the sutures, although this is the same specimen figured by van Morkhoven et al. (1986) who do show that sinuosity. We examined that specimen and noted the presence of the characteristic ridges in the four first chambers of the last whorl, reflecting the curve in the sutures. In our opinion, the best preserved specimen is CC 59493, but its last chamber is broken. Beckmann (1954) differentiated two basic morphotypes in *N. trümpyi* from the Eocene of the Oceanic Formation of Barbados. Our specimens match his high-domed morphotype, although we can find intermediate specimens. This domed morphotype is characterized by a nearly plano-convex morphology with 6-9 chambers; small umbilical mass; larger proloculus; and a shorter coil (3-4 whorls) than the other, lenticular, morphotype. We consider the domed morphotype as conspecific with the type material of the species *Nuttallides crassaformis* (Cushman and Siegfus), after examin-

ing its holotype and paratypes (CC 22358, 22359). Thus we agree with van Morkhoven et al. (1986) that the latter species is a junior synonym of *N. trümpyi*.

In addition, we studied several paratypes of *N. subtrümpyi* (CC 26780, USNM 689080). We think that these specimens are not significantly different from specimens of *N. trümpyi*, in agreement with Belford (1958).

Occurrence: This species is very rare to rare in the Fortuna section.

Oridorsalis umbonatus (Reuss) 1851
Plate 9, figure 9

Rotalina umbonata REUSS 1851, p. 75, pl. 5, fig. 35.
Rotalia umbonata (Reuss). – GALLOWAY and MORREY 1929, p. 26, pl. 4, fig. 1.
Eponides umbonatus (Reuss). – COLE 1928, p. 15, pl. 2, fig. 6. – BERMÚDEZ 1949, p. 249, pl. 17, figs. 22-24. – CUSHMAN and STONE 1949, p. 81, pl. 14, fig. 13. – KAASSCHIETER 1961, p. 211, pl. 13, fig. 1.
Eponides umbonata (Reuss). – NUTTALL 1932, p. 26, pl. 6, figs. 4, 5.
Oridorsalis umbonatus (Reuss). – TJALSMA and LOHMANN 1983, p. 18, pl. 6, fig. 8. – BOLLI et al. 1994, p. 370, pl. 58, figs. 10-13. – ALEGRET and THOMAS 2001, p. 291, pl. 9, figs. 8-9. – SZAREK 2001, p. 144, pl. 24, fig. 1, 2.

Description: Test trochospiral, unequally biconvex; periphery sub-acute; plane view slightly lobulate. Dorsal side evolute, convex, in some specimens with the exception of the outer whorl which is commonly flat and lower than the central part; chambers narrow and low, separated by distinct sutures, at right angles to the spiral suture, straight to faintly curved. Ventral side usually more convex than the spiral one; 5 to 6 chambers in the last whorl. Ventral sutures radial, straight except for a sinuous curve close to the umbo. Wall calcareous, smooth, finely perforate. Aperture a slit at the inner margin of the last chamber, near the periphery, with a slight lip. Secondary apertures present at the intersection of spiral and intercameral sutures on the spiral side could be seen in some specimens only.

Occurrence: Very rare to common in the Fortuna section.

Genus ***Osangularia*** Brotzen 1940

Many of the species included in this genus where originally included in the genus *Parrella* Finlay 1939a, which is now replaced by *Osangularia* Brotzen 1940, since the former generic name was used earlier for a fish genus, *Parrella* Ginsburg 1938.

Osangularia dominicana (Bermúdez) 1949
Plate 10, figures 1-2

Parrella dominicana BERMÚDEZ 1949, p. 272, pl. 21, figs. 4-6.

Description: Test trochospiral, biconvex, lenticular. Usually both sides about equally convex, but in some specimens the involute side is more convex. The sutures on the spiral side are sharply angled with respect to the periphery; about 3 whorls are visible. The wall on the spiral side is covered by thick, glassy calcite, most pronouncedly in the initial part. On the involute side, chamber sutures are slightly curved; there is a pronounced glassy boss in the center. Periphery sub-acute, may have imperforate rim but no true keel. Wall calcareous, smooth, perforate. Aperture is a slit along the base of the apertural face, extending up as a loop-shaped opening into the apertural face, bordered by imperforate rim.

Remarks: The holotype and paratypes (CC 62620, 62621) of *O. dominicana* were studied at the Smithsonian Institution. Our specimens are very similar to them, although most of them have one less whorl, somewhat less oblique sutures, a somewhat less convex dorsal side, and are slightly more coarsely perforate.

O. dominicana is easily distinguished from other *Osangularia* species by its thick dorsal overgrowth of calcite, and oblique dorsal sutures.

Occurrence: This species is very rare to abundant in the Fortuna section.

Osangularia plummerae Brotzen 1940
Plate 10, figure 4

Truncatulina culter (Parker and Jones). – PLUMMER 1926, p. 147, pl. 10, fig. 1; pl. 15, figs. 2.

PLATE 1
All scale bars 100µm unless otherwise indicated.

1-5 *Clavulinoides angularis* (d'Orbigny). 1, sample For 2, side view; 2, sample For 4, side view; 3, sample For 4, side view; 4, sample For 19,5, side view; 5, sample For 1, 5a, side view; 5b, apertural face.

6,7 *Dorothia cylindracea* Bermúdez, sample For 2. 6, side view, 7, juvenile form, front view.

8 *Gaudryina abuillotensis* Bermúdez, sample For 35. 8a, front view, 8b, side view.

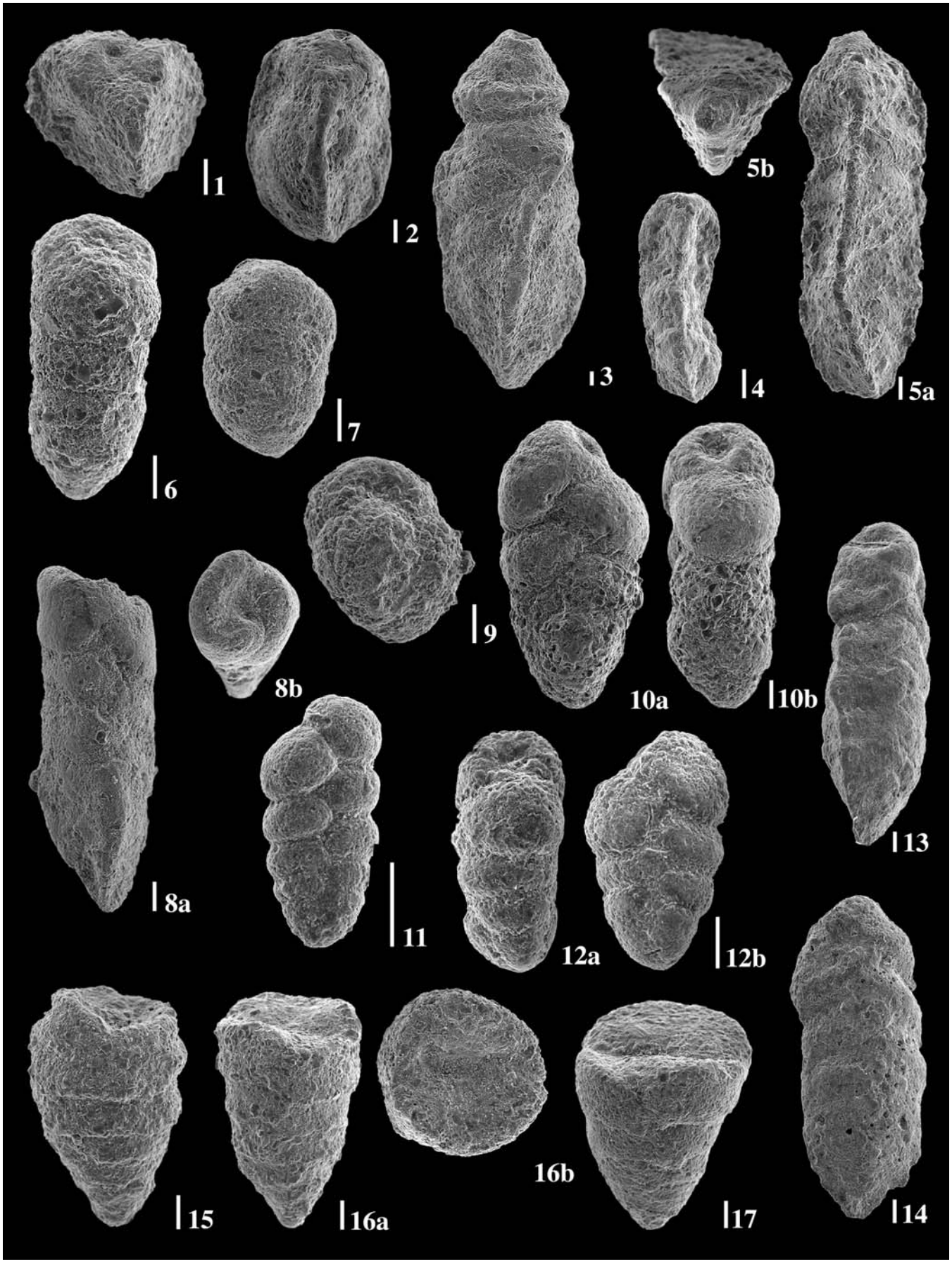
9-10 *Gaudyrina arenata* (Cushman), sample For 4. 9, juvenile form, side view; 10a, front view; 10b, side view.

11-12 *Gaudryina concinna* (Reuss). 11, sample For 18, front view; 12 sample For 4, 12a, side view; 12b, front view.

13,14 *Gaudryina longa* Bermúdez, sample For 35. 13, side view; 14, front view.

15-16 *Marssonella floridana* Applin and Jordan. 15, sample For 19, side view; 16 sample For 10,3; 16a, side view; 16b, apertural face.

17 *Marssonella trinitatensis* Cushman and Renz, sample For 17,5, side view.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Osangularia plummerae BROTZEN 1940, p. 30, text-fig. 8. – SPEIJER 1994, p. 56, pl. 7, fig. 5. – ALEGRET and THOMAS 2001, p. 292, pl. 9, fig. 11.
Parrella expansa TOULMIN 1941, p. 604, text-figs. 3, 4F, G.
Parrella desertorum LEROY 1953, p. 43, pl. 3, fig. 17-19.

Description: Test trochospiral, nearly equally biconvex, sub-circular in outline. Periphery sharply acute, with a distinct flat, imperforate keel. Dorsal side evolute, slightly to moderately convex; chambers increasing gradually in size as added except for those in the last whorl which increase rather rapidly in size; sutures broad, limbate, oblique, curved, flush to slightly elevated. Ventral side convex, with a distinct small ventral boss; 7 to 9 chambers visible. Ventral sutures distinct, radial, curved, limbate, becoming depressed between the last chambers, usually somewhat sigmoid. Wall calcareous, smooth. Aperture usually difficult to see, consisting of a low arched opening in the ventral face, and another slit, angled to the first one, extending into the ventral face, toward the umbilical area.

