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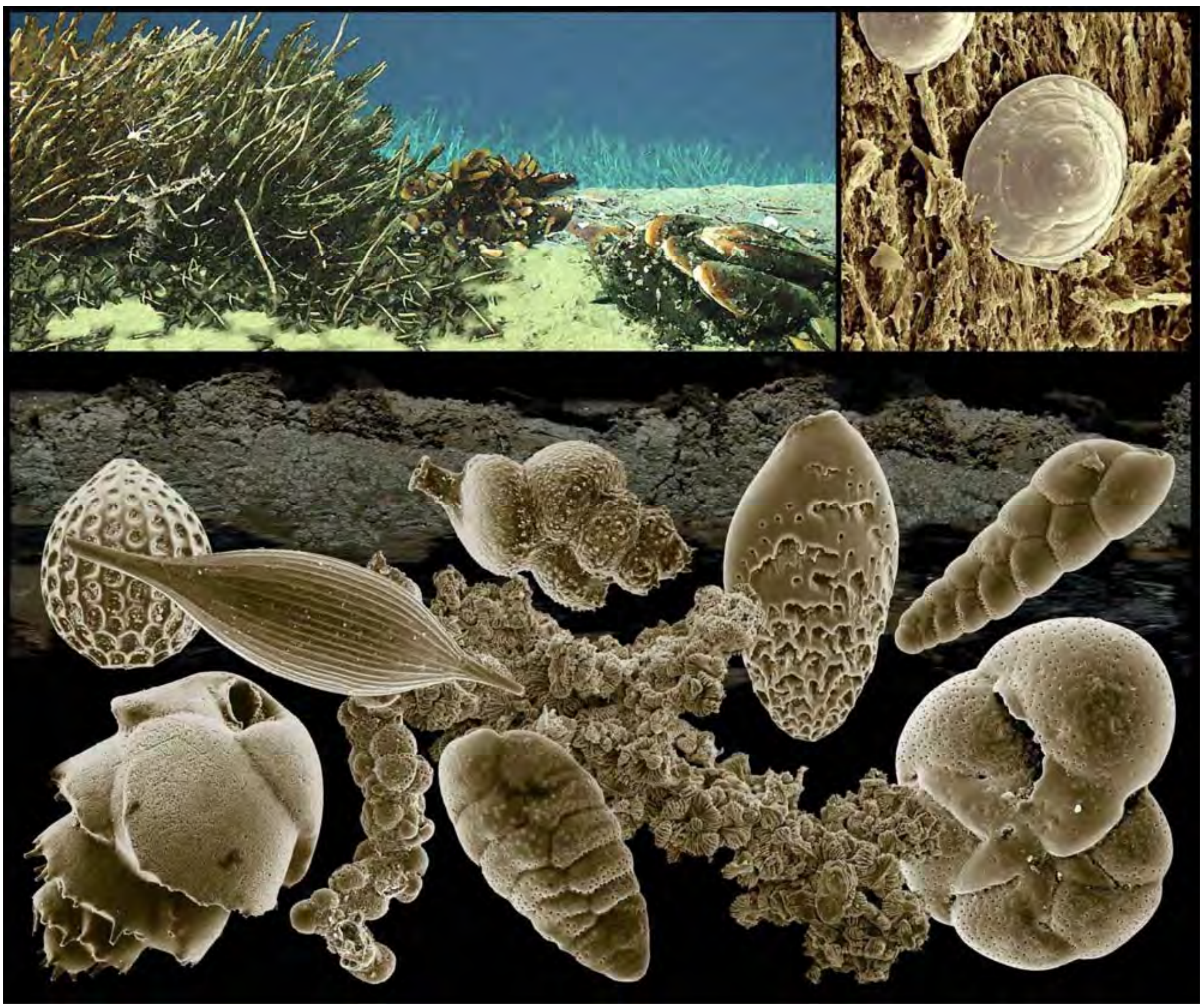
Foraminiferal Communities of Bathyal Hydrocarbon Seeps, Northern Gulf of Mexico: A Taxonomic, Ecologic, and Geologic Study



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Cooperative Agreement
Coastal Marine Institute
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Authors

Barun K. Sen Gupta
Melissa K. Lobegeier
Lorene E. Smith

April 2009

Prepared under MMS Contract
1435-01-99-CA-30951-18182
by
Louisiana State University
Coastal Marine Institute
Baton Rouge, Louisiana 70803

Published by

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Cooperative Agreement
Coastal Marine Institute
Louisiana State University

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CITATION

Suggested citation:

Sen Gupta, B.K., M.K. Lobegeier, and L.E. Smith. 2009. Foraminiferal communities of bathyal hydrocarbon seeps, northern Gulf of Mexico: A taxonomic, ecologic, and geologic study. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2009-013, 385 pp.

ACKNOWLEDGMENTS

Paul Aharon (University of Alabama), Joan Bernhard (Woods Hole Oceanographic Institution), and Harry Roberts helped greatly in sample collection; Erik Cordes (Pennsylvania State University) provided tubeworms from Green Canyon and Mississippi Canyon; Joan Bernhard provided control cores; Xiaogang Xie helped in scanning electron micrography; and Mary Lee Eggart helped with the art work. Submersible dives were funded by NOAA National Undersea Research Program (UNC-Wilmington NURC). Parts of a published article are included here with the permission of Elsevier (see Chapter 4 for details).

ABSTRACT

One hundred eighty-five species of benthic Foraminifera were identified in a study of sediment substrates and tubeworm surfaces in (a) Green Canyon, Garden Banks, and Mississippi Canyon (245-1081 m) and (b) Alaminos, Farnella, and De Soto Canyons (1848-2918 m); the samples were obtained from submersibles in both seep and non-seep (control) areas. One hundred twenty-two species were calcareous, 63 agglutinated. An atlas with illustrations of most species is included in this report.

No species found in this study is endemic to seeps, but 21 species were previously unknown in the Gulf of Mexico. The imprint of water depth on foraminiferal assemblages is clearly detectable, because the species are recruited from the surrounding non-seep habitats. The two major surface-sample groups (clusters) recognized by numerical data analysis are separated by bathymetry. The shallower-water group contains all samples (seep and non-seep) from depths of 245-1081 m; the deeper-water (deepest-bathyal) group contains all samples from 1848-2918 m. Foraminiferal species of wide-ranging morphologic and taxonomic affinities are able to maintain sizeable populations at sites of hydrocarbon seepage; the high bacterial productivity at the seeps is a major factor in the sustenance of these populations. The most conspicuous dominants at seep-influenced substrates (bacterial mats) in the shallower cluster are endobenthic species, especially *Bolivina* spp.; these are possibly facultative anaerobes. The pattern is not as clear in the deepest-bathyal group, because some epibenthic species (e.g., *Nuttallides decorata*) are present among the dominants. In the shallower areas, the diversity (species richness) of both calcareous and agglutinated Foraminifera is higher in non-seep than in seep substrates. This distinction too is not clear in the deepest-bathyal areas. The diversity at some sites may have been elevated by post-mortem mixing of species from different microhabitats. Fifteen sessile, epibenthic Foraminifera colonize surfaces of vestimentiferan tubeworms (and possibly other elevated microhabitats) at hydrocarbon seeps, centimeters to decimeters above the sediment-water interface. These attachment points are sufficiently above locations of gas escape in the seafloor to provide the species with an oxic microhabitat with little or no H_2S. Eight of these species have been found exclusively on tubeworms in this study.

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1. INTRODUCTION

1.1. Background and Scope of Study

Marine hydrocarbon seeps ("cold seeps"), especially those of the Gulf of Mexico, have been the subject of many studies because, like hydrothermal vents ("hot vents"), they support a complex community of organisms in a chemosynthesis-based ecosystem (e.g., Hecker, 1985; Kennicutt et al., 1985; MacDonald et al., 1989; Van Dover, 2000). The present study relates to a very large group of shelled protists, namely benthic Foraminifera, that live in seep-related substrates. This is frequently the most abundant meiofaunal group in diverse marine habitats (e.g., Snider et al., 1984; Gooday, 1986; Gooday et al., 1992). Foraminiferal species respond rapidly to environmental disturbances, and their large extant populations and well-preserved shells make them excellent recorders of present and past marine biodiversity. Some species are capable of inhabiting environments where oxygen is depleted to extremely low levels, or even absent. Hydrocarbon seeps provide a special window to study the Foraminifera of such dysoxic and anoxic environments, and to assess long-term effects of petroleum pollution on foraminiferal communities.

Our preliminary studies of the Foraminifera associated with Gulf of Mexico hydrocarbon seeps, especially those found in or under bacterial (*Beggiatoa*) mats, have indicated the existence of facultative anaerobes within this community (Sen Gupta and Aharon, 1994; Sen Gupta et al., 1997). These studies, however, were too limited in scope for an understanding of spatial and temporal distribution trends, and for an assessment of diversity and abundance anomalies. In particular, the composition of seep foraminiferal communities in the Gulf of Mexico at depths greater than 700 m was wholly unknown at the commencement of the present study, although a later publication (Robinson et al., 2004) reported 32 living species (Rose-Bengal-stained individuals) from Alaminos Canyon and Atwater Canyon. In this context, our investigation involved a quantitative analysis of foraminiferal assemblages retrieved from various shallow and deep bathyal seepage areas in the northern Gulf of Mexico. The foraminiferal microhabitats included bacterial (*Beggiatoa*) mats, mussel beds, substrates of tubeworm colonies, and inorganic sediments around points of hydrocarbon seepage and at control sites away from seeps. In addition, a presence-absence census was also conducted for epibenthic species attached to tubeworm surfaces. Scanning electron micrographs were taken of all species for which suitable specimens were found; some digital photomicrographs were also taken, especially of species attached to tubeworms. All these illustrations are included in a taxonomic atlas that constitutes a major part of this report.

1.2. Material and Methods

Sediment Samples. The sampling locations are shown in Fig. 1.1. Most of the cores used in the present study were retrieved during dives of the submersible *Alvin* in October 2000. This sampling project included three separate research programs involving investigators from (1) LSU (B. K. Sen Gupta, P.I.) and University of South Carolina (USC, J. M. Bernhard, Co-P.I.), (2) Texas A & M University (TAMU, I. R. McDonald, P.I.), and (3) College of William and Mary (CWM, C. L. Van Dover, P.I.).

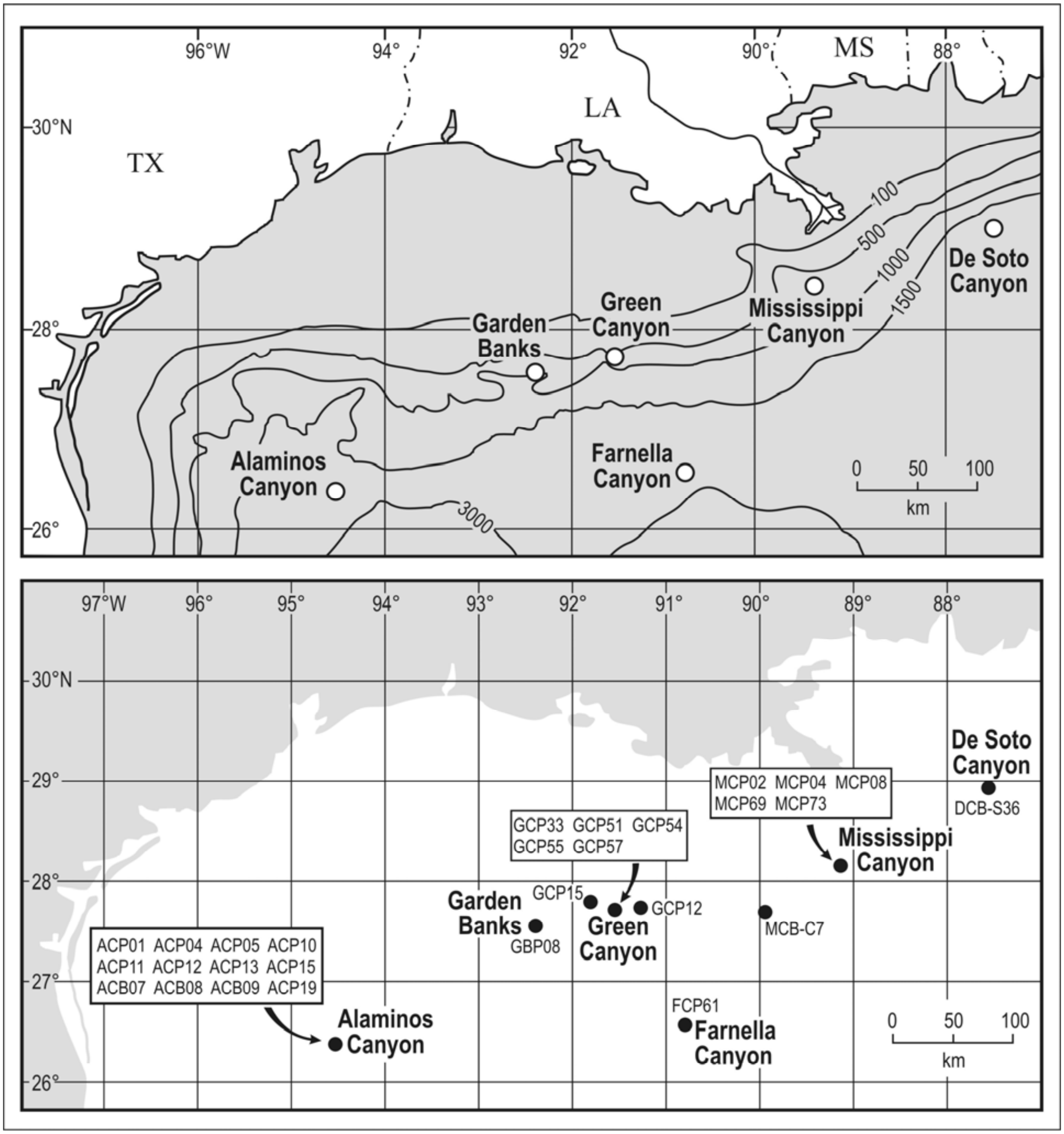

Figure 1.1. Sampling areas and core locations. Top, sampling areas and bathymetry; bottom, approximate locations of coring sites on a latitude-longitude grid. Exact coordinates of sites are given in Table 1-1.

The TAMU dives were funded by MMS (Gulf of Mexico Office) and DOE (National Energy Technology Laboratory); the LSU/USC and CWM dives were supported by NOAA (National Undersea Research Program). The cores retrieved on these *Alvin* dives included eight push cores and four box cores from Alaminos Canyon (water depth 2219-2238 m); five push cores from Mississippi Canyon (1067-1081 m); five push cores from Green Canyon (Block 272, 664-696 m); and one push core from Farnella Canyon (2918m). The coordinates, water depth, and substrate information (seep-related habitat or non-seepage site) for each core are recorded in Table 1-1. The diameter of the push cores was 7 cm and the maximum length was about 25 cm. The box cores were taken (in Alaminos Canyon) with a four-compartment box (width 15 cm, depth 15 cm, height 18 cm). Besides the *Alvin* 2000 cores, three push cores were obtained earlier during dives of the *Johnson Sea-Link* in 1997: two from Green Canyon (Block 180, 245 m; Block 232, 569 m), and one from Garden Banks (640 m). Finally, two control cores from non-seep locations (De Soto Canyon, 1848 m; south of Mississippi Canyon, 1076 m), provided by Dr. Joan Bernhard were used for comparison.

All cores were kept frozen until sectioned in the laboratory. They were split vertically into halves with a buzz saw, and one half was kept for archival purposes. The other half was sectioned in one-centimeter slices. Wherever possible, surface and near-surface samples (0-1 cm and 1-2 cm) from push cores and surface samples (0-1 cm) from box cores were studied. For three cores, samples below the 2-cm level were also studied. The surface samples from push core ACP12 (0-1.5 cm and 1.5-2 cm) and box core ACB08 (0-2 cm) were larger, because the top surfaces were particularly uneven. The core slices were stained with a saturated solution of Rose Bengal (to distinguish between living and dead Foraminifera) and washed over a 63-µm sieve; the residues were dried at 60˚C. These residues were microsplit so that, if possible, 300 plus benthic foraminiferal specimens could be picked and counted. Pyrite-filled shells of calcareous and agglutinated Foraminifera and specimens with authigenic carbonate or barite overgrowth were not included in the total counts. In samples with excessive numbers of tube-like agglutinated Foraminifera, such as MCP73 from Mississippi Canyon, >100 calcareous benthic Foraminifera were picked from the split sample and numbers of tubular Foraminifera counted.

Numerical data analyses. Our numerical database consists of species-level abundances of both living individuals and empty shells (unstained by Rose Bengal) of Foraminifera in core samples. The relative abundances of calcareous species were subjected to Q-mode cluster analysis, using Ward's minimum variance method with squared Euclidean distance. Data on agglutinated Foraminifera were excluded from analysis because counts of agglutinated Foraminifera in these samples are seriously affected by taphonomic problems. In particular, tubular Foraminifera such as *Hyperammina*, *Rhizammina*, and *Saccorhiza* are frequently fragmented, and the correct number of specimens is difficult to estimate (see Licari et al., 2003; Mackensen et al., 1993; Schmiedl et al., 1997; Wollenburg and Mackensen, 1998; Kurbjeweit et al., 2000).

Two data sets were analyzed, one on just the surface samples (0-1 cm), the other on both surface and near-surface samples (0-1 cm and 1-2 cm). When performing Q-mode cluster analysis (CA) on the first data set (28 0-1 cm samples), six samples—all from Alaminos Canyon (ACP01, ACP10, ACP11, ACP12, ACB08, ACB09)—were excluded, because each of them contained less than 25 calcareous benthic individuals. Fifty-three variables, defined as species constituting at least 2% of the assemblage in at least one sample, were used in the clustering procedure. For CA of the second data set (49 0-1 and 1-2 cm samples), nine samples were excluded, because of the paucity of calcareous individuals; these were: ACP01a (= ACP01 0-1 cm), ACP10a, ACP10b (= ACP10 1-2 cm), ACP11a, ACP11b, ACP12a (= ACP12 0-1.5 cm), ACP12b (= ACP12 1.5-2 cm), ACB08a (= ACB08 0-2 cm), and ACB09a. Fifty-four species (2% or more in one or more samples) were used.

Tubeworm Foraminifera. Tubeworms from Alaminos Canyon were retrieved during our *Alvin* dive of 2000; the others (from Green Canyon and Mississippi Canyon) were contributed by Erik Cordes of Pennsylvania State University. Air-dried tubeworms, with internal soft tissue removed, were first examined under a binocular microscope, photographed, and sketched, showing places of foraminiferal colonization. The tubes were then sectioned transversely by a Dremel tool. The attached Foraminifera were identified and documented by digital photomicrography and scanning electron micrography—in growth positions, and, if necessary, as detached specimens.

Table 1-1

Core Location, Inventory of Surface and Near-Surface Samples, Submersible-Dive Reference, Water Depth, Geographic Coordinates, and Substrate Character

CORE NUMBER	SAMPLES	LOCATION	DIVE NUMBER	WATER DEPTH (m)	LATITUDE & LONGITUDE	SUBSTRATE
ACP01	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3624	2226	26º21.355' N 94º29.87156' W	White mud mound
ACP04	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3624	2227	26º21.35798' N 94º29.87998' W	White mud mound
ACP05	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3624	2225	26º21.35744' N 94º29.87757' W	Mud next to tubeworm clump
ACP10	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3625	2219	26º21.33252' N 94º29.86254' W	Orange bacterial mat with tubeworm roots
ACP11	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3625	2219	26º21.33252' N 94º29.86254' W	Mud next to mussel bed
ACP12	0-1.5 cm 1.5-2 cm	Alaminos Canyon	*Alvin* 3625	2219	26º21.33252' N 94º29.86254' W	Mud next to mussel bed
ACP13	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3625	2221	26º21.32115' N 94º29.8938' W	White, fluffy bacterial mat
ACP15	0-1 cm 1-2 cm	Alaminos Canyon	*Alvin* 3625	2221	26º21.32115' N 94º29.8938' W	Orange bacterial mat
ACB07	0-1 cm	Alaminos Canyon	*Alvin* 3624	2227	26º21.35635' N 94º29.87757' W	Gray bacterial mat with tubeworm roots
ACB08	0-2 cm	Alaminos Canyon	*Alvin* 3624	2227	26º21.35635' N 94º29.87757' W	Gray bacterial mat
ACB09	0-1 cm	Alaminos Canyon	*Alvin* 3624	2227	26º21.3596' N 94º29.87757' W	Fluffy bacterial mat (H_2S odor)
ACB19	0-1 cm	Alaminos Canyon	*Alvin* 3625	2219	26º21.35910' N 94º29.89801' W	Non-seep gray mud (control)
MCP02	0-1 cm 1-2 cm	Mississippi Canyon	*Alvin* 3631	1067	28º7.58' N 89º8.61' W	Mud from ridge top, near mussel bed
MCP04	0-1 cm 1-2 cm	Mississippi Canyon	*Alvin* 3631	1072	28º7.24097' N 89º8.4266' W	Gray bacterial mat
MCP08	0-1 cm 1-2 cm	Mississippi Canyon	*Alvin* 3631	1071	28º7.235' N 89º8.42' W	Gray bacterial mat
MCP69	0-1 cm 1-2 cm	Mississippi Canyon	*Alvin* 3630	1081	28º7.59777' N 89º8.62017' W	Bacterial mat
MCP73	0-1 cm 1-2 cm	Mississippi Canyon	*Alvin* 3631	1070	28º7.218' N 89º8.375' W	Black sediment with bacterial mat
GCP33	0-1 cm 1-2 cm	Green Canyon (Block 272)	*Alvin* 3626	664	27º41.1582' N 91º32.3409' W	White bacterial mat
GCP51	0-1 cm 1-2 cm	Green Canyon (Block 272)	*Alvin* 3627	696	27º41.01363' N 91º32.26124' W	Bacterial mat on mound with clams
GCP54	0-1 cm 1-2 cm	Green Canyon (Block 272)	*Alvin* 3627	675	27º41.01' N 91º32.25' W	White bacterial mat
GCP55	0-1 cm 1-2 cm	Green Canyon (Block 272)	*Alvin* 3627	689	27º41.13654' N 91º32.34759' W	Non-seep, buff-colored mud (control)
GCP57	0-1 cm 1-2 cm	Green Canyon (Block 272)	*Alvin* 3627	675	27º41.19448' N 91º32.28009' W	Sand (control)

Table 1-1. Core Location, Inventory of Surface and Near-Surface Samples, Submersible-Dive Reference, Water Depth, Geographic Coordinates, and Substrate Character (continued).

CORE NUMBER	SAMPLES	LOCATION	DIVE NUMBER	WATER DEPTH (m)	LATITUDE & LONGITUDE	SUBSTRATE
FCP61	0-1 cm	Farnella Canyon	*Alvin* 3628	2918	26º26.954' N 90º46.421' W	Tubeworm clump
GCP12	0-1 cm 1-2 cm	Green Canyon (Block 232)	*JSL* 2900 (1997)	569	27º44.44' N 91º19.08' W	White bacterial mat
GCP15	0-1 cm 1-2 cm	Green Canyon (Block 180)	*JSL* 2902 (1997)	245	27º47.8036' N 91º43.6981' W	Non-seep gray mud (control)
GBP08	0-1 cm 1-2 cm	Garden Banks (Block 427)	*JSL* 2896 (1997)	640	27º33.51' N 92º25.26' W	Non-seep gray mud (control)
DCB-S36	0-1 cm	De Soto Canyon	Bernhard	1848	28º55.4' N 87º39' W	Non-seep (control)
MCB-C7	0-1 cm	South of Mississippi Canyon	Bernhard	1076	27º43.7' N 89º58.7' W	Non-seep (control)

2. SYSTEMATICS

2.1. Introduction

The taxonomy of the large majority of benthic foraminiferal species encountered in this study is given in this chapter, with references to some previous uses of the chosen names and to significant synonyms. Where necessary, brief descriptions and reasons for accepting controversial names are given. Illustrations of 180 species, arranged alphabetically by their names, are given in the plates of the Atlas (Appendix); references to these plates accompany the species descriptions here. For suprageneric categories, we follow Loeblich and Tappan (1987), as modified by Sen Gupta (1999). Unless mentioned otherwise, the illustrations are scanning electron micrographs; the exceptions are digital photomicrographs.

The species described or discussed in this section are listed in Table 2-1. Five rare species, although named in a table of occurrences later (Table 3-1), are not included here, because of a lack of specimens suitable for illustration.