Remarks: Following Alegret and Thomas (2001), we consider *Parrella expansa* as an objective synonym of *O. plummerae*. We examined its paratypes (CC 38531) at the Smithsonian Institution. They clearly show the distinct sharp, somewhat ragged, transparent keel that is wider than that in most specimens in our material. They are somewhat flatter than most of our specimens.

We have observed several ones with an extremely convex dorsal side, which we consider tentatively as a different species related to *O. plummerae* (*O.* cf. *O. plummerae*).

We also examined the holotype of *O. desertorum* (CC 58028). It closely resembles our material and does not differ significantly from the paratypes of *O. expansa*, showing the conspicuous keel, limbate spiral and intercameral sutures, and relatively flat test.

Occurrence: This species is very rare to common in the Fortuna section.

Osangularia cf. ***O. plummerae*** Brotzen 1940
Plate 10, figure 3

Osangularia plummerae BROTZEN 1940, p. 30, text-fig. 8.

Description: The specimens included in this species mainly differ from *O. plummerae* by their more strongly convex dorsal side (see *O. plummerae*).

Occurrence: These specimens are very rare to rare in the Fortuna section.

Pararotalia audouini (d'Orbigny) 1850
Plate 10, figure 5

Rotalia audouini D'ORBIGNY 1850, p. 407, pl. 2, figs. 9-10. – KAASSCHIETER 1961, p. 241, pl. 16, figs. 8-10.
Pararotalia subinermis? BATHIA 1955, p. 683, pl. 67, fig.3.
Pararotalia audouini (d'Orbigny). – MURRAY and WRIGHT 1974, p. 120, pl. 11, figs. 8-10. – MATHELIN and SZTRÀKOS 1993, p. 83, pl. 42, fig. 12.

Description: Test trochospiral, biconvex, compressed, usually the ventral side somewhat more convex; in some specimens the dorsal side is flat. Periphery sub-acute, with imperforate keel, ornamented with spines usually broken or eroded, becoming lobulate in the last chambers. Dorsal side evolute, about two whorls visible; sutures not depressed, slightly curved, limbate. Ventral side involute, 7 to 10 nearly triangular chambers in the last whorl separated by distinct, strongly depressed, radial sutures. Elevated and prominent umbo, surrounded by a distinct furrow. Wall calcareous, finely perforate. Aperture a small slit at the base of the umbilical face.

Remarks: Murray and Wright (1974) proposed that *Pararotalia subinermis* Bhatia 1955 is a synonym of *P. audouini*. The original description by Bathia is in complete agreement with our material, but we have not seen the type material of this species. We therefore tentatively agree with Murray and Wright (1974) that *P. subinermis* may be a synonym of *P. audouini*.

Occurrence: This species is abundant in sample For 35, rare in a few other samples.

Planulina cooperensis Cushman 1933
Plate 10, figure 6

PLATE 2

All scale bars 100µm unless otherwise indicated.

1 *Pseudoclavulina* sp. A, sample For 5, side view.

2,3 *Pseudoclavulina trinitatensis* Cushman and Renz. 2, sample 10,3, side view; 3, sample For 4, side view.

4-5 *Spiroplectinella carinata* (d'Orbigny). 4, sample For 18; 4a, front view; 4b, apertural face; 5, sample For 4, front view.

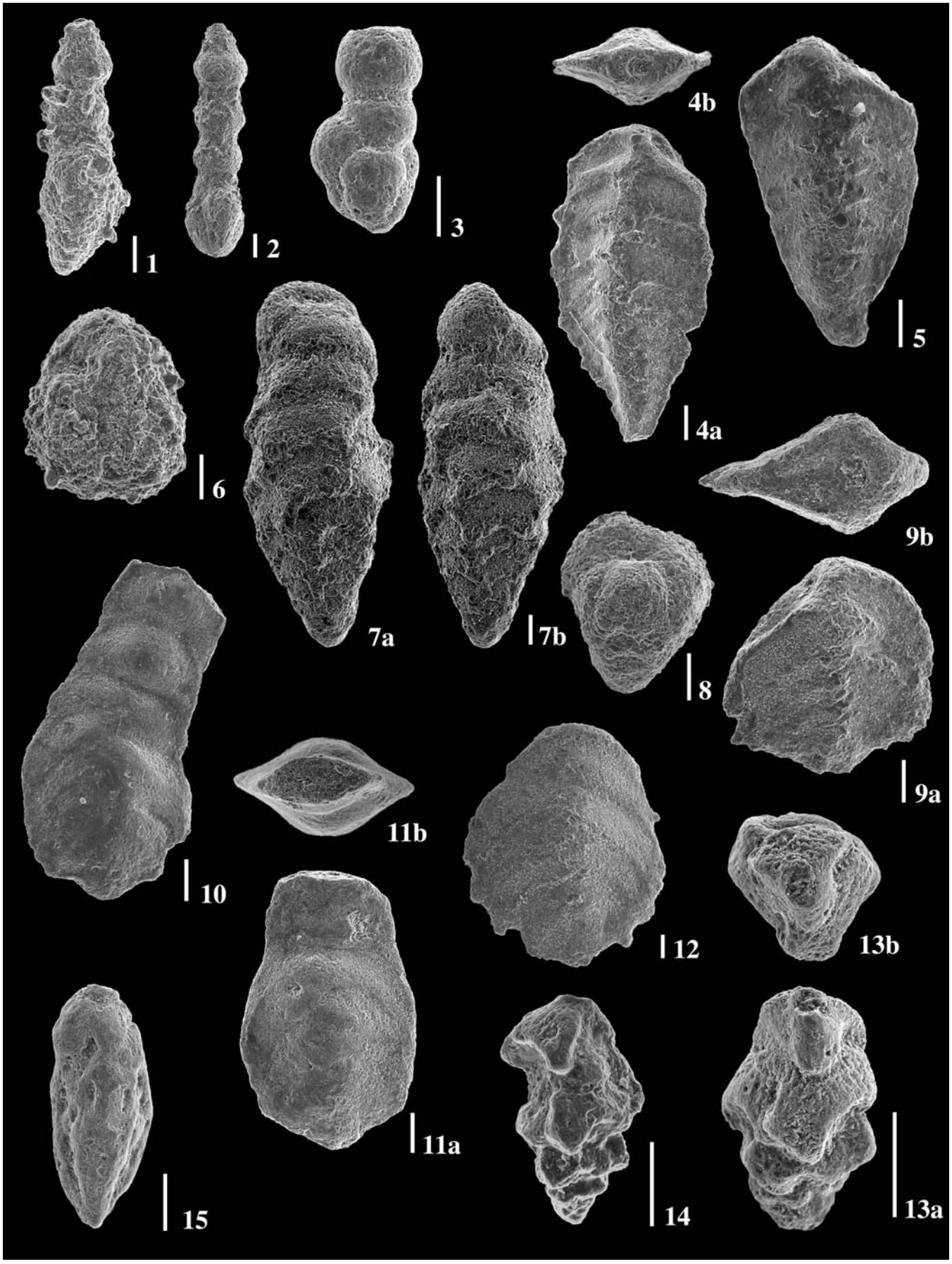
6 *Thalmannammina subturbinata* (Grzybowski), sample For 10, side view.

7-8 *Tritaxilina caperata* (Brady). 7, sample For 10; 7a, side view; 7b, front view; 8, sample For 7,3, juvenile form, side view.

9-12 *Vulvulina advena* Cushman. 9, sample For 19; 9a, front view; 9b, apertural face; 10, sample For 4, front view; 11, sample For 4; 11a, front view; 11b, apertural face; 12, sample For 19, front view.

13-14 *Angulogerina muralis* (Terquem), sample For 2; 13a, side view; 13b, apertural face; 14, side view.

15 *Angulogerina* sp. A, sample For 9, side view.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Planulina cocoaensis Cushman *var. cooperensis* CUSHMAN 1933, p. 20, pl. 2, fig. 12.
Planulina cooperensis Cushman. – BANDY 1949, p. 113, pl. 21, fig. 1.

Description: Test strongly compressed, fully evolute on one side, almost fully evolute on the other side, periphery truncate. Chambers numerous, about 10 in the last whorl, separated by limbate, curved, imperforate sutures, becoming depressed at the last chambers. Wall calcareous, smooth, perforate. Aperture broken in all the studied material.

Remarks: This species is distinguished from other *Planulina* species by its extremely compressed test.

Occurrence: Very rare to rare in the Fortuna section.

Planulina subtenuissima (Nuttall) 1928
Plate 10, figures 7-8

Anomalina subtenuissima NUTTALL 1928, p. 100, pl. 7, figs. 13, 15; p. 100, tex-fig. 6.
Planulina subtenuissima (Nuttall). – VAN MORKHOVEN et al. 1986, p. 198, pl. 67A, figs. 1, 2; pl. 67B, figs. 1-2. – BOLLI et al. 1994, p. 369, pl. 57, fig. 9

Description: Test low trochospiral, compressed, discoidal, periphery truncate. Ventral side very slightly convex, involute; about 10 chambers visible, increasing rapidly in size as added, separated by depressed, curved sutures; ventral surface with a distinct, central, circular boss of clear shell material. Dorsal side flat, semi-evolute, 2 whorls visible, the central part obscured by an overgrowth of shell material. Sutures on both sides distinct, strongly curved, limbate, becoming more depressed as more chambers are added. Wall calcareous, finely perforate. Aperture hardly visible, a small interiomarginal slit.

Remarks: Our specimens match the original description of *P. subtenuissima* well, although our specimens appear to be somewhat less perforate. This difference may be due to the poorer state of preservation of our specimens.

Specimens referred to this taxon vary in the size of the ventral boss. Specimens with a small boss are very similar to *Planulina costata* (Hantken) 1875, but this species has a small umbonal ventral depression.

Occurrence: These specimens are very rare to abundant, the latter only in sample For 16,4.

Pullenia jarvisi Cushman 1936
Plate 10, figure 9

Pullenia jarvisi CUSHMAN 1936b, p. 77, pl. 13, fig. 6. - BOLLI et al. 1994, p. 152, pl. 42, figs. 1-3. – WIDMARK 1997, p. 56, pl. 25, figs. E, F. – ALEGRET and THOMAS 2001, p. 298, pl. 10, fig. 6.
Pullenia quinqueloba (Reuss). – CUSHMAN and JARVIS 1932, p. 49, pl. 15, fig. 4. – KAASSCHIETER 1961, p. 202, pl. 11, fig. 2 (non Reuss).