2.2. Foraminiferal Orders

2.2.1. Order Astrorhizida

Superfamily Astrorhizacea

Family Rhabdamminidae

Genus *Rhabdammina*

***Rhabdammina abyssorum* Sars**

Rhabdammina abyssorum Sars, 1869, p. 248.
Rhabdammina abyssorum Sars – Barker, 1960, p. 42, pl. 21, figs. 1-13.
Rhabdammina abyssorum Sars – Jones, 1994, p. 32, pl. 21, figs. 1-8, 10-13.

Morphology: Shell has three and sometimes four or five tubes radiating from a globular central cavity.

Figures:
Plate 152, fig. 1, Alaminos Canyon Boxcore B6 bulk sample, side view.
Scale bars = 50 μm.

***Rhabdammina discreta* Brady**

Rhabdammina discreta Brady, 1881, p. 48, pl. 22, figs. 7-10.
Rhabdammina discreta Brady – Brady, 1884, p. 268, pl. 22, figs. 11-13.
Rhabdammina discreta Brady – Cushman, 1918, p. 21, pl. 11, fig. 1.
Psammosiphonella discreta (Brady) – Barker, 1960, p. 44, pl. 22, figs. 7-10.

Table 2-1

Alphabetical List of Species Described or Discussed in Chapter 2

SPECIES	
Abditodentrix pseudothalmanni (Boltovskoy and Giussani de Kahn)	*Cornuspira involvens* (Reuss)
Adercotryma glomeratum (Brady)	*Cribromiliolinella subvalvularis* (Parr)
Ammobaculites catenulatus Cushman and McCulloch	*Cribrostomoides subglobosus* (Cushman)
Ammobaculites filiformis Earland	*Cystammina pauciloculata* (Brady)
Ammodiscus tenuis (Brady)	*Dentalina sp.*
Ammolagena clavata (Jones and Parker)	*Deuterammina rotaliformis* (Heron-Allen and Earland)
Ammoscalaria tenuimargo (Brady)	*Discammina compressa* (Goës)
Amphicoryna hirsuta (d'Orbigny)	*Discanomalina semipunctata* (Bailey)
Anomalinoides globulosus (Chapman and Parr)	*Dorothia scabra* (Brady)
Anomalinoides mexicanus Parker	*Eggerella bradyi* (Cushman)
Archimerismus subnodosus (Brady)	*Epistominella exigua* (Brady)
Barbourinella atlantica (Bermúdez)	*Epistominella vitrea* Parker
Bolivina alata (Seguenza)	*Eponides turgidus* Phleger and Parker
Bolivina albatrossi Cushman	*Eubuliminella morgani* (Andersen)
Bolivina barbata Phleger and Parker	*Fissurina fissa* (Heron-Allen and Earland)
Bolivina daggarius Parker	*Fissurina* sp. cf. *F. incomposita* (Patterson and Pettis)
Bolivina goesii Cushman	*Fursenkoina seminuda* (Natland)
Bolivina sp. cf. *B. hastata* Phleger and Parker	*Gaudryina minuta* Earland
Bolivina lowmani Phleger and Parker	*Gavelinopsis tranlucens* (Phleger and Parker)
Bolivina minima Phleger and Parker	*Globocassidulina subglobosa* (Brady)
Bolivina ordinaria Phleger and Parker	*Glomospira gordialis* (Jones and Parker)
Bolivina sp. cf. *B. pusilla* Schwager	*Glomospira irregularis* (Grzybowski)
Bolivina subaenariensis Cushman	*Gyroidina bradyi* (Trauth)
Bolivina translucens Phleger and Parker	*Gyroidina orbicularis* (Parker, Jones, and Brady)
Bolivinita quadrilatera (Schwager)	*Gyroidinoides* sp. cf. *G. polius* (Phleger and Parker)
Bulimina aculeata d'Orbigny	*Gyroidinoides* sp. cf. *G. regularis* (Phleger and Parker)
Bulimina alazanensis Cushman	*Haplophragmoides* sp. cf. *H. kirki* Wickenden
Bulimina marginata d'Orbigny	*Haynesina germanica* (Ehrenberg)
Bulimina mexicana Cushman	*Hoeglundina elegans* (d'Orbigny)
Buzasina ringens (Brady)	*Hormosina pilulifera* (Brady)
Calcituba polymorpha von Roboz	*Hormosinella distans* (Brady)
Cassidulina carinata Silvestri	*Hormosinella guttifera* (Brady)
Cassidulina curvata Phleger and Parker	*Hyperammina friabilis* Brady
Cassidulina obtusa Williamson	*Hyperammina laevigata* Wright
Cassidulinoides tenuis Phleger and Parker	*Hyperammina* sp.
Chilostomella oolina Schwager	*Ioanella tumidula* (Brady)
Cibicides lobatulus (Walker and Jacob)	*Karreriella bradyi* (Cushman)
Cibicides wuellerstorfi (Schwager)	*Karrerulina apicularis* (Cushman)
Cibicidoides pachyderma (Rzehak)	*Lagena chrysalis* Heron-Allen and Earland
Cibicidoides robertsonianus (Brady)	*Lagena hispida* Reuss
Cornuspira foliacea (Philippi)	*Lagena hispidula* Cushman

Table 2-1. Alphabetical List of Species Described or Discussed in Chapter 2 (continued).

SPECIES	
Lagenammina difflugiformis (Brady)	*Pseudoclavulina serventyi* (Chapman and Parr)
Lagenammina laguncula Rhumbler	*Pseudogaudryina atlantica* (Bailey)
Lagenammina tubulata (Rhumbler)	*Pseudoglandulina comatula* (Cushman)
Lamінononion tumidum (Cushman and Edwards)	*Pseudotrochammina* sp.
Laticarinina pauperata (Parker and Jones)	*Pullenia bulloides* (d'Orbigny)
Lenticulina calcar (Linnaeus)	*Pullenia quinqueloba* (Reuss)
Lenticulina gibba (d'Orbigny)	*Pyrgo lucernula* (Schwager)
Lenticulina pliocaena (Silvestri)	*Pyrgo murrhina* (Schwager)
Lenticulina thalmanni (Hessland)	*Pyrgo nasuta* Cushman
Lituotuba lituiformis (Brady)	?*Pyrgo* sp.
Martinottiella communis (d'Orbigny)	*Quinqueloculina bosciana* d'Orbigny
Melonis affinis (Reuss)	*Reophax agglutinatus* Cushman
Melonis pompilioides (Fichtel and Moll)	*Reophax scorpiurus* Dénys de Montfort
Miliolinella warreni Andersen	*Rhabdammina abyssorum* Sars
Miliolinella sp.	*Rhabdammina discreta* Brady
Multifidella nodulosa (Cushman)	*Rhizammina algaeformis* Brady
Neocrosbyia minuta (Parker)	*Rhizammina indivisa* Brady
Nonionella iridea Heron-Allen and Earland	*Robertina subcylindrica* (Brady)
Nuttallides decorata (Phleger and Parker)	*Robertinoides bradyi* (Cushman and Parker)
Oolina apiopleura (Loeblich and Tappan)	*Rutherfordoides mexicanus* (Cushman)
Oolina globosa (Montagu)	*Saccammina helenae* (Rhumbler)
Oolina ovum (Ehrenberg)	*Saccorhiza ramosa* (Brady)
Oolina squamosa (Montagu)	*Saracenaria altifrons* (Parr)
Orectostomina camposi (Brönnimann and Beurlen)	*Seabrookia earlandi* Wright
Oridorsalis umbonatus (Reuss)	*Sigmoilinita elliptica* (Galloway and Wissler)
Osangularia culter (Parker and Jones)	*Sigmoilopsis schlumbergeri* (Silvestri)
Osangularia rugosa (Phleger and Parker)	*Siphonina pulchra* Cushman
Parafissurina botelliformis (Brady)	*Siphonodosaria calomorpha* (Reuss)
Parafissurina kerguelenensis (Parr)	*Siphotextularia rolshauseni* Phleger and Parker
Parafissurina lateralis (Cushman)	*Spirillina vivipara* Ehrenberg
Paratrochammina challengeri Brönnimann and Whittaker	*Spiroplectammina* sp.
Parvigenerina arenacea (Heron-Allen and Earland)	*Stainforthia complanata* (Egger)
Patellina corrugata Williamson	*Stainforthia compressa* (Bailey)
Planispirinoides bucculentus var. *placentiformis* (Brady)	*Stainforthia pontoni* (Cushman)
Planulina ariminensis d'Orbigny	*Subreophax monile* (Brady)
Planulina foveolata (Brady)	*Tetrataxiella* sp.
Plectofrondicularia advena (Cushman)	*Textularia foliacea occidentalis* Cushman
Portatrochammina antarctica (Parr)	*Textularia* sp. cf. *T. mayori* Cushman
Praeglobobulimina ovata (d'Orbigny)	*Textularia mexicana* Cushman
Praeglobobulimina ovula (d'Orbigny)	*Textulariella barrettii* (Jones and Parker)
Procerolagena gracilis (Williamson)	*Trifarina bradyi* Cushman
Prolixoplecta parvula (Cushman)	*Trifarina jamaicensis* (Cushman and Todd)
Psammosphaera fusca Schulze	*Triloculina tricarinata* d'Orbigny
Pseudoclavulina mexicana (Cushman)	*Usbekistania charoides* (Jones and Parker)

Table 2-1. Alphabetical List of Species Described or Discussed in Chapter 2 (continued).

SPECIES	
Uvigerina auberiana d'Orbigny	*Valvulineria glabra* Cushman
Uvigerina bellula Bandy	*Valvulineria mexicana* Parker
Uvigerina flintii Cushman	*Vasiglobulina reticulata* Poag
Uvigerina peregrina Cushman	*Veleroninoides jeffreysii* (Williamson)
Vaginulinopsis subaculeata (Cushman)	*Veleroninoides wiesneri* (Parr)

Rhabdammina discreta Brady – Charnock and Jones, 1990, p. 152, pl. 1, fig. 25; pl. 2, fig. 23.
Rhabdammina discreta Brady – Kaminski *et al*., 1990, p. 363-364, pl. 1 fig. 3.
Rhabdammina discreta Brady – Jones, 1994, p. 32, pl. 22, figs. 7-10.

Morphology: Tubular shell, straight with constrictions at irregular intervals.

Remarks: As Berggren and Kaminski (1990) pointed out there is confusion about the morphology of the genus *Rhabdammina.* We are following Kaminski *et al.* (1990) in including single-branched, open agglutinated tubes under *Rhabdammina*.

Figures:
Plate 153, figs. 1-4, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Rhizammina*

Rhizammina algaeformis Brady

Rhizammina algaeformis Brady, 1879, p. 39, pl. 4, figs. 16-17.
Rhizammina algaeformis Brady – Brady, 1884, p. 274, pl. 28, figs. 1-11.
Rhizammina algaeformis Brady – Barker, 1960, p. 58, pl. 28, figs. 1-11.
Rhizammina algaeformis Brady – Jones, 1994, p. 36, pl. 28, figs. 1-11.

Morphological comments: Shell tubular, branching dichotomously.

Figures:
Plate 154, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 2, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, side view; fig. 3, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Rhizammina indivisa Brady

Rhizammina indivisa Brady, 1884, p. 277, pl. 29, figs. 5-7.
Rhizammina indivisa Brady – Cushman, 1918, p. 32, 33, pl. 12, figs. 7-10.
Testulosiphon indivisa (Brady) – Avnimelech, 1952, p. 64, 66.
Testulosiphon indivisa (Brady) – Barker, 1960, p. 60, pl. 29, figs. 5-7.
Testulosiphon indivisa (Brady) – Jones, 1994, p. 36, pl. 29, figs. 5-7.

Morphology: Shell an elongate tube tapering towards the ends; shell wall composed of two layers with varying numbers of planktonic Foraminifera overlying a finer clay layer.

Remarks: The original generic description of *Rhizammina* by Brady (1879) is of a branching tube. Branching or simple tubes are described in Loeblich and Tappan (1964) and only branching tubes in Loeblich and Tappan (1987). Kaminski *et al.* (1990) decribed *Rhizammina indivisa* as "unbranched curved tubes with a thin, finely agglutinated wall." However, in this study we have noted a wide variation in material picked up by the Foraminifera starting with a few planktonic shells on a fine clayey matrix to a complete layer of planktonic Foraminifera shells on finer material underneath.

Figures:
Plate 155, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, Mississippi Canyon Core P-69 Sample 0-1 cm, side view; fig. 3, De Soto Canyon control sample DGOMB2 S36, side view; fig. 4, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 µm.

Family Psammosphaeridae

Genus *Psammosphaera*

Psammosphaera fusca Schulze

Psammosphaera fusca Schulze, 1875, p. 113, pl. 2, figs. 8a-f.
Psammosphaera fusca Schulze – Brady, 1884, p. 249, pl. 18, figs. 1-8.
Psammosphaera fusca Schulze – Cushman, 1918, p. 34, 35, pl. 13, figs. 1-6; pl. 14, figs. 1-3.
Psammosphaera fusca Schulze – Barker, 1960, p. 36, pl. 18, figs. 1, 5-8.
Psammosphaera parva Flint – Barker, 1960, p. 36, pl. 18, figs. 2-4.
Psammosphaera fusca Schulze – Jones, 1994, p. 31, pl. 18, figs. 1-8.

Morphology: Shell a single, rough-textured, rounded chamber composed of loosely cemented large sand grains; no definite apertures.

Remarks: This is the original type species of the genus *Psammosphaera* Schulze 1875.

Figures:
Plate 137, figs. 1-2, Green Canyon Core P-51 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Family Saccamminidae

Genus *Lagenammina*

Lagenammina difflugiformis (Brady)

Reophax difflugiformis Brady, 1879, p. 51, pl. 4, figs. 3a, b.
Reophax difflugiformis Brady – Brady, 1884, p. 289, pl. 30, figs. 1-3.
Proteonina difflugiformis (Brady) – Cushman, 1918, p. 47, 48, pl. 21, figs. 1, 2.

Proteonina difflugiformis (Brady) – Phleger and Parker, 1951, p. 2, pl. 1, figs. 4, 5.
Reophax difflugiformis Brady – Barker, 1950, p. 62, pl. 30, figs. 1-3.
Lagenammina difflugiformis Brady – Charnock and Jones, 1990, p. 146, pl. 1, fig. 2; pl. 13, fig. 2.
Lagenammina sp. – Kaminski *et al.*, 1990, p. 365, pl. 2, fig. 2.
Lagenammina difflugiformis Brady – Jones, 1994, p. 36, pl. 30, figs. 1-3.

Morphology: Shell a single flask-shaped chamber; tubular neck tapering to terminal aperture.

Remarks: Kaminski *et al.* (1990) referred this species to *Lagenammina* sp. stating that *Lagenammina difflugiformis* (Brady) is in need of taxonomic revision based on type material. However, Charnock and Jones (1990) noted the similarity of their fossil specimens with the Recent types of *L. difflugiformis* in the Brady collection in the British Museum (Natural History).

Figures:
Plate 91, figs. 1-3, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 μm.

Lagenammina laguncula **Rhumbler**

Lagenammina laguncula Rhumbler, 1911, p. 92, 111, pl. 1, fig. 4.
Proteonina longicollis Wiesner, 1931, p. 82, pl. 6, fig. 55.

Morphology: Shell a single elongate chamber with a long thin neck and a round aperture.

Remarks: Wiesner (1931) states that *Proteonina longicollis* resembles *Lagenammina laguncula* Rhumbler but differs in its firm chamber ("fest Sandschale"). We accept *L. laguncula* due to priority.

Figures:
Plate 92, fig. 1, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view.
Scale bar = 50 μm.

Lagenammina tubulata **(Rhumbler)**

Saccammina tubulata Rhumbler, 1931, in Wiesner, 1931, p. 82, pl. 23, fig. 1.
Proteonina bulbosa Chapman and Parr, 1937, p. 150, pl. 10, fig. 42.
Lagenammina tubulata (Rhumbler) – Kuhnt et al., 2000, p. 279, pl. 1, fig. 14; pl. 10, fig. 2.

Morphology: Shell a single globular chamber terminating in a long, slender neck.

Remarks: The descriptions of *Lagenammina tubulata* (Rhumbler, in Wiesner, 1931) and *Proteonina bulbosa* by Chapman and Parr (1937) are essentially the same. We accept *S. tubulata* due to priority.

Figures:
Plate 93, figs. 1-3, De Soto Canyon control sample DGOMB2 S36, side view; fig. 4, Alaminos Canyon Boxcore B6 bulk sample, side view.
Scale bars = 50 µm.

Genus *Saccammina*

Saccammina helenae (Rhumbler)

Proteonina helenae Rhumbler, 1913, p. 380, pl. 2, figs. 16-17.
Proteonina helenae Rhumbler – Cushman, 1918, p. 50, pl. 20, figs. 6, 7.

Morphology: Shell a single chamber, fusiform in shape, tapering towards the aperture; shell wall composed of tests of planktonic foraminifera; aperture circular in shape.

Figures:
Plate 159, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, Alaminos Canyon Boxcore B6 bulk sample, side view.
Scale bars = 50 µm.

Superfamily Hippocrepinacea

Family Hippocrepinidae

Genus *Hyperammina*

Hyperammina friabilis Brady

Hyperammina friabilis Brady, 1884, p. 258, pl. 23, figs. 1-3, 5, 6.
Hyperammina friabilis Brady – Cushman, 1918, p. 75, 76, pl. 29, figs. 1-3.
Hyperammina friabilis Brady – Barker, 1960, p. 46, pl. 23, figs. 1-3, 5, 6.
Hyperammina friabilis Brady – Charnock and Jones, 1990, p. 150, pl. 1, fig. 14; pl. 13, fig. 15.
Hyperammina friabilis Brady – Jones, 1994, p. 33, pl. 23, figs. 1-3, 5, 6.

Morphology: Shell a straight, elongate tube which may taper slightly towards one end; proloculus large and rounded but frequently absent due to breakage.

Remarks: Differs from *H. elongata* Brady in its larger size, stouter dimensions and more broadly rounded proloculus.

Figures:
Plate 81, fig. 1, Alaminos Canyon Core PC10 Sample 0-1 cm, side view; fig. 2, Alaminos Canyon Boxcore B19.1 Sample 0-1 cm, side view; fig. 3, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 µm.

***Hyperammina laevigata* Wright**

Hyperammina elongata var. *laevigata* Wright, 1891, p. 466, pl. 20, fig. 1.
Hyperammina elongata Brady – Brady, 1884, p. 257, pl. 23, figs. 9, 10.
Hyperammina laevigata Wright – Cushman, 1918, p. 77, 78, pl. 29, figs. 5, 6.
?*Hyperammina tubulosa* Earland, 1934, p. 75, pl. 2, fig. 21.
Hyperammina laevigata Wright – Barker, 1960, p. 46, pl. 23, figs. 9, 10.
Hyperammina laevigata Wright – Jones, 1994, p. 33, pl. 23, figs. 9, 10.

Morphology: Shell a simple elongate tube, straight to slightly curved; proloculous varies from elongate to slightly bulbous; shell wall fine grained, smooth and polished; aperture a round opening.

Remarks: Barite-covered shells of *H. laevigata* are common in Mississippi Canyon Core P-73. *Hyperammina tubulosa* is probably synonymous with *H. laevigata* as the aboral end of *H. laevigata* is variable.

Figures:
Plate 82, figs. 1-2, De Soto Canyon control sample DGOMB2 S36, side view; fig. 3, Mississippi Canyon Core P-73 Sample 0-1 cm, side view; fig. 4, Mississippi Canyon Core P-73 Sample 1-2 cm, side view; fig. 5, Mississippi Canyon Core P-73 Sample 0-1 cm, side view; figs. 6-8, barite-encrusted specimens, Mississippi Canyon Core P-73 Sample 0-1 cm, side view.

Plate 83, barite-encrusted specimens, figs. 1, 3, 4, 8, Mississippi Canyon Core P-73 Sample 1-2 cm, side view; figs. 2, 5, 6, 7, Mississippi Canyon Core P-73 Sample 0-1 cm, side view.
Scale bars = 50 µm.

***Hyperammina* sp.**

Morphology: Shell a straight or slightly curved elongate tube; without a separate proloculus; shell wall composed of large sand grains, cemented closely together.

Remarks: Somewhat similar to *Hyperammina rugosa* Verdenius and van Hinte, 1983, p. 187, pl. 1, figs. 12-14. Kaminski *et al.* (1990) refer to this species as: “Straight tubular fragments with extremely coarse agglutination. A proloculus is sometimes present.”

Figures:
Plate 84, fig. 1, Alaminos Canyon Core PC10 Sample 0-1 cm (Rose-Bengal-stained), side view; fig. 2, Mississippi Canyon Core P-69 Sample 0-1 cm, side view; fig. 3, De Soto Canyon control sample DGOMB2 S36, side view; fig. 4, Green Canyon Core P-55 Sample 0-1 cm (Rose-Bengal-stained), side view.
Scale bars = 50 µm.

Genus *Saccorhiza*

***Saccorhiza ramosa* (Brady)**

Hyperammina ramosa Brady, 1879, p. 33, pl. 3, figs. 14-15.
Hyperammina ramosa Brady – Brady, 1884, p. 261, pl. 23, figs. 15-19.
Saccorhiza ramosa (Brady) – Eimer and Fickert, 1899, p. 670.
Saccorhiza ramosa (Brady) – Cushman, 1918, p. 81, 82, pl. 30, figs. 3, 4.
Saccorhiza ramosa (Brady) – Barker, 1960, p. 46, pl. 23, figs. 15-19.
Saccorhiza ramosa (Brady) – Poag, 1981, p. 82, pl. 15, fig. 4; pl. 16, figs. 4a, b.
Saccoriza ramosa (Brady) – Denne, 1990, pl. 12, fig. 5.
Saccorhiza ramosa (Brady) – Jones, 1994, p. 33, pl. 23, figs. 15-19.

Morphology: Shell a tubular chamber, straight, rounded, or branched; rounded proloculus (rarely seen in our specimens); shell wall composed of cemented sand grains, and frequently, numerous sponge spicules.

Figures:
Plate 160, figs. 1-3, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 4, Alaminos Canyon Boxcore B19.1 Sample 0-1 cm, side view.
Scale bars = 50 µm.

2.2.2. Order Lituolida

Superfamily Ammodiscacea

Family Ammodiscidae

Genus *Ammodiscus*

***Ammodiscus tenuis* (Brady)**

Trochammina (Ammodiscus) tenuis Brady, 1884, p. 51, pl. 38, figs. 4-6.
Ammodiscus incertus (d'Orbigny) – Cushman, 1918, p. 95, 96, pl. 39, figs. 1-8.
Involutina tenuis (Brady) – Barker, 1960, p. 78, pl. 38, figs. 5, 6.
Ammodiscus tenuis (Brady) – Charnock and Jones, 1990, p. 155, pl. 2, fig. 8; pl. 14, fig. 6.
Ammodiscus tenuis (Brady) – Jones, 1994, p. 43, pl. 38, figs. 4-6.

Morphology: Shell large; planispirally coiled with several overlapping convolutions.

Remarks: Brady's fig. 6 appears to show growth lines. None can be seen on any of our specimens.

Figures:
Plate 5, figs. 1-2, Alaminos Canyon Boxcore B7.1 Sample 0-1 cm, side view; figs. 3-5, Alaminos Canyon Boxcore B8.1 Sample 0-2 cm, side view; fig. 6, Alaminos Canyon Boxcore B6 bulk sample, side view.
Scale bars = 50 μm.

Genus *Ammolagena*

Ammolagena clavata (Jones and Parker)

Trochammina irregularis var. *clavata* Jones and Parker, 1860, p. 304.
Webbina clavata (Jones and Parker) – Brady, 1884, p. 349, pl. 41, figs. 12-16.
Ammolagena clavata (Jones and Parker) – Eimer and Fickert, 1899, p. 673.
Ammolagena clavata (Jones and Parker) – Cushman, 1918, p. 89, 90, pl. 34, figs. 2-5; pl. 35, figs. 1-3.
Ammolagena clavata (Jones and Parker) – Barker, 1960, p. 84, pl. 41, figs. 12-16.
Ammolagena clavata (Jones and Parker) – Charnock and Jones, 1990, p. 155, pl. 2, fig. 9; pl. 14, fig. 7.
Ammolagena clavata (Jones and Parker) – Kaminski *et al.*, 1990, p. 365, pl. 3, fig. 1.
Ammolagena clavata (Jones and Parker) – Jones, 1994, p. 46, pl. 41, figs. 12-16.
Ammolagena clavata (Jones and Parker) – Bender, 1995, p. 41, pl. 2, figs. 9a, 9b.
Ammolagena clavata (Jones and Parker) – Kuhnt *et al.*, 2000, p. 278, pl. 12, figs. 5-9.