Description: Test planispiral, compressed, fully involute; periphery rounded, lobulate in plan view. 5 to 6 chambers in the final whorl, inflated, increasing rapidly in size and rather uniformly triangular in shape. Sutures distinct, depressed, radial, sometimes slightly curved towards the umbo. Wall calcareous, smooth; aperture an elongate slit extending from one umbilicus to the other, usually filled with sediment due to its concave apertural face.

Remarks: The last chamber of these specimens is usually broken or compressed.

We examined the holotype (CC 15459) at the Smithsonian Institution, which also has a broken last chamber. Our specimens strongly resemble the holotype. The slide with the holotype of *P. jarvisi* had a note indicating that there was also a plesiotype of *Pullenia quinqueloba* Reuss, but Alegret and Thomas (2001) were of the opinion that this specimen was *P. jarvisi*.

Occurrence: This species is very rare in the Fortuna section.

Pullenia quinqueloba (Reuss) 1851
Plate 10, figure 10

Nonionina quinqueloba REUSS 1851, p. 71, pl. 5, fig. 31.
Pullenia quinqueloba (Reuss). – PLUMMER 1926, p. 136, pl. 8, fig. 12. – COLE 1927, p. 32, pl. 5, fig. 15.-GALLOWAY and MORREY 1929, p. 44, pl. 6, fig. 17. – TOULMIN 1941, p. 607, pl. 81, fig. 24. – CUSHMAN and TODD 1943, p. 10, pl. 2, fig. 5; pl,3, fig. 8. – BERMÚDEZ 1949, p. 276, pl. 21, figs. 32, 33. – CUSHMAN 1951, p. 59, pl. 17, fig. 6. – KAASSCHIETER 1961, p. 202, pl. 11, fig. 1. – MURRAY and WRIGHT 1974, p. 120, pl. 18, figs. 13,14- TJALSMA

PLATE 3
All scale bars 100µm unless otherwise indicated.

1-2 *Anomalinoides acutus* (Plummer). 1, sample For 33; 1a, ventral view; 1b, peripheral view; 1c, dorsal view; 2, sample For 17,5; 2a, ventral view; 2b, peripheral view, 2c, dorsal view.

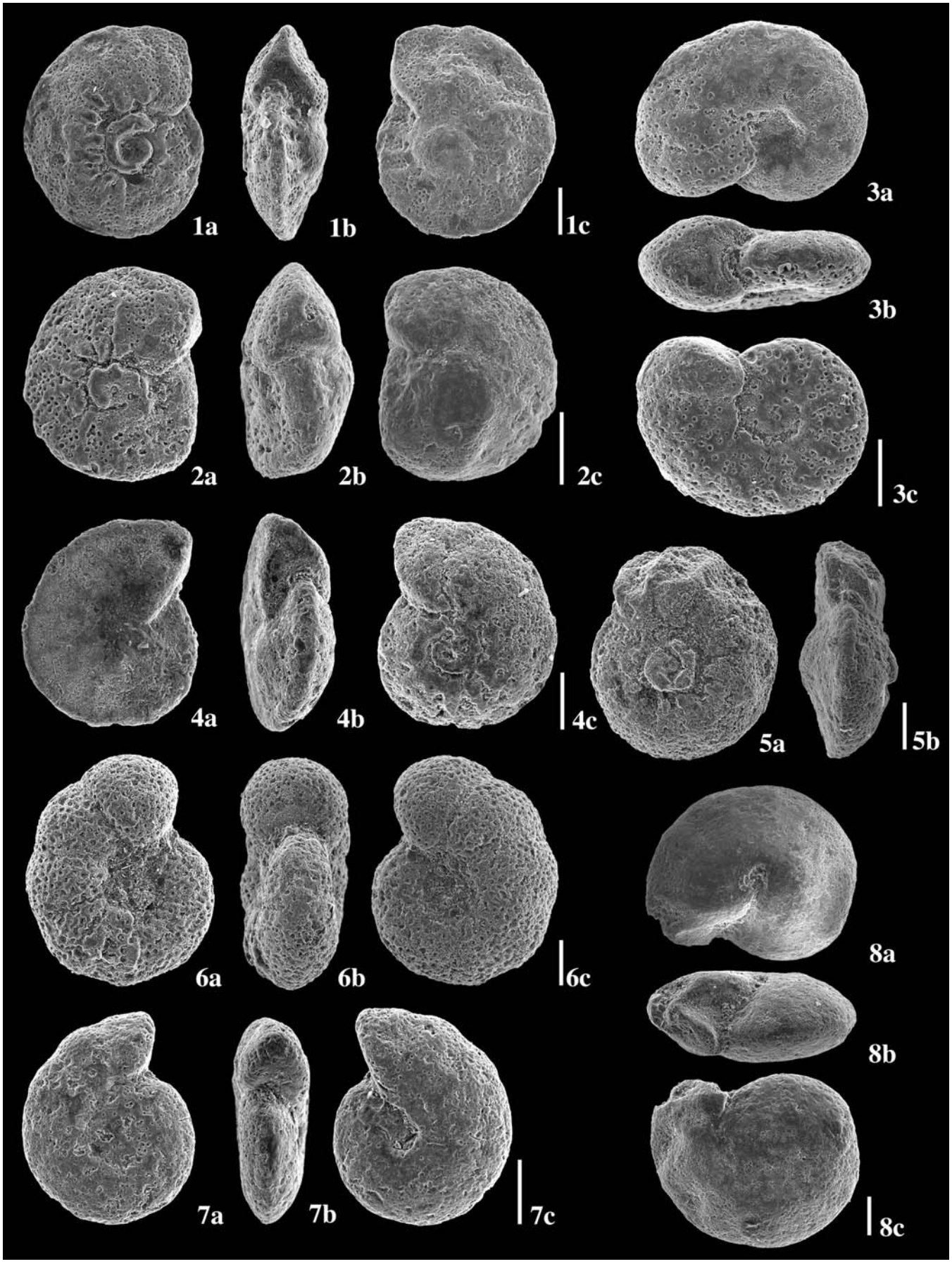
3 *Anomalinoides alazanensis* (Nuttall), sample For 17,5; 3a, ventral view; 3b, peripheral view; 3c, dorsal view.

4-5 *Anomalinoides* cf. *A. cocoaensis* (Cushman). 4, sample For 4; 4a, dorsal view; 4b, peripheral view; 4c, ventral view; 5, sample For 18,5; 5a, ventral view; 5b, peripheral view.

6 *Anomalinoides* cf. *A. capitatus* (Gümbel), sample For 7,3; 6a, ventral view; 6b, peripheral view; 6c, dorsal view.

7 *Anomalinoides spissiformis* (Cushman and Stainforth), sample For 17,5, 7a, ventral view; 7b, peripheral view; 7c, dorsal view.

8 *Anomalinoides* cf. *A. spissiformis* (Cushman and Stainforth), sample For 4, 8a, ventral view; 8b, peripheral view; 8c, dorsal view.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and LOHMANN 1983, p. 36, pl. 16, fig. 2. – KUHNT et al. 2002, p. 152, pl. 12, figs. 18-20.

Description: Test planispiral, closely coiled, fully involute, somewhat compressed. Periphery very slightly lobulate to smooth, peripheral margin broadly rounded. Chambers 5 to 6 in the last whorl, increasing gradually in size as added; sutures slightly depressed, nearly straight. Wall calcareous, smooth; aperture a long narrow slit extending over the periphery at the base of apertural face from umbilici to umbilici.

Remarks: Some authors (Bermúdez 1949; Tjalsma and Lohmann 1983) included in this species only specimens with four chambers according to their description, although they show six-chambered specimens in their figures.

P. jarvisi is distinguished from *P. quinqueloba* by its distinct concave apertural face, more depressed sutures, more lobulate periphery and thus more inflated chambers. Some specimens, however, are difficult to assign to one or the other species.

Occurrence: Very rare in the Fortuna section.

Quadrimorphina allomorphinoides (Reuss) 1860
Plate 11, figure 1

Valvulina allomorphinoides REUSS 1860, p. 223, pl.11, fig. 6.
Discorbis allomorphinoides (Reuss). – CUSHMAN 1926, p. 606, pl. 20, figs. 18-19; pl. 21, fig. 5. – PLUMMER 1926, p. 139, pl. 9, fig. 2.
Valvulineria allomorphinoides (Reuss). – CUSHMAN 1931, p. 43, pl. 6, fig. 2. – CUSHMAN 1951, p. 50, pl. 14, figs. 8-9.
Quadrimorphina allomorphinoides (Reuss). – BOLLI et al. 1994, p. 153, pl. 42, figs. 14, 15. – WIDMARK 1997, p.59, pl. 26, figs. F, G. – ALEGRET and THOMAS 2001, p. 298, pl. 10, fig. 7.

Description: Test trochospiral, biconvex, oval; periphery broadly rounded. Chambers somewhat distinct, about 4 visible in the last whorl at the ventral involute side, increasing rapidly in size as added, with a large final embracing chamber. Sutures slightly depressed, faintly curved. Test calcareous, smooth, glistening. Aperture a low interiomarginal slit below an overlapping umbilical flap.

Remarks: Specimens referred to this taxon are distinguished from other *Quadrimorphina* species by their elongate final chamber and distinct umbilical lip. In our material some specimens are compressed, changing their overall shape.

Occurrence: This species is very rare to abundant, the latter only in sample For 13,5.

Reussella oberburgensis (Freyer) 1864
Plate 11, figure 2

Verneuilina oberburgensis FREYER 1864, p. 6, pl. 1, fig. 2.
Reussella limbata (Terquem). – KAASSCHIETER 1961, p. 192, pl. 8, figs. 20, 21; pl. 9, fig. 10.
Reussella oberburgensis (Freyer). – CUSHMAN 1945, p. 26, lám. 5, fig. 7. – MATHELIN and SZTRÀKOS 1993, p. 79, pl. 34, fig. 27.

Description: Test triserial, elongate, increasing gradually in diameter from the pointed initial end, greatest width just below the apertural part of the test. Test triangular in cross section, with slightly concave sides, peripheral angles obtuse, sometimes angular with projecting small spines at the lower end of the chambers. Chambers distinct, not inflated. Sutures distinct, faintly curved, flush or depressed. Wall calcareous, smooth, coarsely perforate. Aperture a slit at the base of the last chamber, at the base of the flat or concave apertural face; last chamber(s) commonly broken.

Remarks: Several plesiotypes collected by Cushman (1945) were examined at the Smithsonian Institution (CC 44125, 44126); these show the distinctly concave sides characteristic for this species and strongly resemble our specimens.

Occurrence: Very rare to rare in the Fortuna section.

PLATE 4
All scale bars 100µm unless otherwise indicated.

1-3 *Aragonia aragonensis* (Nuttall). 1, sample For 11,3, front view; 2, sample For 11,3; 2a, front view; 2b, apertural face; 3, sample For 12,5; 3a, front view; 3b, apertural face.