Morphology: Shell a single ovate chamber with a tubular extension; commonly attached to planktonic Foraminifera in our samples.

Remarks: In some specimens the ovate chamber may be unattached (plate-figs. 2, 4) and may have been removed by mechanical breakage (plate-fig. 3) leaving only the tubular extension. In the figures of Kuhnt *et al.* (2000) the ovate chamber is also absent. Bender (1995) noted that some specimens show an ovoid central chamber with two tubular exits leading to terminal apertures. This is the type species by original monotypy of the genus *Ammolagena* Eimer and Fickert 1899.

Figures:
Plate 6, figs. 1-2, Green Canyon Core P-55 Sample 0-1 cm, side view; fig. 3, De Soto Canyon control sample DGOMB2 S36, side view; fig. 4, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Glomospira*

Glomospira gordialis (Jones and Parker)

Trochammina squamata var. *gordialis* Jones and Parker, 1860, p. 304.
Ammodiscus gordialis (Jones and Parker) – Brady, 1884, p. 333, pl. 38, figs. 7-9.
Glomospira gordialis (Jones and Parker) – Cushman, 1918, p. 99, 100, pl. 36, figs. 7-9.
Glomospira gordialis (Jones and Parker) – Barker, 1960, p. 78, pl. 38, figs. 7-9.
Glomospira gordialis (Jones and Parker) – Charnock and Jones, 1990, p. 156, pl. 2, fig. 12; pl. 14, fig. 9.
Glomospira gordialis (Jones and Parker) – Jones, 1994, p. 43, pl. 38, figs. 7-9.

Morphology: Shell coiled irregularly rather than streptospirally; coiling in some specimens tending to be planispiral.

Remarks: This is the type species by original monotypy of the genus *Glomospira* Rzehak1885. It was lectotypified by Berggren and Kaminski (1990).

Figures:
Plate 69, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 µm.

Glomospira irregularis (Grzybowski)

Ammodiscus irregularis Grzybowski, 1898, p. 285, pl. 11, figs. 2-3.
Ammodiscus demarginatus Grzybowski, 1898, p. 284-285, pl. 10, fig. 34.
Glomospira irregularis (Grzybowski) – Charnock and Jones, 1990, p. 157, pl. 2, fig. 14; pl. 14, fig. 11.
Glomospira irregularis (Grzybowski) – Kaminski et al., 1990, p. 365-366, pl. 3, fig. 3.

Morphology: Shell coiled haphazardly.

Remarks: Charnock and Jones (1990) retain the name *Glomospira irregularis* over *G. demarginatus* despite the latter having priority by page, because according to current I.C.Z.N. rules, this is not a means of establishing seniority.

Figures:
Plate 70, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 2, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 µm.

Genus *Usbekistania*

***Usbekistania charoides* (Jones and Parker)**

Trochammina squamata var. *charoides* Jones and Parker, 1860, p. 304.
Ammodiscus charoides (Jones and Parker) – Brady, 1884, p. 334, pl. 38, figs. 10-16.
Glomospira charoides (Jones and Parker) – Cushman, 1918, p. 100, 101, pl. 36, figs. 10-15.
Glomospira charoides (Jones and Parker) – Barker, 1960, p. 78, pl. 38, figs. 10-16.
Usbekistania charoides (Jones and Parker, 1860) – Charnock and Jones, 1990, p. 158, pl. 2, figs. 17-19; pl. 14, fig. 13.
Glomospira charoides (Jones and Parker) – Denne, 1990, pl. 6, fig. 15.
Glomospira charoides (Jones and Parker) – Kaminski *et al.*, 1990, p. 365, pl. 3, fig. 2.
Usbekistania charoides (Jones and Parker, 1860) – Jones, 1994, p. 43, pl. 38, figs. 10-16.

Morphology: Shell streptospirally coiled to form a subglobular mass.

Remarks: Jones states that this species was referred to *Usbekistania* by Charnock and Jones (1990) and comments: "It has recently been lectotypified by Berggren and Kaminski (1990). It is also, by synonymy with the originally designated *Glomospirella* (*Usbekistania*) *mubarakensis* Suleymanov 1960, the type species of *Usbekistania* Suleymanov 1960. *Usbekistania* differs from the irregularly coiled *Glomospira* in being strictly streptospiral, that is in being characterized by regular changes in the axis of coiling."

Figures:
Plate 183, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 3, De Soto Canyon control sample DGOMB2 S36, side view; figs. 4-6, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 µm.

Superfamily Hormosinacea

Family Hormosinidae

Genus *Hormosinella*

***Hormosinella distans* (Brady)**

Lituola (Reophax) distans Brady, 1881, p. 50.
Reophax distans (Brady) – Brady, 1884, p. 296, pl. 31, figs. 18-22.
Reophax distans (Brady) – Cushman, 1920, 12, pl. 3, figs. 5, 6.
Reophax distans delicatulus Cushman – Parker, 1954, p. 482, pl. 1, fig. 4.
Reophax distans (Brady) – Barker, 1960, p. 64, pl. 31, figs. 18-22.
Hormosinella distans (Brady) – Charnock and Jones, 1990, p. 163-164, pl. 4, figs. 10-11; pl. 15, fig. 11.

Hormosinella distans (Brady) – Kaminski *et al.*, 1990, p. 366, pl. 3, fig. 10.
Hormosinella distans (Brady) – Jones, 1994, p. 38, pl. 31, figs. 18-22.

Morphology: Chambers vary from rounded and globular to fusiform and tapering; linked by stoloniferous tubes.

Remarks: Specimens of this study were all unilocular. The specimen illustrated in plate 79, fig. 1 matches Cushman's *Reophax distans* var. *delicatulus* (1920), and that in plate 79, fig. 2 matches his *R. distans* var. *turbo* (1920). This is the type species of the genera *Hormosinella* Shchedrina 1969 and *Cadminus* Saidova 1970.

Figures:
Plate 79, figs. 1-3, De Soto Canyon control sample DGOMB2 S36, side view; fig. 4, Green Canyon Core P-57 Sample 1-2 cm, side view.
Scale bars = 50 µm.

Hormosinella guttifera **(Brady)**

Lituola (Reophax) guttifera Brady, 1881, p. 49.
Reophax guttifera (Brady) – Brady, 1884, p. 295, pl. 31, figs. 10-15.
Reophax guttifera (Brady) – Barker, 1960, p. 64, pl. 31, figs. 10-15.
Hormosinella guttifera (Brady) – Jones, 1994, p. 38, pl. 31, figs. 10-15.

Morphology: A series of pyriform chambers tapering into stoloniferous tubes which connect the chambers together.

Figures:
Plate 80, figs. 1-2, south of Mississippi Canyon control sample DGOMB2 C7, side view; fig. 3, Green Canyon Core P-57 Sample 1-2 cm, side view.
Scale bars = 50 µm.

Genus *Reophax*

Reophax agglutinatus **Cushman**

Reophax scorpiurus Dénys de Montfort – Brady, 1884, pl. 30, fig. 13.
Reophax agglutinatus Cushman, 1913, p. 637, pl. 79, figs. 6a, 6b.
Reophax agglutinatus Cushman – Cushman, 1920, p. 9, 10, pl. 2, figs. 4, 5.
Reophax agglutinans Cushman – Barker, 1960, p. 62, pl. 30, fig. 13.
Reophax agglutinans Cushman – Jones, 1994, p. 37, pl. 30, fig. 13.

Morphology: 3 to 4 gradually enlarging pear-shaped chambers; shell wall composed largely of planktonic foraminiferal tests, dominantly *Globigerina*.

Remarks: Brönnimann and Whittaker (1980) comment that the *Challenger* specimen shown by pl. 30 fig. 13 differs from *R. scorpiurus* Dénys de Montfort *s.s.* and *R. bradyi*.

Figures:
Plate 150, figs. 1-2, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 μm.

Reophax scorpiurus **Dénys de Montfort**

Reophax scorpiurus Dénys de Montfort, 1808, p. 331.
Reophax scorpiurus Dénys de Montfort – Brady, 1884, p. 291, pl. 30, figs. 12, 15-17.
Reophax scorpiurus Dénys de Montfort – Cushman, 1920, p. 6, 7, pl. 1, figs. 5-7.
Reophax scorpiurus Dénys de Montfort – Phleger and Parker, 1951, p. 3, pl. 1, figs. 7, 8.
Reophax scorpiurus Dénys de Montfort – Parker, 1954, p. 484, pl. 1, fig. 11.
Reophax scorpiurus Dénys de Montfort – Barker, 1960, p. 62, pl. 30, figs. 12, 15-17.
Reophax scorpiurus Dénys de Montfort – Brönnimann and Whittaker, 1980, p. 261, figs. 1-7, 12, 17 (neotype).
Reophax scorpiurus Dénys de Montfort – Jones, 1994

Morphology: 3 to 4 pear-shaped asymmetric chambers increasing rapidly in size, in an irregular series; coarsely agglutinated shell wall; aperture terminal and rounded on a neck.

Remarks: This species is conspecific with the neotype assigned by Brönnimann and Whittaker (1980).

Figures:
Plate 151, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Subreophax*

Subreophax monile **(Brady)**

Trochammina (Hormosina) monile – Brady, 1881, p. 52, pl. 39, figs. 10-13.
Hormosina monile (Brady) – Brady, 1884, p. 328, pl. 39, figs. 10-13.
Hormosina monile (Brady) – Cushman, 1920, p. 30, pl. 6, fig. 4.
Hormosina monile (Brady) – Barker, 1960, p. 80, pl. 39, figs. 10-13.
Subreophax monile (Brady) – Jones, 1994, p. 44, pl. 39, figs. 10-13.

Morphology: Uniserial series of chambers, straight to curved; chambers rounded to globular, may be the same size throughout the series or increasing slightly in size; shell wall rough to hispid; round aperture is located on the top of a collar.

Figures:
Plate 174, fig. 1, Green Canyon Core P-51 Sample 0-1 cm, side view; figs. 2-3, Green Canyon Core P-51 Sample 1-2 cm, side view; figs. 4a-b, Green Canyon Core P-51 Sample 1-2 cm, 4a: side view, 4b: tilted side view.
Scale bars = 50 μm.

Genus *Archimerismus*

Archimerismus subnodosus (Brady)

Hyperammina subnodosa Brady, 1884, p. 259, pl. 23, figs. 11-14.
Hyperammina subnodosa Brady – Cushman, 1918, p. 76, 77, pl. 29, figs. 7, 8.
Hyperammina subnodosa Brady – Barker, 1960, p. 46, pl. 23, figs. 11-14.
Archimerismus subnodosus (Brady) – Jones, 1994, p. 33, pl. 23, figs. 11-14.

Morphology: Shell elongate; elongate tubular chambers, irregularly increasing in size, separated by constrictions in the shell wall that do not form true septa.

Remarks: *Hyperammina subnodosa* is the type species of the genus *Archimerismus* (Loeblich and Tappan, 1984). *Archimerismus* differs from *Hyperammina* in having incipient septa.

Figures:
Plate 12, fig. 1, Alaminos Canyon Core PC5 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Genus *Hormosina*

Hormosina pilulifera (Brady)

Reophax pilulifera Brady, 1884, p. 292, pl. 30, figs. 18-20.
Reophax pilulifer Brady – Cushman, 1920, p. 7, pl. 2, fig. 1.
Reophax pilulifer Brady – Barker, 1960, p. 62, pl. 30, figs. 18-20.
Hormosina pilulifera Brady – Charnock and Jones, 1990, p. 162, pl. 4, fig. 5; pl. 15, fig. 7.
Hormosina pilulifera Brady – Jones, 1994, p. 37, pl. 30, figs. 18-20.

Morphology: Shell uniserial or slightly curved; symmetrical globular chambers increasing in size rapidly; aperture terminal and rounded on a short neck.