4 *Asterigerina brencei* Haque, sample For 35; 4a, dorsal view; 4b, peripheral view; 4c, ventral view.

5-6 *Asterigerina fimbriata* Todd, sample For 16,4; 5a, dorsal view; 5b, peripheral view; 5c, ventral view; 6a, ventral view; 6b, peripheral view; 6c, dorsal view.

7-8 *Bolivina nobilis* Hantken. 7, sample For 17,5; 7a, front view; 7b, apertural face; 8, sample For 12,5, front view.

9-10 *Bolivinoides crenulata* (Cushman). 9, sample For 13,5; 9a, front view; 9b, apertural face; 10, sample For 7,3, front view.

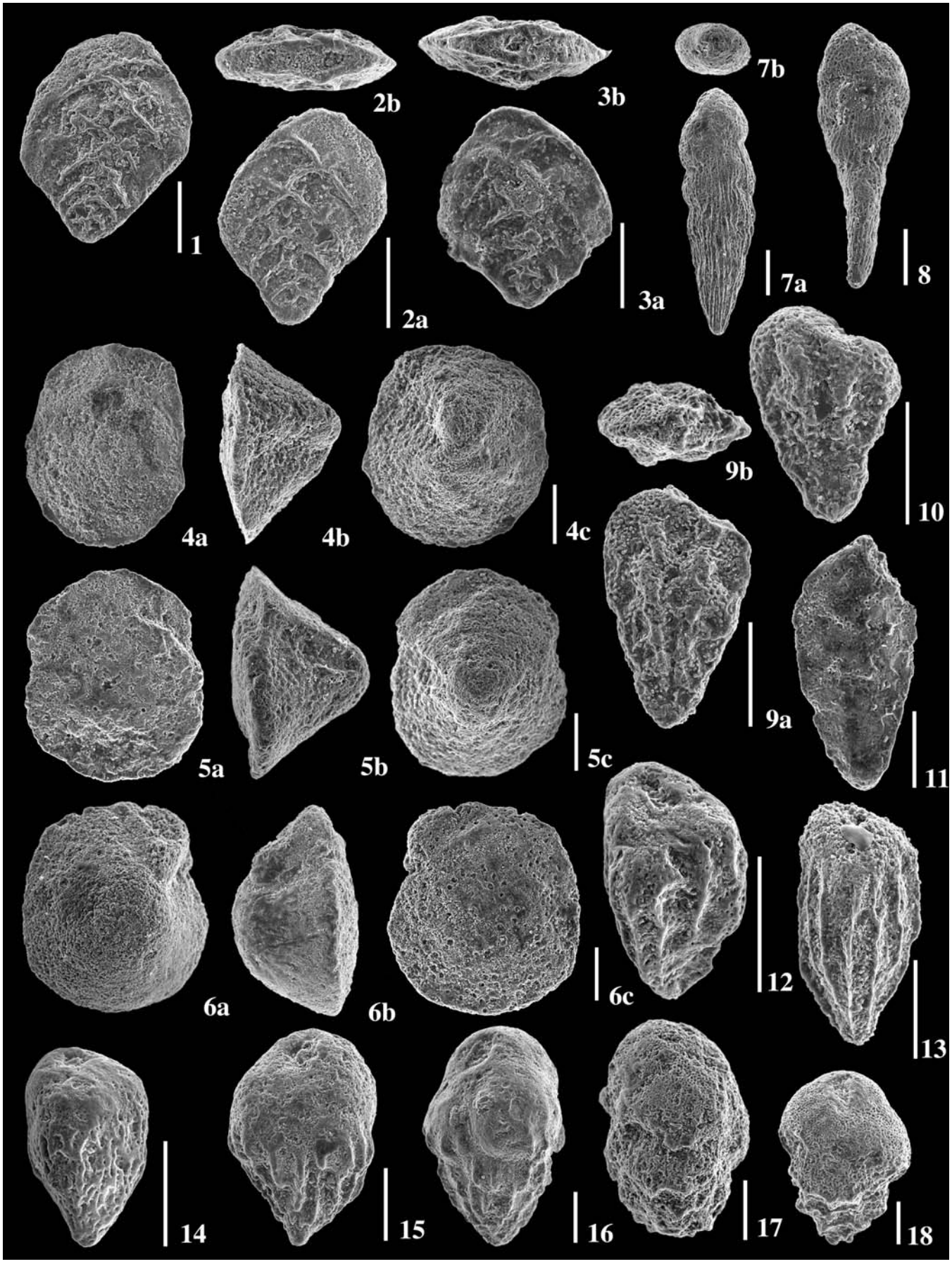
11 *Brizalina carinata* (Terquem), sample For 33, front view.

12, 13 *Bulimina alazanensis* Cushman. 12, sample For 3, side view; 13, sample For 6, side view.

14 *Bulimina semicostata* Nuttall, sample For 7,3, side view.

15, 16 *Bulimina mexicana* Cushman. 15, sample For 2, side view; 16, sample For 4, side view.

17, 18 *Bulimina trinitatensis* Cushman and Jarvis. 17, sample For 14,5, side view; 18, sample For 4, side view.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Siphogenerinoides eleganta (Plummer) 1926
Plate 11, figures 3-4

Siphogenerina eleganta PLUMMER 1926, p. 126, pl. 8, figs. 1a-c.
Siphogenerinoides eleganta (Plummer). – CUSHMAN and TODD 1946, p. 59, pl. 10, fig. 18. – CUSHMAN and BERMÚDEZ 1948, p. 71, pl. 11, fig. 9. – LEROY 1953, p. 49, pl. 2, fig. 20, 21. – OLSSON 1960, p. 31, pl. 4, fig. 24.

Description: Test elongate, first part biserially arranged, usually shorter than the uniserial last part with cuneate chambers. Chambers distinct, broad, low, and inflated, especially the last ones, separated by distinct, constricted sutures. Wall calcareous, coarsely perforate, less coarsely perforate over the upper surface of the chamber. Ornamented with irregular longitudinal striations, usually present only on the biserial part of the test. Aperture terminal, elliptical, bordered by a rim.

Remarks: We examined specimens of *S. eleganta* at the Smithsonian Institution, including those described by LeRoy (1953) and Cushman and Todd (1946) (CC 58014, 46399). These specimens strongly resemble our specimens and are in agreement Plummer's description.

Almost all our specimens show a well developed uniserial part, which is much rarer in Plummer's material according to her description (see *S. kugleri* for differential analysis).

Occurrence: Very rare to rare in the Fortuna section.

Siphogenerinoides kugleri (Cushman and Renz) 1941
Plate 11, figure 5

Siphogenerina kugleri CUSHMAN and RENZ 1941, p. 22, pl. 3, fig. 23. – CUSHMAN and RENZ 1947, p. 31, pl. 7, fig. 4. – BOLLI et al. 1994, p. 346, pl. 78, fig. 46.

Description: Test elongate, circular in transverse view, initial part of the test rounded. Early stage biserial, gradually tapering, uniserial later stage with sides nearly parallel. Chambers numerous, distinct, adult ones broad and low, slightly inflated; sutures distinct, adult ones straight and horizontal, slightly depressed, somewhat crenulated. Wall calcareous, perforate, ornamented with longitudinal, sometimes anastomizing ribs throughout the test, getting thinner or fading out towards the apertural part of the test. Aperture terminal, central, rounded.

Remarks: We examined the holotype and paratypes of *S. kugleri* (CC 35911, 45966) which have somewhat thinner and more numerous ribs than our specimens. The type material shows the aperture with a cylindrical neck; in our specimens these appear to be broken off.

This species differs from *S. eleganta* by the ribs that are continuous throughout the specimen, less depressed sutures, the basal crenulation of the last chambers, and the much shorter and less well visible biserial part of the test.

Occurrence: This species is very rare to abundant, the latter only in sample For 6,5.

Genus ***Siphonodosaria*** Silvestri 1924

Hayward (2002) considers the genus *Siphonodosaria* and the genus *Nodogenerina* Cushman 1927a to be congeneric, since "both type species share the same apertural features", and the strong morphological variability within populations makes it impossible to separate the species into two genera. Jones (1994) regards the genus *Siphonodosaria* as a junior synonym of *Stilostomella* Guppy 1894, whereas Hayward (2002) keeps the genus name *Stilostomella* "for specimens which are pustulose, hispid or finely spinose over the entire test and neck" and other morphological and apertural characteristics. We include in the genus *Siphonodosaria* all uniserial specimens with a rounded aperture, produced on a slight neck.

Siphonodosaria annulifera (Cushman and Bermúdez) 1936
Plate 11, figure 6

Ellipsonodosaria annulifera CUSHMAN and BERMÚDEZ 1936, p. 28, pl. 5, figs. 8, 9.
Stilostomella annulifera (Cushman and Bermúdez). – BECKMANN 1954, p. 370, pl. 21, fig. 23.

Description: Test elongate, uniserial, slender, gently curved and slightly tapering, with a distinct initial spine, usually broken. Chambers distinct, increasing gradually in size as added, very slightly inflated except the last ones. Sutures very distinct, very broad and transparent, initially slightly raised but becoming more depressed towards the later chambers. Wall calcareous, perforate, smooth. Aperture terminal, elliptical, at the end of a short neck.

PLATE 5
All scale bars 100µm unless otherwise indicated.

1 *Cibicidoides* cf. *C. dutemplei* (d'Orbigny), sample For 35; 1a, dorsal view; 1b, peripheral view; 1c, ventral view.