Figures:
Plate 78, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; figs. 2-3, south of Mississippi Canyon control sample DGOMB2 C7, side view; fig. 4, Green Canyon Core P-57

Sample 1-2 cm, side view; fig. 5, Green Canyon Core P-55 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Superfamily Lituolacea

Family Haplophragmoididae

Genus *Buzasina*

Buzasina ringens (Brady)

Trochammina ringens Brady, 1879, p. 57, pl. 5, figs. 12a, b.
Haplophragmoides ringens (Brady) – Cushman, 1920, p. 49, 50, pl. 9, fig. 2.
Alveolophragmium ringens (Brady) – Parker, 1954, p. 487, pl. 1, fig. 19.
Alveolophragmium ringens (Brady) – Barker, 1960, p. 82, pl. 40, figs. 17, 18.
Buzasina ringens (Brady) – Jones, 1994, p. 45, pl. 40, figs. 17, 18.

Morphology: Shell planispirally enrolled with rapidly enlarging and strongly overlapping chambers; 5 chambers; shell wall thin; areal and slit-like aperture.

Remarks: Five chambers have been reported to be in each whorl of this species and are clearly seen in *Challenger* pl. 40 fig. 18. Our specimens show only two to four chambers in the final whorl. This is the type species of the genus *Buzasina* Loeblich and Tappan 1985.

Figures:
Plate 31, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, Alaminos Canyon Boxcore B6 bulk sample, side view; fig. 3, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 µm.

Genus *Cribrostomoides*

***Cribrostomoides subglobosus* (Cushman)**

Lituola subglobosa Sars, 1868 (1869), p. 250 (nomen nudum); Sars, 1872, p. 253.
Haplophragmium latidorsatum (Bornemann) - Brady, 1884, p. 307, pl. 34, figs. 8-10.
Haplophragmoides subglobosum (Sars) – Cushman, 1910, p. 105, text figs. 162-164.
Alveophragmium subglobosum (Sars) – Parker, 1954, p. 487, pl. 2, figs. 1, 2.
Alveophragmium subglobosum (Sars) – Barker, 1960
Cribrostomoides subglobosus (Cushman) – Jones, 1994, p. 40, pl. 34, figs. 8-10.

Morphology: Shell planispiral; periphery broadly rounded; chambers highly inflated; aperture a slit lying obliquely at the base of the final chamber.

Figures:
Plate 50, figs. 1a-b, Green Canyon (Block 272) Core P-57 Sample 1-2 cm, 1a: side view, 1b: edge view.
Scale bars = 50 μm.

Genus *Haplophragmoides*

Haplophragmoides **sp. cf.** ***H. kirki*** **Wickenden**

Haplophragmoides kirki Wickenden, 1932, p. 85, pl. 1, figs. 1a-c.
Haplophragmoides kirki Wickenden – Verdenius and van Hinte, 1983, p. 193, pl. 5, fig. 13.
Haplophragmoides kirki Wickenden – Charnock and Jones, 1990, p. 170, pl. 5, figs. 17-18; pl. 16, fig. 10.
Haplophragmoides cf. *kirki* Wickenden – Kaminski et al., 1990, p. 368, pl. 5, figs. 3a, b.

Morphology: Shell planispiral, involute; 4-5 chambers in the final whorl; quadrate in outline; shell wall finely agglutinated; aperture a simple arch at the base of the final chamber.

Remarks: As with Kaminski *et al.* (1990), our specimens are more robust than the typical *H. kirki* from the upper Cretaceous of Alberta.

Figures:
Plate 75, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: side view, c: apertural view.
Scale bars = 50 μm.

Genus *Veleroninoides*

Veleroninoides jeffreysii **(Williamson)**

Haplophragmium canariensis d'Orbigny – Brady, 1884, p. 310, pl. 35, figs. 1-3, 5.
Nonionina jeffreysii Williamson 1858, p. 34, figs. 72, 73.
Haplophragmoides canariensis (d'Orbigny) - Cushman, 1920, p. 38, pl. 8, fig. 1.
Cribrostomoides jeffreysii (Williamson) – Haynes, 1973.
Veleroninoides jeffreysii (Williamson) – Jones, 1994, p. 41, pl. 35, figs. 1-3, 5.

Morphology: Planispiral, discoid shell; lobulate periphery; broad and deep umbilicus.

Remarks: This species is flatter than *V. wiesneri*. *V. jeffreysii* has been reported from Gulf of Mexico seafloor sediments, but in our samples it is found only attached to tubeworms.

Figures:
Plate 192, fig. 1, Mississippi Canyon tubeworm EC1, digital photomicrograph; fig. 2, Mississippi Canyon tubeworm MC2.

***Veleroninoides wiesneri* (Parr)**

Trochammina trullissata Brady, 1884, p. 342, pl. 40, figs. 14, 15 (not figs. 13, 16).
Haplophragmoides trullissata (Brady) – Cushman, 1920, p. 43, pl. 9, fig. 5.
Labrospira wiesneri Parr, 1950, p. 272, pl. 4, figs. 25-26.
Alveolophragmium wiesneri (Parr) – Parker, 1954, p. 488, pl. 1, fig. 23.
Alveolophragmium wiesneri (Parr) – Barker, 1960, p. 82, pl. 40, figs. 14,15.
Cribrostomoides wiesneri (Parr) – Denne, 1990, pl. 4, fig. 11.
Veleroninoides wiesneri (Parr) – Jones, 1994, p. 45, pl. 40, figs. 14-15.

Morphology: Shell evolute planispiral; periphery slightly lobulate; about 3 whorls; chambers of the earlier whorls seen in the depressed umbilical region, about 7 chambers in the final whorl; aperture slit at the base of the final chamber.

Figures:
Plate 193, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; figs. 2-3, Green Canyon Core P-57 Sample 1-2 cm, side view.
Scale bars = 50 µm.

Family Discamminidae

Genus *Ammoscalaria*

***Ammoscalaria tenuimargo* (Brady)**

Haplophragmium tenuimargo Brady, 1882, p. 715.
Haplophragmium tenuimargo Brady – Brady, 1884, p. 303, pl. 33, figs. 13-16.
Ammobaculites tenuimargo (Brady) - Cushman, 1920, p. 65, pl. 13, figs. 3-5.
Ammoscalaria tenuimargo (Brady) – Höglund, 1947, p. 151.
Ammoscalaria tenuimargo (Brady) – Jones, 1994, p. 40, pl. 33, figs. 13-16.

Morpholgy: Coarsely agglutinated shell, with a planispiral initial coil followed by a rectilinear series of chambers; aperture terminal.

Remarks: This is the type species of the genus *Ammoscalaria*. In our samples, it is found only attached to tubeworms.

Figures:
Plate 7, fig. 1, Alaminos Canyon tubeworm LS1, digital photomicrograph; fig. 2, Alaminos Canyon tubeworm LS4, digital photomicrograph; fig. 3, Alaminos Canyon tubeworm LS3; fig. 4, higher magnification view of initial coil in fig. 3.

Genus *Discammina*

***Discammina compressa* Goës**

Lituolina irregularis (Römer) var. *compressa* Goës, 1882, p. 141, pl. 12, figs. 421-423.
Haplophragmium emaciatum Brady, 1884, p. 305, pl. 33, figs. 26-28.
Haplophragmoides emaciatum (Brady) – Cushman, 1920, p. 40, 41, pl. 8, fig. 4.
Discammina compressa (Goës) – Barker, 1960, p. 68, pl. 33, figs. 26-28.
Discammina compressa (Goës) – Poag, 1981, p. 58, pl. 9, fig. 4; pl. 10, figs. 4a, b.
Discammina compressa (Goës) – Jones, 1994, p. 40, pl. 33, figs. 26-28.

Morphology: Shell planispiral; somewhat umbilicate; up to 3 whorls; later chambers inflated; shell wall composed of sand grains, roughly finished; aperture a narrow, elongate slit at the base of the final chamber.

Remarks: This is the type species by synonymy with the originally designated *D. fallax* Lacroix 1932, of the genus *Discammina* Lacroix 1932. Goës' original description of *D. compressa* and Cushman's description of *H. emaciatum* both mention a shell wall containing varying amounts of sponge spicules. Our specimens, however, contain no spicules.

Figures:
Plate 54, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 1a: side view, 1b: side view, 1c: edge view; fig. 2, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, edge view; figs. 3-4, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: edge view. Scale bars = 50 μm.

Family Lituotubidae

Genus *Lituotuba*

***Lituotuba lituiformis* (Brady)**

Trochammina lituiformis Brady, 1879, p. 59, pl. 5, fig. 16.
Trochammina lituiformis Brady – Brady, 1884, p. 342, pl. 40, figs. 4-7.
Lituotuba lituiformis (Brady) – Cushman, 1920, p. 59, pl. 12, figs. 1, 2.
Lituotuba lituiformis (Brady) – Barker, 1960, p. 82, pl. 40, figs. 4-7.
Lituotuba lituiformis (Brady) – Jones, 1994, p. 44, 45, pl. 40, figs. 4-7.

Morphology: Initial end coiled planispirally, followed by uniserial, rounded to globular chambers.

Remarks: This is the type species by subsequent designation of the genus *Lituotuba* Rhumbler, 1895.

Figures:
Plate 101, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 μm.

Family Lituolidae

Genus *Ammobaculites*

Ammobaculites catenulatus Cushman and McCulloch

Ammobaculites catenulatus Cushman and McCulloch, 1939, p. 90, pl. 7, figs. 11-14.

Morphology: Shell compressed; initally planispirally coiled, later uncoiled and rectilinear; umbilical region somewhat depressed; sutures indistinct; aperture terminal.

Figures:
Plate 3, figs. 1a-d, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: side view, 1c: edge view, 1d: apertural view; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 2a: side view, 2b: side view.
Scale bars = 50 μm.

Ammobaculites filiformis Earland

Haplophragmium agglutinans d'Orbigny – Brady, 1884, p. 301, pl. 32, figs. 22-23.
Ammobaculites agglutinans var. *filiformis* Earland, 1934, p. 92, pl. 3, figs. 11-13.
Ammobaculties filiformis Earland – Barker, 1960, p. 66, pl. 32, figs. 22-23.
Ammobaculites filiformis Earland – Jones, 1994, p. 39, pl. 32, figs. 21?, 22-23.

Morphology: Shell very small; initial end coiled, followed by a rectilinear series of round chambers; number of chambers in the series ranges between 4 and 10; aperture terminal and rounded.

Figures:
Plate 4, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 2, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 3, Alaminos Canyon Core PC5 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Superfamily Haplophragmiacea

Family Ammosphaeroidinidae

Genus *Adercotryma*

***Adercotryma glomeratum* (Brady)**

Lituola glomerata Brady, 1878, p. 433, pl. 20, figs. 1a-c.
Haplophragmium glomerata (Brady) – Brady, 1884, p. 309, pl. 34, figs. 15-18.
Haplophragmoides glomeratum (Brady) – Cushman, 1920, p. 47, 48, pl. 9, fig. 6.
Adercotryma glomeratum (Brady) – Parker, 1954, p. 486, pl. 1, fig. 18.
Adercotryma glomeratum (Brady) – Poag, 1981, p. 35, pl. 15, fig. 2; pl. 16, figs. 2a, 2b.
Adercotryma glomeratum (Brady) – Denne, 1990, pl. 1, fig. 2.
Adercotryma glomeratum (Brady) – Jones, 1994, p. 41, pl. 34, figs. 15-18.

Morphology: Shell subglobular to elongated in the axis of coiling; streptospirally enrolled; few whorls; few chambers in each whorl; chambers elongated in the axis of coiling; aperture a low interiomarginal arch located towards the umbilicus.

Remarks: This is the type species of the genus *Adercotryma* Loeblich and Tappan 1952. Brönnimann and Whittaker (1987), who designated a lectotype for it, point out that the correct trivial name is the neuter *glomerat-um* rather than the feminine *glomerat-a*.

Figures:
Plate 2, figs. 1-3, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 μm.

Genus *Cystammina*

***Cystammina pauciloculata* (Brady)**

Trochammina pauciloculata Brady, 1879, p. 58, pl. 5, figs. 13-14.
Trochammina pauciloculata Brady – Brady, 1884, p. 344, pl. 41, figs. 1, 2.
Ammochilostoma pauciloculata (Brady) – Cushman, 1920, p. 86.
Cystammina pauciloculata (Brady) – Jones, 1994, p. 45. pl. 41, fig. 1.

Morphology: Shell ovoid, obscurely spiral; early chamber hidden, only 3-4 chambers visible; sutures distinct, depressed; shell wall finely arenaceous, smooth; aperture an elongate arched slit at the base of the final chamber.