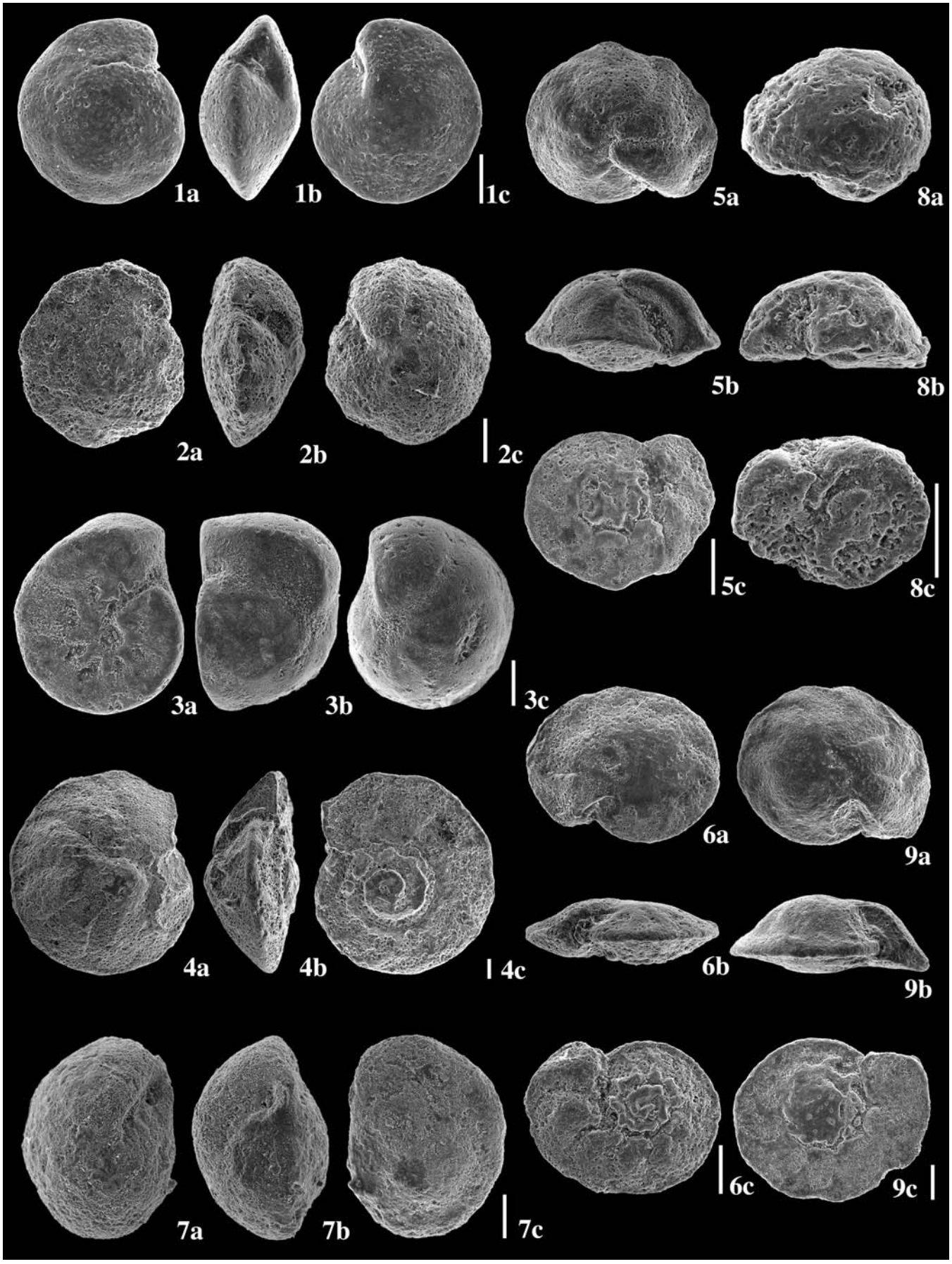
2 *Cibicidoides eocaenus* (Gümbel). 2, sample For 3; 2a, ventral view; 2b, peripheral view; 2c, dorsal view;

3 *Cibicidoides grimsdalei* (Nuttall), sample For 17,5; 3a, dorsal view; 3b, peripheral view; 3c, ventral view.

4-6 *Cibicidoides hadjibulakensis* Bykova. 4, sample For 13; 4a, ventral view; 4b, peripheral view; 4c, dorsal view; 5, sample For 17; 5a, ventral view; 5b, peripheral view; 5c, dorsal view; 6, sample For 3; 6a, ventral view; 6b, peripheral view; 6c, dorsal view.

7 *Cibicidoides naranjoensis* (White), sample For 19; 7a, ventral view; 7b, peripheral view; 7c, dorsal view.

8-9 *Cibicidoides proprius* Brotzen, sample For 18; 8, juvenile form, 8a, ventral view; 8b, peripheral view; 8c, dorsal view; 9, sample For 12; 9a, ventral view; 9b, peripheral view; 9c, dorsal view.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Remarks: We studied the holotype and paratype of *S. annulifera* (CC 23099, 23100), which have somewhat more raised sutures than our specimens. Thus, we include in this species all the specimens with very broad, transparent sutures. Cushman and Bermúdez (1936) described this species after *Nodosaria annulifera* was defined by Gümbel (1868). At present, we preserve the name used by Cushman and Bermúdez (1936) to prevent taxonomic confusion, although it is invalid if the species placed in the genus *Nodosaria* by Gümbel is now placed in the genus *Siphonodosaria*. Because we have not studied Gümbel´s material, we cannot resolve this question.

Occurrence: This species is very rare to common in the Fortuna section, abundant in sample For 35.

Siphonodosaria pomuligera (Stache) 1865
Plate 11, figure 7

Dentalina pomuligera STACHE 1865, p. 204, pl. 22, fig. 31.
Nodosaria pomuligera (Stache). – PLUMMER 1926, p. 81, pl. 4, figs. 15a,b; pl. 14, fig. 3.
Nodosaria (?) *abyssorum* BRADY 1881, p. 63, pl. 63, figs. 8, 9.
Dentalina cf. *pomuligera* Stache. – TOULMIN 1941, p. 586, pl. 79, fig. 19.
Siphonodosaria abyssorum (Brady). – NOMURA 1995, p. 291, pl. 2, fig. 1.
Stilostomella abyssorum (Brady). – JONES 1994, p. 74, pl. 63, figs. 8, 9; suppl. pl. 2, figs. 8, 9. – KUHNT et al. 2002, p. 156, pl. 13, figs. 11-13.
Siphonodosaria pomuligera (Stache). – HAYWARD 2002, p. 305, pl. 3, figs. 37-40.

Description: Test elongate, slightly curved, uniserial. Chambers distinct, increasing gradually in size, spherical, slightly ovate and more inflated as added; initial chamber with one or two off-centre spines, usually broken. Sutures distinct, straight, somewhat limbate, becoming more depressed as the test grows. Wall calcareous, smooth, perforate. Aperture terminal, with a short-medium neck with a phialine lip, usually broken.

Remarks: Hayward (2002) considered *S. abyssorum* (Brady) 1881 as a junior synonym of this species; from published figures we tend to agree with these authors and thus use the name *S. pomuligera*.

Occurrence: The specimens, which are usually broken, are very rare in the lowermost part of the Fortuna section, and very rare to abundant from sample For 13,5 to For 35.

Genus ***Uvigerina*** d'Orbigny 1826

The generic classification of species related to *Uvigerina* such as *Siphouvigerina* or *Neouvigerina* is difficult, and there is little consensus in the literature, probably because the genera are differentiated by their apertural characteristics (internal toothplates), which commonly are not visible. In addition, a number of subspecies, varieties, and species have been described based on differences in their degree and type of ornamentation. In many cases this has led to taxonomic problems, because the type and degree of ornamentation may change even within one specimen, and vary considerably within populations.

Uvigerina hispida Schwager 1866
Plate 11, figure 8

Uvigerina hispida SCHWAGER 1866, p. 249, pl. 7, fig. 95. – GALLOWAY and MORREY 1929, p. 39, pl. 6, fig. 3. – BOERSMA 1984, p. 74, pl. 1, figs. 1-4. – VAN MORKHOVEN et al. 1986, p. 62, pl. 20, figs. 1-4. – KATZ and MILLER 1987, p. 306, pl. 2, fig. 1. – MILLER and KATZ 1987a, p. 289, pl. 2, fig. 4. – MILLER and KATZ 1987b, p. 140, pl. 2, fig. 2. – KATZ and MILLER 1993, pl. 4, fig. 7. – NOMURA 1995, p. 291, pl. 2, fig. 6. – KUHNT et al. 2002, p. 158, pl. 14, figs. 5-8.
Hopkinsina notohispida? FINLAY 1939b, p. 105, pl. 15, figs. 10-11.
Neouvigerina hispida (Schwager). – HAYWARD 2002, p. 301, pl. 1, fig. 14.

Description: Test elongate, about two times as long as broad. Chambers triserially arranged, later chambers inflated, tending to become biserial; sutures distinctly depressed. Wall calcareous, ornamented with numerous short, thick spines. Aperture circular, at the end of a cylindrical neck with a phialine lip; lip commonly broken off.

Remarks: Microspheric and macrospheric forms differ in shape. The microspheric forms show a pointed initial end; the macrospheric forms are subcylindrical and have a broadly rounded apex. They vary in size, but we do not see differences in ornamentation.

We examined paratypes of *Uvigerina notohispida* (Finlay) (USNM 689187) considered by the author to be "the New Zealand Middle Tertiary representative of the Indo-Pacific Pliocene *Uvigerina hispida* Schwager". He noted that *U. notohispida* has

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PLATE 6
All scale bars 100µm unless otherwise indicated.

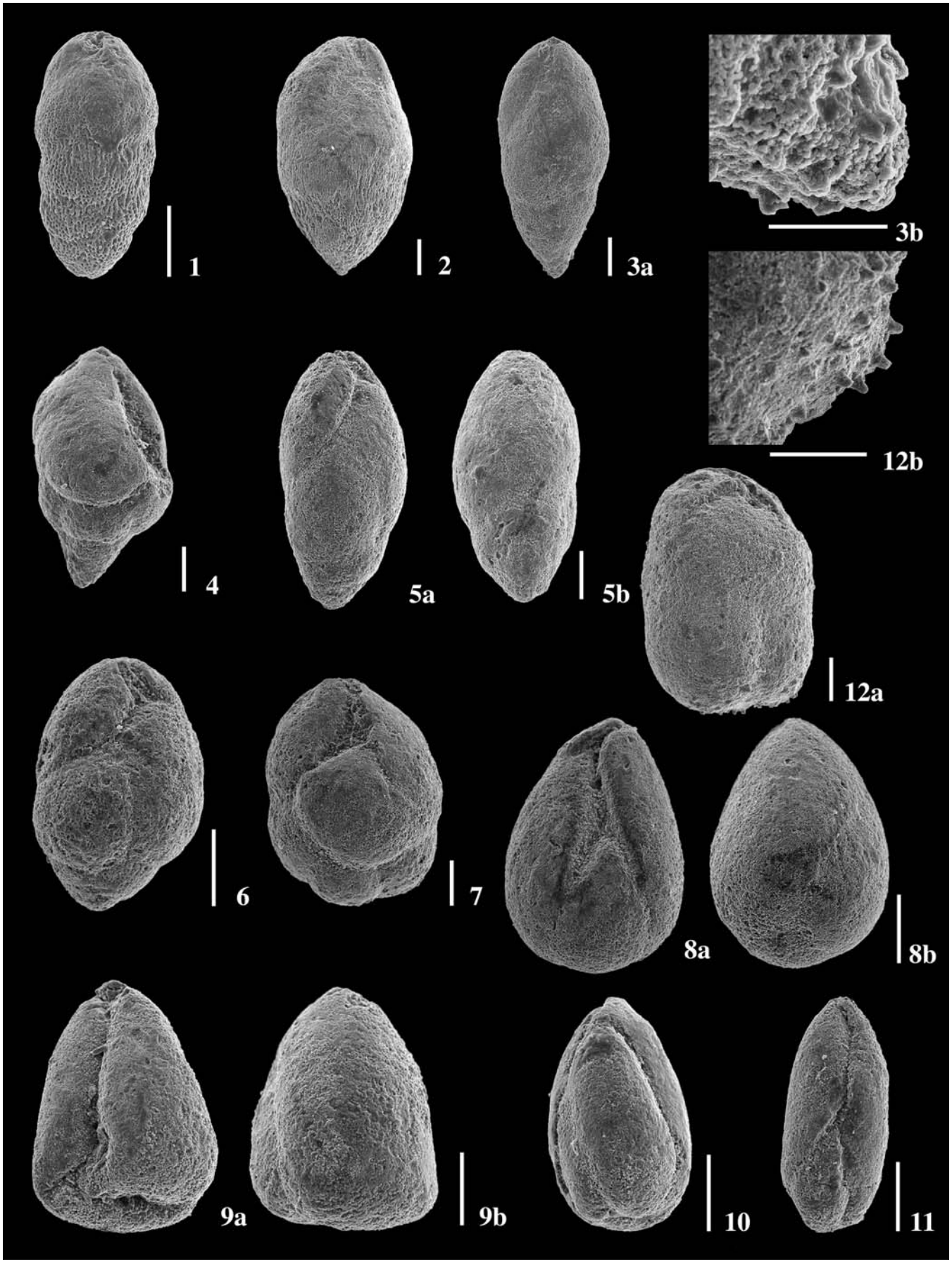
1-3 *Globobulimina pupoides* (d'Orbigny). 1, sample For 17,5, side view; 2, sample For 4, side view; 3, sample For 6,5; 3a, side view, 3b, detail of spines (scale bar: 40 µm).

4-5 *Globobulimina ovata* (d'Orbigny). 4, sample For 6, side view; 5, sample For 2; 5a, side view; 5b, side view.

6,7 *Globobulimina pyrula* (d'Orbigny). 6, sample For 12,5, side view; 7, sample For 12, side view.

8-11 *Globobulimina pacifica* Cushman. 8, sample For 3; 8a, side view; 8b, side view; 9, sample For 4; 9a, side view; 9b, side view; 10, sample For 3, side view; 11, sample For 12,5, side view.

12 *Globobulimina spinescens* (Brady), sample For 8; 12a, side view; 12b, detail of spines.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blunter, shorter, more densely spaced spines than *U. hispida*. Boersma (1984) considered that *U. notohispida* differed from *U. hispida* by "lacking the secondary smaller spines interspersed between coarser spines characteristic of *U. hispida"*. Hayward (2002) considered both species to be members of one morphologically variable species, attributing the different ornamentation to varying preservation.

Occurrence: This species is very rare in the lower part of the Fortuna section and abundant in sample For 33.

Uvigerina pigmea d'Orbigny 1826
Plate 11, figures 9-11

Uvigerina pigmea d'ORBIGNY 1826, p. 269, pl. 12, figs. 8-9.
Uvigerina pygmea d'Orbigny. – d'ORBIGNY 1846, p. 190, pl. 11, fig. 25, 26.
Uvigerina pygmaea d'Orbigny. – GALLOWAY and MORREY 1929, p. 39, pl. 6, fig. 5. – AGIP S.p.A. 1982, pl. 34, figs. 3. – PAPP and SCHMID 1985, p. 74, pl. 65, figs. 1-5. – LOEBLICH and TAPPAN 1987, p. 151, pl. 573, figs. 21-23.
Uvigerina pigmaea d'Orbigny. – NUTTALL 1932, p. 21, pl. 5, fig. 6. – BOERSMA 1984, p. 128, pl. 1, figs. 1-6; pl. 2, figs. 1-5. – KATZ and MILLER 1993, pl. 4, fig. 3.

Description: Test elongate, fusiform, apical part rounded, periphery slightly lobulate. Chambers triserially arranged to biserial, slightly inflated. Sutures distinct, depressed. Wall calcareous, finely perforate, ornamented with numerous ridge-like, low costae that do not continue from one chamber to another. The costae are irregularly oriented and fragmented in some specimens. The last chamber has short spines rather than costae in some specimens. Aperture terminal, round, at the end of a short neck with a slight phialine lip.

Remarks: We have included in this species specimens with spines on their last chamber, costae on earlier chambers.

Occurrence: This species is very rare to abundant in the Fortuna section.

Uvigerina rippensis Cole 1927
Plate 11, figures 12-14

Uvigerina rippensis COLE 1927, p. 27, pl. 2, fig. 16. – TJALSMA and LOHMANN 1983, p. 38, pl. 14, figs. 6, 7. – BOERSMA 1984, p. 137, pl. 1, figs. 1-4; pl. 3, figs. 1-6. – MATHELIN and SZTRÀKOS 1993, p. 79, pl. 34, fig. 14. – BIGNOT 1998, p. 436, pl. 2, figs. 7, 8.

Description: Test elongate, nearly fusiform with the greatest width at or above the middle of the test; periphery slightly lobulate. Chambers triserially arranged, becoming loosely biserial. Chambers inflated, rounded; sutures depressed usually forming at an angle of about 45º with the coiling axis. Test calcareous, finely perforate, ornamented with distinct, longitudinal costae, that vary in height and crenulation; usually broken into spines at both ends and sometimes at the center of the test. Aperture round, at the end of a short, cylindrical neck with a phialine lip, usually enclosed by costae extending up from the final chamber.

Remarks: The costate and spini-costate species resemble each other closely in overall morphology, and vary from specimen to specimen in spinosity and crenulation. In addition, costae may be broken up into segments in not well-preserved specimens. *U. hispida* differs by its spiny ornamentation, with spines not arranged longitudinally, and has no costae. *U. pigmea* differs from *U. rippensis* mainly by its lower costae, somewhat more elongate test and greater number of chambers. *U. rippensis* can be recognized by its crenulate, ragged costaes.

Occurrence: This species is very rare to abundant in the Fortuna section.

Valvulineria cf. ***V. haitiana*** Bermúdez 1949
Plate 11, figure 15

Valvulineria haitiana BERMÚDEZ 1949, p. 257, pl. 18, figs. 1-3.

Description: Test trochospiral, unequally biconvex. Periphery broadly rounded, gently lobulate. Dorsal side evolute, less convex than ventral side, consisting of two visible whorls; sutures radial, gently curved, limbate, flush to slightly depressed between the last chambers. Ventral side involute, 6-7 chambers in the last whorl, more inflated as the test grows. Especially the last chamber, from which a flap extends over the ventral, depressed, star-like umbilical area, is strongly inflated. Sutures radial, straight, thickened near the umbilicus, somewhat depressed between the last chambers. Wall calcareous, smooth,

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PLATE 7
All scale bars 100µm unless otherwise indicated.

1-2 *Coleites galeebi* Haque, sample For 18,5; 1a, dorsal view; 1b, peripheral view; 1c, ventral view; 2a, dorsal view; 2b, peripheral view; 2c, ventral view.

3 *Fursenkoina dibollensis* (Cushman and Applin), sample For 35; 3a, front view; 3b, side view.

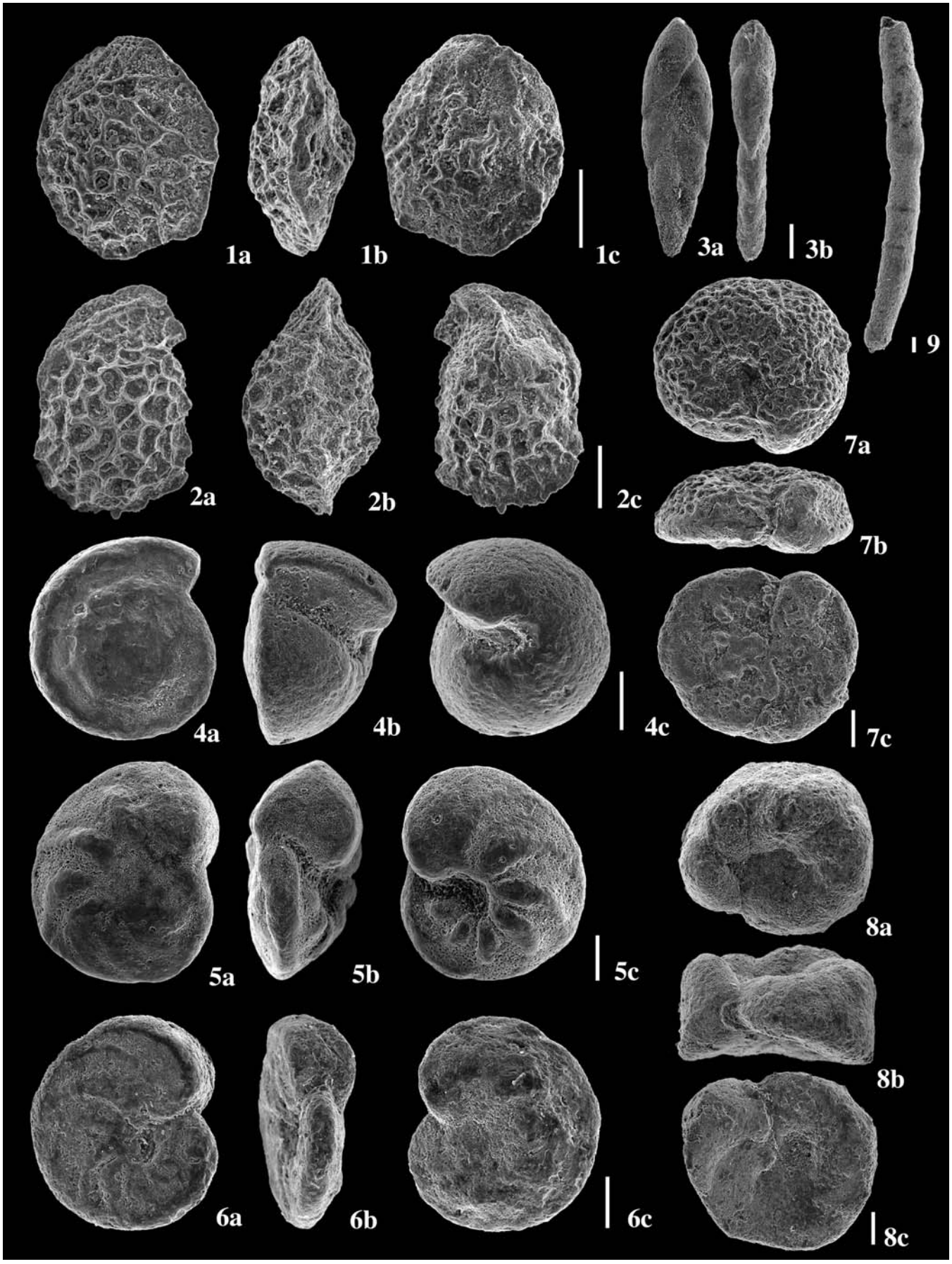
4 *Gyroidinoides girardanus* (Reuss), sample For 5; 4a, dorsal view; 4b, peripheral view; 4c, ventral view.