Figures:
Plate 51, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 2, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Superfamily Spiroplectamminacea

Family Spiroplectamminidae

Genus *Orectostomina*

***Orectostomina camposi* (Brönnimann and Beurlen)**

Spiroplectamminoides camposi Brönnimann and Beurlen, 1977, p. 87, 88, pl. 3, figs. 1-3, 6-8, 10.
Orectostomina camposi (Brönnimann and Beurlen) – Loeblich and Tappan, 1987, p. 111, pl. 119, figs. 13-17.

Morphology: Shell elongate; rounded periphery; early chambers arranged in a planispiral coil followed by a short biserial stage; biserial chambers increasing rapidly in height; shell wall finely agglutinated; aperture an oblong crescent-like opening surrounded by thin, strongly protruding lips in the center of the septal face of the final chamber.

Figures:
Plate 115, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view.
Scale bars = 50 μm.

Genus *Spiroplectammina*

***Spiroplectammina* sp.**

Morphology: Shell elongate, some specimens slightly curved; initial end broadly rounded and slightly tapered; early chambers arranged in a planispiral coil, later chambers biserially arranged; shell wall finely agglutinated; aperture at the base of the final chamber.

Remarks: This species resembles Cushman's *Spiroplecta wrightii* (1922, p. 5) but not Silvestri's illustration of the type specimens (Loeblich and Tappan, 1987, pl. 120, figs. 1-6).

Figures:
Plate 170, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, De Soto Canyon control sample DGOMB2 S36, side view; fig. 3, De Soto Canyon control sample DGOMB2 S36, side view; fig. 4, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 μm.

Family Pseudobolivinidae

Genus *Parvigenerina*

***Parvigenerina arenacea* (Heron-Allen and Earland)**

Bifarina porrecta (Brady) var. *arenacea* Heron-Allen and Earland, 1922, p. 132, pl. 4, figs. 23-26.
Parvigenerina arenacea (Heron-Allen and Earland) – Loeblich and Tappan, 1987, p. 116, pl. 123, figs. 13-16.

Morphology: Shell elongate; early chambers arranged biserially, later chambers becoming uniserial; shell wall finely agglutinated; aperture terminal on a distinct neck.

Remarks: Charnock and Jones (1990) noted that this genus differs from *Plectinella* Marie in becoming semi-uniserial to uniserial in later stages.

Figures:
Plate 123, figs. 1a-b, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view. Scale bars = 50 μm.

Superfamily Verneuilinacea

Family Prolixoplectidae

Genus *Karrerulina*

***Karrerulina apicularis* (Cushman)**

Gaudryina siphonella Reuss - Brady, 1884, p. 382, pl. 46, figs. 17-19.
Gaudryina apicularis Cushman, 1911, p. 70, textfig. 110.
Gaudryina apicularis Cushman – Cushman, 1922, p. 72, 73, pl. 8, fig. 4.
Plectina apicularis (Cushman) – Cushman, 1937, p. 110, pl. 12, figs. 22-26
Plectina apicularis (Cushman) – Phleger and Parker, 1951, p. 6, pl. 3, fig. 3.
Plectina apicularis (Cushman) – Parker, 1954, p. 495, pl. 3, fig. 18.
Karreriella (Karrerulina) apicularis (Cushman) – Barker, 1960, p. 94, pl. 46, figs. 17-19.
Karreriella apicularis (Cushman) – Pflum and Frerichs, 1976, pl. 1, fig. 2.
Karreriella apicularis (Cushman) – Poag, 1981, pl. 15, fig. 5; pl. 16, figs. 5a, b.
Karrerulina conversa (Grzybowski) – Charnock and Jones, 1990, p. 195, 196, pl. 12, fig. 19; pl. 25, fig. 10.
Karrerulina apicularis (Cushman) – Denne, 1990, pl. 7, fig. 10.
Karrerulina conversa (Grzybowski) – Jones, 1994, p. 51, pl. 46, figs. 17-19.
Karrerulina apicularis (Cushman) – Bender, 1995, p. 46, pl. 6, fig. 1; pl. 11, fig. 2.
Karrerulina apicularis (Cushman) – Kuhnt et al., 2000, p. 279, pl. 8, figs. 6-9.

Morphology: Shell elongate; early chambers arranged triserially, later chambers becoming biserial, biserial portion making up more than half of the shell; sutures depressed; shell wall coarsely agglutinated; aperture rounded at the end of a neck-like extension on the final chamber.

Remarks: It is the type species, by synonymy with the originally designated *Gaudryina apicularis* Cushman 1911, of the genus *Karrerulina* Finlay 1940.

Figures:
Plate 87, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, De Soto Canyon control sample DGOMB2 S36, side view with a broken final chamber; figs. 3-4, Alaminos Canyon Boxcore B6 bulk sample, side view.
Scale bars = 50 μm.

Prolixoplecta parvula **Cushman**

Textularia parvula Cushman, 1922, p. 11, pl. 6, figs. 1, 2.
Textularia parvula Cushman – Phleger and Parker, 1951, p. 5, pl. 2, fig. 8.
Prolixoplecta parvula (Cushman) – Denne, 1990, pl. 10, fig. 13.

Morphology: Shell elongate, tapering from pointed initial end to rounded apertural end; numerous distinct chambers; sutures depressed; wall agglutinated; aperture at the base of the final chamber.

Figures:
Plate 136, fig. 1, Mississippi Canyon Core P-69 Sample 0-1 cm, side view; fig. 2, Mississippi Canyon Core P-69 Sample 1-2 cm, side view; figs. 3-4, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, side view; fig. 5, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Family Verneuilinidae

Genus *Gaudryina*

Gaudryina minuta **Earland**

Gaudryina minuta Earland, 1934, p. 121, pl. 5, figs. 45, 46.
Gaudryina cf. *minuta* Parker, 1954, p. 493, pl. 15, 16.

Morphology: Shell elongate, tapering to the initial end; early chambers arranged triserially, later chambers arranged biserially; sutures depressed; aperture a textularian slit on the inner margin of the final chamber.

Remarks: Parker (1954) states that her *Gaudryina* cf. *minuta* specimens are larger and more elongate than *Gaudryina exilis* Cushman and Bronnimann and in some cases reach a greater length than that given by Earland. *Gaudryina exilis* Cushman and Bronnimann differs from *G. minuta* Earland in its larger size, much shorter triserial stage and shorter chambers. Some of our specimens reach 0.55 mm in length, thus exceeding the maximum length of 0.4 mm given by Parker (1954).

Figures:
Plate 66, figs. 1, 4, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2-3, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Genus *Barbourinella*

***Barbourinella atlantica* (Bermúdez)**

Barbourina atlantica Bermúdez, 1939, p. 10, pl. 1, figs. 1-4.
Barbourinella atlantica (Bermúdez) – Loeblich and Tappan, 1987, p. 137, pl. 144, figs. 15, 16.

Morphology: Shell triangular in section; triserial throughout; shell wall coarsely agglutinated; aperture located in the center of the final chamber, circular to elongate on a short neck.

Remarks: Bermúdez’s original description of the aperture states that it is in the center of the terminal face of the final chamber, circular, and protected by a short and protracted neck. Our specimens match this description except the apertures are elongated rather than circular. We consider this to be within the natural range of morphological variation.

Figures:
Plate 13, figs. 1, 3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: apertural view; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 2a: side view, 2b: apertural view.
Scale bars = 50 µm.

Superfamily Ataxophragmiacea

Family Globotextulariidae

Genus *Tetrataxiella*

***Tetrataxiella* sp.**

Morphology: Shell spiral, trochoid; 3-5 whorls with 4 chambers in each whorl; periphery subacute; ventral surface with a sunken umbilicus; sutures on ventral surface straight, slightly depressed; shell wall finely agglutinated with occasional larger sand grains; aperture interiomarginal and umbilical loop.

Remarks: The species is placed in *Tetrataxiella* Seiglie 1964 (conical, quadriserial throughout, aperture an interiomarginal arch opening into the umbilicus; Caribbean). Charnock and Jones (1990) noted that Brönnimann and Whittaker (1988, p. 88) synonymised *Tetrataxiella* Seiglie with *Gravellina* Brönnimann, 1953.

Figures:
Plate 175, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: ventral view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 2, dorsal view; figs. 3a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 3a: side view, 3b: ventral view; fig. 4, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Family Textulariellidae

Genus *Textulariella*

Textulariella barrettii **(Jones and Parker)**

Textularia barrettii Jones and Parker, 1876, p. 99, text-figs.
Textularia trochus d'Orbigny – Brady, 1884, p. 367, pl. 43, fig. 17; pl. 44, fig. 3.
Textularia barrettii Jones and Parker – Brady, 1884, p. 367, pl. 44, figs. 6-8.
Textularia barrettii Jones and Parker – Cushman, 1922, p. 20, pl. 3, figs. 3-6.
Textulariella barrettii (Jones and Parker) – Cushman, 1937, p. 66, pl. 7, figs. 5-8.
Textulariella barrettii (Jones and Parker) – Barker, 1960, p. 88, pl. 43, fig. 17; p. 90, pl. 44, figs. 3, 6-8.
Textulariella barrettii (Jones and Parker) – Denne, 1990, pl. 13, fig. 10.
Textulariella barrettii (Jones and Parker) – Jones, 1994, p. 48, pl. 43, fig. 17; p. 49, pl. 44, figs. 3, 6-8.

Morphology: Shell conical; circular in transverse section; sutures distinct, frequently slightly raised; aperture a low, elongate opening at the inner margin of the final chamber.

Remarks: This is the type species of the genus *Textulariella* Cushman 1927. It has been lectotypified by Loeblich and Tappan (1964).

Figures:
Plate 179, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 µm.

2.2.3. Order Trochamminida

Superfamily Trochamminacea

Family Trochamminidae

Genus *Paratrochammina*

***Paratrochammina challengeri* Brönnimann and Whittaker**

Lituola nautiloidea Lamarck var. *globigeriniformis* Parker and Jones, 1865, p. 407, pl. 15, figs. 46-47; pl. 17, figs. 96-98.
Trochammina globigeriniforme (Parker and Jones) – Brady, 1884, p. 312, pl. 35, figs. 10a-c (not fig. 11).
Ammoglobigerina globigeriniformis (Parker and Jones) – Barker, 1960, p. 72, pl. 35, fig. 10.
Paratrochammina challengeri Brönnimann and Whittaker, 1988, p. 43, 44, figs. 16H-K.
Paratrochammina challengeri Brönnimann and Whittaker – Bender, 1995, p. 47, pl. 5, fig. 9.
Paratrochammina challengeri Brönnimann and Whittaker – Jones, 1994, p. 41, 42, pl. 35, fig. 10.

Morphology: Shell trochospiral; lobulate outline, rounded periphery; 3 whorls, 4 chambers in final whorl; chambers subglobular, increasing rapidly in size; deep umbilical depression; depressed sutures; coarsely agglutinated; asymmetric, crescentic, intermarginal aperture.

Remarks: Agglutinated particles in shells of of this species may be very coarse, and may include planktonic foraminiferal shells (e.g., plate 122, fig. 1).

Figures:
Plate 122, fig. 1, Alaminos Canyon Boxcore B6 bulk sample, ventral view; fig. 2, De Soto Canyon control sample DGOMB2 S36, dorsal view.
Scale bars = 50 μm.

Genus *Portatrochammina*

***Portatrochammina antarctica* (Parr)**

Trochammina inflata (Montagu) – Wiesner, 1931, p. 111, pl. 17, figs. 201a-c (not *Nautilus inflatus* Montagu, 1808).
Trochammina wiesneri Parr, 1950, p. 279, pl. 5, fig. 14.
Trochammina antarctica Parr, 1950, p. 280, pl. 5, figs. 1, 2.
Portatrochammina antarctica antarctica (Parr) - Brönnimann and Whittaker, 1988, p. 64-66, figs. 25A-C; 26A-G.
Portatrochammina antarctica wiesneri (Parr) – Brönnimann and Whittaker, 1988, p. 68, 69, figs. 25D-F; 26H-K; 27D-I.

Morphology: Shell trochospiral; convex on dorsal side, shallow concave on ventral side; slightly lobulate outline, rounded periphery; 3 whorls, 5-6 chambers in final whorl; sutures depressed; aperture interiomarginal arch, covered by a large umbilical flap.