5-6 *Hanzawaia ammophila* (Gümbel). 5, sample For 17; 5a, dorsal view; 5b, peripheral view; 5c, ventral view; 6, sample For 17,5; 6a, dorsal view; 6b, peripheral view; 6c, ventral view.

7 *Hanzawaia bundensis* Van Bellen, sample For 10,3; 7a, ventral view; 7b, peripheral view; 7c, dorsal view.

8 *Hanzawaia cubensis* (Cushman and Bermúdez), sample For 16,7; 8a, ventral view; 8b, peripheral view; 8c, dorsal view.

9 *Laevidentalina elegans* (d'Orbigny), sample For 35, side view.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finely perforate. Aperture in the ventral umbilical area, extending slightly to the periphery.

Remarks: The umbilical area is large and not fully covered by the flap extending from the last chamber; the flap in our specimens might not be complete because of some breakage. The holotype and several paratypes (CC 62379, 62380, 62381) resemble our specimens, but are somewhat thicker in cross section and the umbilical area is somewhat narrower.

Occurrence: This species is very rare to rare in the Fortuna section.

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PLATE 8

All scale bars 100µm unless otherwise indicated.

1 *Lenticulina clericii* (Fornasini), sample For 4; 1a, side view; 1b, peripheral view.

2-3 *Lenticulina cultrata* (Montfort). 2, sample For 6; 2a, side view; 2b, peripheral view; 3, sample For 1; 3a, side view; 3b, peripheral view.

4 *Lenticulina insulsa* (Cushman), sample For 18; 4a, side view; 4b, peripheral view.

5 *Lenticulina rotulata* (Lamarck), sample For 4; 5a, side view; 5b, peripheral view.

6-7 *Lenticulina turbinata* (Plummer). 6, sample For 10,3; 6a, side view; 6b, peripheral view; 7, sample For 10; 7a, side view; 7b, peripheral view.

8 *Lenticulina velascoensis* White, sample For 3; 8a, side view; 8b, peripheral view.

9 *Lenticulina williamsoni* (Reuss), sample For 18; 10a, side view; 10b, peripheral view.

10 *Lenticulina yaguatensis* Bermúdez, sample For 17; 9a, side view; 9b, peripheral view.

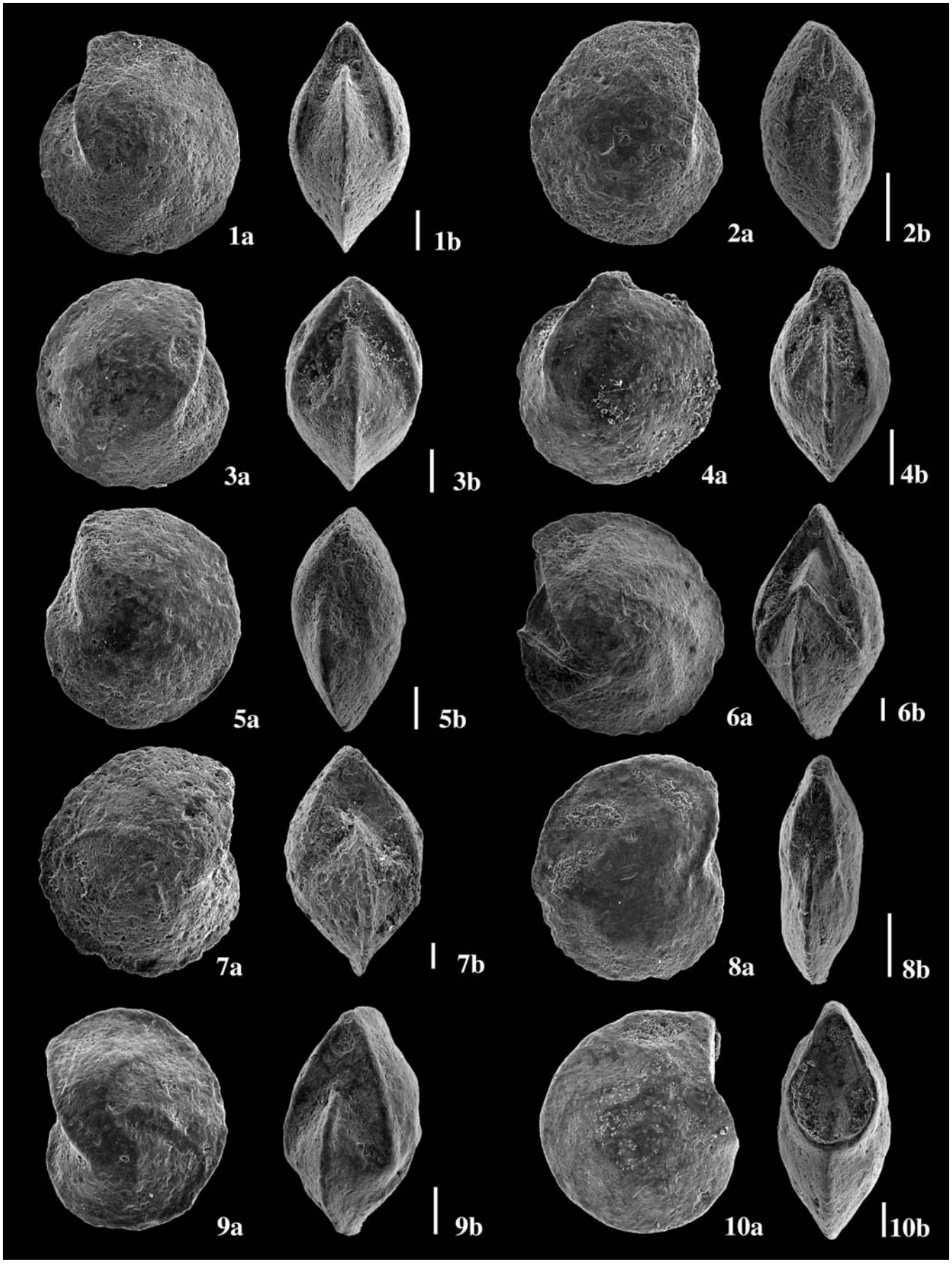
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PLATE 9

All scale bars 100µm unless otherwise indicated.

1-2 *Lobatula lobatula* (Walker and Jacob). 1, sample For 16,4; 1a, dorsal view; 1b, peripheral view; 1c, ventral view; 2, sample For 16,7; 2a, dorsal view; 2b, peripheral view; 2c, ventral view.

3 *Loxostomoides applini* (Plummer), sample For 11,3; 3a, apertural face; 3b, side view.

4 *Nonion affine* (Reuss), sample For 35; 4a, peripheral view; 4b, side view.

5-6 *Nonion havanense* Cushman and Bermúdez. 5, sample For 7,3, peripheral view; 6, sample For 10; 6a, peripheral view; 6b, side view.

7-8 *Nuttallides trümpyi* (Nuttall). 7, sample For 4; 7a, ventral view; 7b, peripheral view; 7c, dorsal view; 8, sample For 9; 8a, ventral view; 8b, peripheral view.

9 *Oridorsalis umbonatus* (Reuss), sample For 17,5; 9a, ventral view; 9b, peripheral view; 9c, dorsal view.

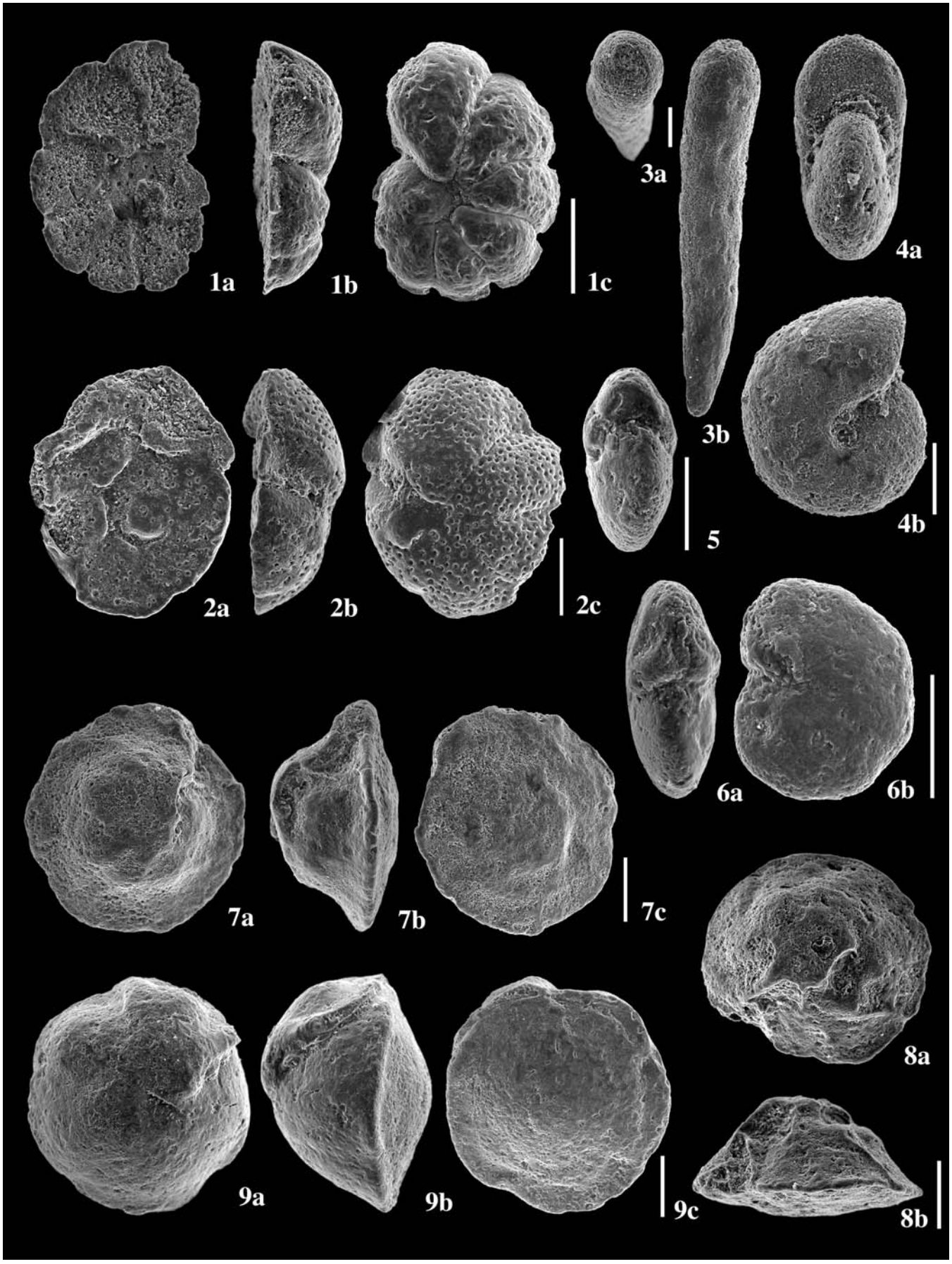
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PLATE 10

All scale bars 100µm unless otherwise indicated.

1-2 *Osangularia dominicana* (Bermúdez). 1, sample For 10,3; 1a, dorsal view; 1b, peripheral view; 1c, ventral view; 2, sample For 7,3; 2a, ventral view; 2b, peripheral view; 2c, dorsal view.

3 *Osangularia* cf. *O. plummerae* Brotzen, sample For 17,5; 3a, ventral view; 3b, peripheral view; 3c, dorsal view.

4 *Osangularia plummerae* Brotzen, sample For 12,5; 4a, dorsal view; 4b, peripheral view; 4c, ventral view.

5 *Pararotalia audouini* (d'Orbigny), sample For 35; 5a, ventral view; 5b, peripheral view; 5c, dorsal view.

6 *Planulina cooperensis* Cushman, sample For 16,4; 6a, peripheral view; 6b, ventral view.

7-8 *Planulina subtenuissima* (Nuttall). 7, sample For 16,4, peripheral view; 8, sample For 14,5; 8a, dorsal view; 8b, peripheral view; 8c, ventral view.

9 *Pullenia jarvisi* Cushman, sample For 11,3; 9a, peripheral view; 9b, side view.

10 *Pullenia quinqueloba* (Reuss), sample For 10,3; 10a, side view; 10b, peripheral view.

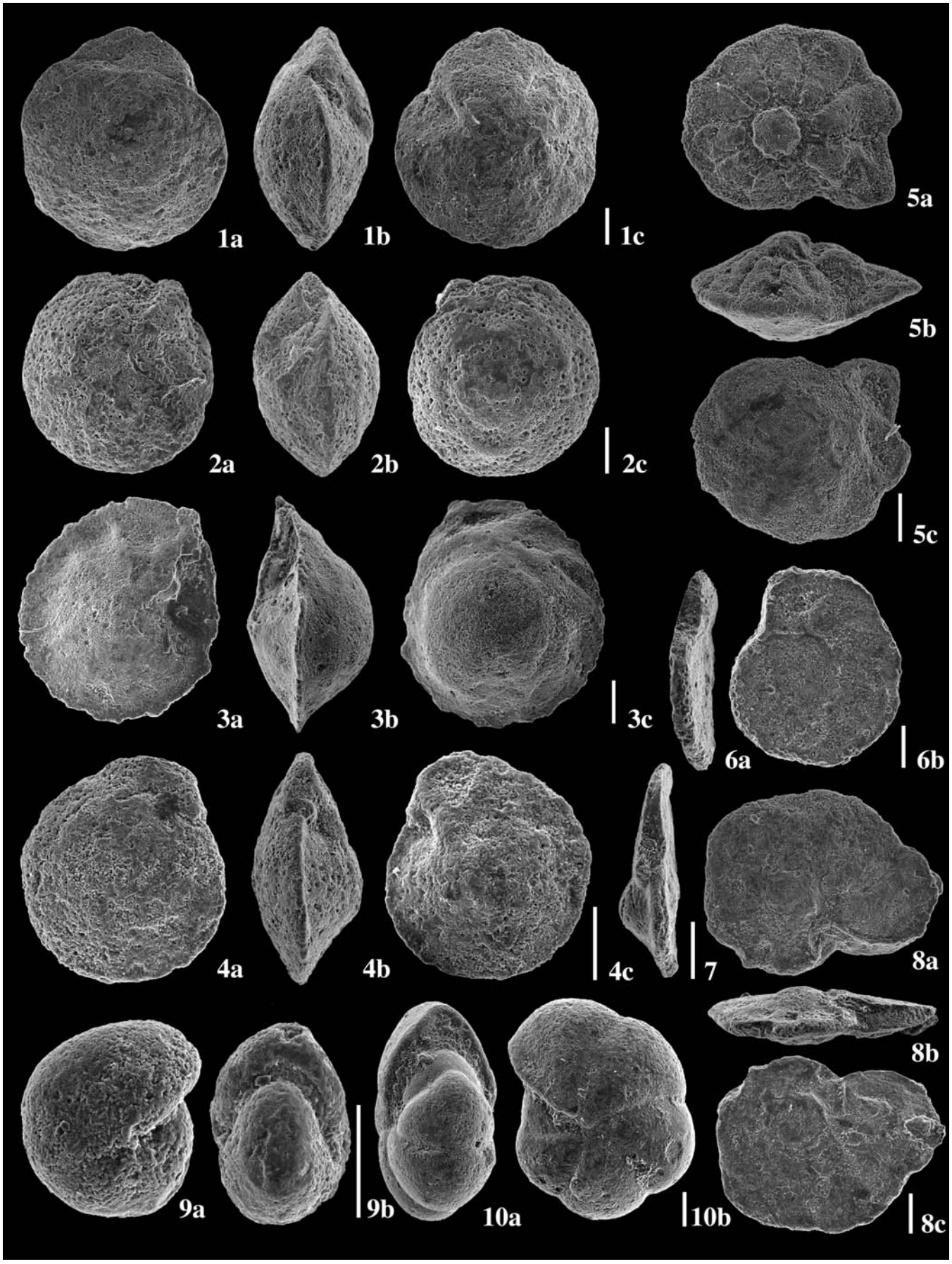
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PLATE 11

All scale bars 100µm unless otherwise indicated.

1 *Quadrimorphina allomorphinoides* (Reuss), sample For 13,5; 1a, ventral view; 1b, dorsal view.

2 *Reussella oberburgensis* Freyer, sample For 15,5; 2a, side view; 2b, apertural face.

3-4 *Siphogenerinoides eleganta* (Plummer). 3, sample For 8; 3a, side view; 3b, apertural face; 4, sample For 1, side view.

5 *Siphogenerinoides kugleri* (Cushman and Renz), sample For 6, side view.

6 *Siphonodosaria annulifera* (Cushman and Bermúdez), sample For 19,5, side view.

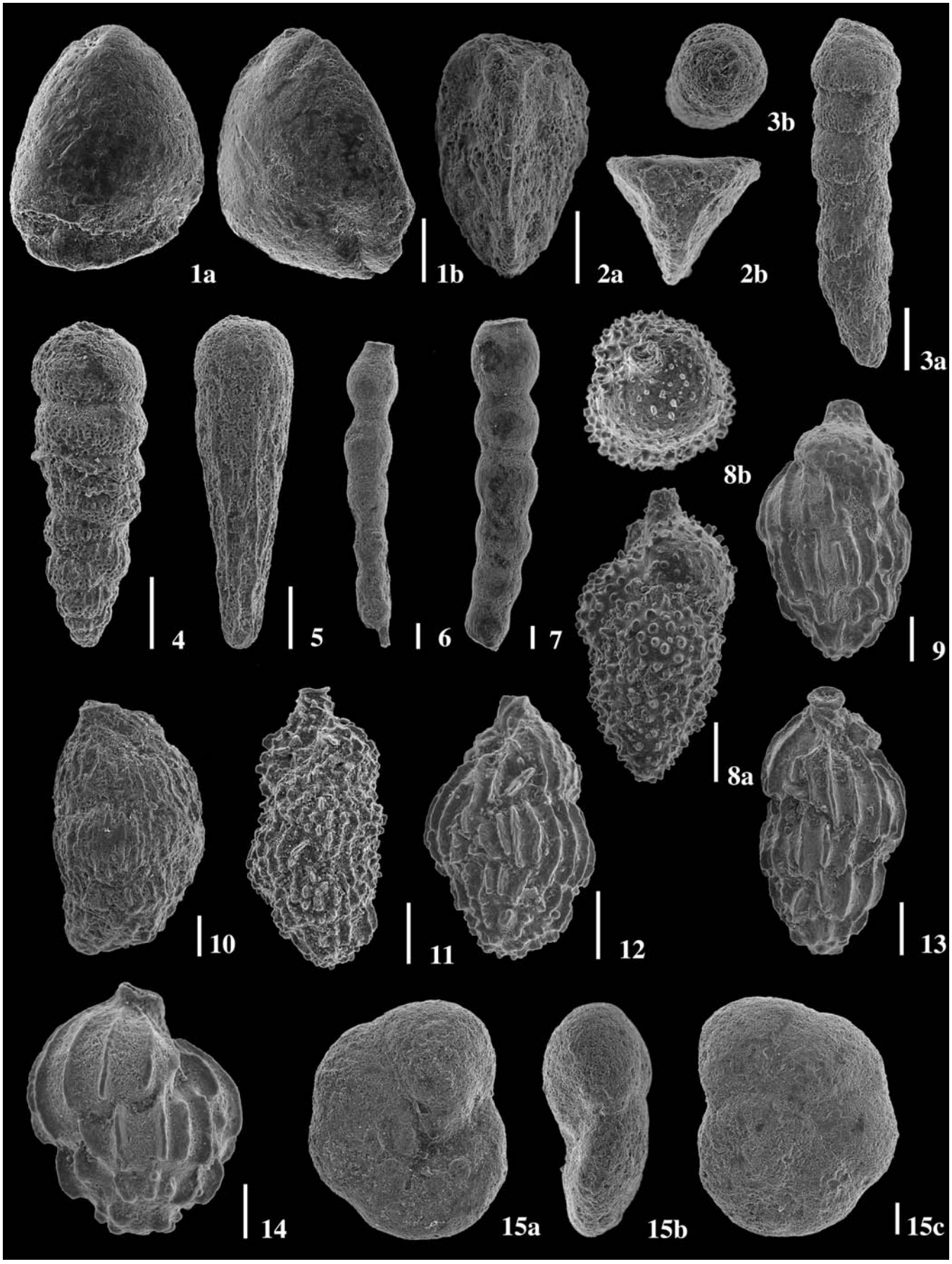
7 *Siphonodosaria pomuligera* (Stache), sample For 18, side view.

8 *Uvigerina hispida* Schwager, sample For 31, 8a, side view; 8b, apertural face.

9-11 *Uvigerina pigmea* d'Orbigny. 9, sample For 4, side view; 10, sample For 16, side view; 11, sample For 16,4, side view.

12-14 *Uvigerina rippensis* Cole. 12, sample For 16, side view; 13, sample For 4, side view; 14, sample For 4, side view.

15 *Valvulineria* cf. *V. haitiana* Bermúdez, sample For 10; 15a, ventral side; 15b, peripheral view; 15c, dorsal view.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