Remarks: Previous umbilical flaps can be seen in some specimens (e.g., plate 132, fig. 5). Parr (1950) differentiated between *Trochammina antarctica* and *T. wiesneri* saying that *T. wiesneri* has a smoother, flatter shell and lower chambers causing the periphery to be subacute rather than broadly rounded as it is in *T. antarctica*. Parr (1950) also noted the characteristic greater length of the final chamber. The SEM photograph of the holotype (fig. 25E) included in Brönnimann and Whittaker (1988) shows that the periphery of *T. wiesneri* is rounded, not subacute. The other features may also be variable and hence Brönnimann and Whittaker (1988) concluded that the morphological differences between the two species were not great and gave them subspecific status. Since these slightly diffrenet morphologies are found in co-occurring individuals, and since the roundness of the margin is a gradational feature, we see no justification for recognizing sympatric subspecies. However, as Bronnimann and Whittaker were the first revisers of the original nomenclature, their designated species name (*Portatrochammina antarctica*) remains valid.

Figures:
Plate 132, fig. 1, Alaminos Canyon Core PC15 Sample 0-1 cm, dorsal view; fig. 2, Alaminos Canyon Core PC15 Sample 0-1 cm, ventral view; fig. 3, Alaminos Canyon Core PC15 Sample 10-11 cm, ventral view; fig. 4, De Soto Canyon control sample DGOMB2 S36, dorsal view; fig. 5, De Soto Canyon control sample DGOMB2 S36, ventral view; fig. 6, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, ventral view.
Scale bars = 50 µm.

Genus *Pseudotrochammina*

Pseudotrochammina sp.

Morphology: Shell trochospiral; periphery rounded, lobulate; 7-8 chambers in the final whorl; depressed umbilicus; sutures depressed; aperture narrow, rimmed, elongate with everted border, situated on apertural face parallel to basal suture.

Remarks: This partly resembles *P. echolsi* Brönnimann and Whittaker (1988), but it has a greater number of chambers in the final whorl and the location of the aperture.

Figures:
Plate 142, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view.
Scale bars = 50 µm.

Genus *Deuterammina*

***Deuterammina rotaliformis* (Heron-Allen and Earland)**

Trochammina rotaliformis Heron-Allen and Earland, 1911, p. 309.
Trochammina rotaliformis Wright - Cushman, 1920, p. 77, pl. 16, figs. 1, 2.
Deuterammina (Deuterammina) roatliformis (Heron-Allen and Earland) - Bronnimann and Whittaker, 1983, p. 348, text-figs. 1-3, 25.

Morphology: Low-trochospiral, finely agglutinated shell, with slightly lobulate periphery; broad and deep umbilicus.

Remarks: The shell is fragile. In our samples, the species is found only attached to tubeworms.

Figures:
Plate 53, fig. 1, Green Canyon tubeworm EC3, digital photomicrograph; fig. 2, Green Canyon tubeworm EC3, digital photomicrograph; fig. 3, Green Canyon tubeworm EC3; fig. 4, same specimen as in fig. 2.

2.2.4. Order Textulariida

Superfamily Textulariacea

Family Eggerellidae

Genus *Dorothia*

***Dorothia scabra* (Brady)**

Gaudryina pupoides Brady, 1870, p. 300, pl. 8, fig. 5.*Gaudryina scabra* Brady, 1884, p. 381, pl. 46, fig. 7.
Textularia aspera Brady, 1884, pl. 44, figs. 12-13.
Gaudryina scabra Brady – Cushman, 1922, p. 68, pl. 11, figs. 6, 7.
Dorothia scabra (Brady) – Cushman, 1937, p. 98, pl. 11, figs. 3, 4.
Dorothia scabra (Brady) – Barker, 1960, p. 90, pl. 44, figs. 12, 13; p. 94, pl. 46, pl. 46, fig. 7.
Dorothia scabra (Brady) – Charnock and Jones, 1990, p. 190, pl. 12, fig. 2; pl. 24, fig. 2.
Dorothia scabra (Brady) – Jones, 1994, p. 49, pl. 44, figs. 12, 13; p. 50, 51, pl. 46, fig. 7.
"Dorothia" scabra (Brady) – Bender, 1995, p. 44, pl. 6, figs. 6, 7; pl. 10, fig. 3.

Morphology: Shell elongate, tapering to the initial end; early chambers arranged triserially, later chambers becoming biserial; 3-5 pairs of chambers in biserial portion, chambers inflated; sutures distinct, depressed; shell wall rather coarsely arenaceous; aperture simple arch at the inner margin of the final chamber.

Remarks: Both coccoliths (plate 57, figs. 1 and 2) and sand grains (plate 57, fig. 3) have been observed as the primary agglutinated particles in this species. Our specimens do not have the breadth of the figured specimens of other authors.

Figures:
Plate 57, fig. 1, De Soto Canyon control sample DGOMB2 S36, side view; fig. 2, De Soto Canyon control sample DGOMB2 S36, side view with a broken final chamber; fig. 3, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Eggerella*

Eggerella bradyi (Cushman)

Verneuilina pygmaea Egger – Brady, 1884, p. 385, pl. 47, figs. 4-7.
Verneuilina bradyi Cushman, 1911, p. 54, figs. 87a, b.
Verneuilina bradyi Cushman – Cushman, 1922, p. 59, pl. 11, fig. 1.
Verneuilina bradyi Cushman – Thalmann, 1932.
Eggerella brady (Cushman) – Thalmann, 1937.
Eggerella bradyi (Cushman) – Barker, 1960, p. 96, pl. 47, figs. 4-7.
Eggerella bradyi (Cushman) – Denne, 1990, pl. 5, fig. 5.
Eggerella bradyi (Cushman) – Jones, 1994, p. 51, 52, pl. 47, figs. 4-7.

Morphology: Shell triserial and pyramidal; chambers rapidly increasing in size, those in final whorl inflated; aperture an elongate slit at the base of the final chamber, frequently with a thickened lip.

Remarks: This is the type species of the genus *Eggerella* Cushman 1933.

Figures:
Plate 58, fig. 1, Alaminos Canyon Core PC4 Sample 0-1 cm, side view; fig. 2, Alaminos Canyon Core PC5 Sample 0-1 cm, side view; fig. 3, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Karreriella*

Karreriella bradyi (Cushman)

Gaudryina pupoides d'Orbigny – Brady, 1884, p. 378, pl. 46, figs. 1-4.
Gaudryina bradyi Cushman, 1911, p. 67, text-fig. 107.
Gaudryina bradyi Cushman – Cushman, 1922, p. 74, pl. 12, fig. 8.
Karreriella bradyi (Cushman) – Cushman, 1937, p. 135, pl. 16, figs. 6-11.
Karreriella bradyi (Cushman) – Phleger and Parker, 1951, p. 6, pl. 3, figs. 4.
Karreriella bradyi (Cushman) – Parker, 1954, p. 495, pl. 3, fig. 11.
Karreriella bradyi (Cushman) – Barker, 1960, p. 94, pl. 46, figs. 1-4.

Karreriella bradyi (Cushman) – Andersen, 1961, p. 28, pl. 3, figs. 2a, b.
Karreriella bradyi (Cushman) – Denne, 1990, pl. 7, fig. 9.
Karreriella bradyi (Cushman) – Jones, 1994, p. 50, pl. 46, figs. 1-4.
Karreriella bradyi (Cushman) – Bender, 1995, p. 46, pl. 6, fig. 11.
Karreriella bradyi (Cushman) – Kuhnt et al., 2000, p. 279, pl. 8, figs. 16, 18.

Morphology: Shell elongate, tapering to blunt initial end; early chambers arranged triserially, later chambers becoming biserial, biserial portion making up about three-quarters of the shell; sutures depressed; aperture oval, raised lip, close to the inner margin of the final chamber.

Figures:
Plate 86, fig. 1, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view; fig. 3, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Genus *Martinottiella*

Martinottiella communis (d'Orbigny)

Clavulina communis d'Orbigny, 1846, p. 196, pl. 12, figs. 1, 2.
Clavulina communis d'Orbigny – Brady, 1884, p. 394, pl. 48, figs. 1-8 (not 9-13).
Clavulina communis (d'Orbigny) – Cushman, 1922, p. 84, 85, pl. 16, figs. 4, 5.
Martinottiella bradyana (Cushman) – Barker, 1960, p. 98, pl. 48, figs. 1, 2, 5.
Martinottiella communis (d'Orbigny) – Barker, 1960, p. 98, pl. 48, figs. 3-4, 6-8.
Martinottiella communis (d'Orbigny) – Papp and Schmid, 1985, p. 74, 75, pl. 66, figs. 1-8.
Martinottiella communis (d'Orbigny) – Hermelin, 1989, p. 34, pl. 2, figs. 5-6.
Martinottiella communis (d'Orbigny) – Denne, 1990, pl. 8, fig. 14.
Martinottiella communis (d'Orbigny)– Jones, 1994, p. 52, pl. 48, figs. 1-2, ?3, 4-8.
Martinottiella communis (d'Orbigny) – Bender, 1995, p. 46, pl. 6, fig. 16.

Morphology: Shell elongate; early portion trochospiral, later becoming uniserial; chambers numerous; sutures indistinct, only slightly depressed; shell wall finely agglutinated; aperture terminal, rounded to arcuate slit, on a short neck.

Remarks: Jones comments that *Clavulina communis* d'Orbigny 1846 is the type species of the genus *Martinotiella* Cushman 1933 (which differs from *Clavulina* d'Orbigny 1826 in its initially trochospiral rather than triserial chamber arrangement).

Figures:
Plate 102, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: apertural view.
Scale bars = 50 μm.

Genus *Multifidella*

Multifidella nodulosa (Cushman)

Clavulina communis d'Orbigny – Brady, 1884, pl. 48, figs. 9-12 (part).
Clavulina communis d'Orbigny var. *nodulosa* Cushman, 1922, p. 85, pl. 18, figs. 1-3.
Listerella nodulosa (Cushman) – Cushman, 1937, p. 150, pl. 17, figs. 13-19.
Martinottiella nodulosa (Cushman) – Barker, 1960, p. 98, pl. 48, figs. 9-13.
Multifidella nodulosa (Cushman) – Loeblich and Tappan, 1964, C277, fig. 185, no. 4.
Multifidella nodulosa (Cushman) – Loeblich and Tappan, 1987, p. 171, 172, pl. 190, figs. 8, 9.
Multifidella nodulosa (Cushman) – Jones, 1994, p. 52, 53, pl. 48, figs. 9-13.

Morphology: Shell elongate; early portion trochospiral, later becoming uniserial; shell wall finely agglutinated; aperture terminal, cribrate with elongate slits and bordering lips.

Remarks: This is the type species of the genus *Multifidella* Loeblich and Tappan 1961. *Multifidella* differs from *Martinottiella* in having a cribrate aperture of slits with bordering lips. The chambers of our specimens are more rounded and less cylindrical than those of other authors. However, they are within the natural range of variation.

Figures:
Plate 107, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: apertural view.
Scale bars = 50 μm.

Family Textulariidae

Genus *Textularia*

Textularia foliacea occidentalis Cushman

Textularia foliacea Heron-Allen and Earland var. *occidentalis* Cushman, 1922, p. 16, pl. 2, fig. 13.
Textularia foliacea Heron-Allen and Earland var. *occidentalis* Cushman – Phleger and Parker, 1951, p. 5, pl. 1, figs. 28, 29.
Textularia foliacea occidentalis Cushman – Parker, 1954, p. 491, pl. 2, fig. 10.
Textularia occidentalis Cushman – Andersen, 1961, p. 23, pl. 1, figs. 2a, b.
Textularia foliacea occidentalis Cushman – Denne, 1990, pl. 13, fig. 7.

Morphology: Shell triangular to leaf-shaped, tapering to initial end; apertural end truncated; 7-9 pairs of chambers; sutures frequently obscure; shell wall coarsely agglutinated; aperture elongate slit at the base of the inner margin of the final chamber.

Remarks: *Textularia foliacea occidentalis* differs from *T. foliacea* in being broader and less tapered with a less acute initial end.

Figures:
Plate 176, figs. 1, 3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: apertural view; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 2a: side view, 2b: apertural view.
Scale bars = 50 μm.

***Textularia* sp. cf. *T. mayori* Cushman**

Textularia mayori Cushman, 1922, p. 23, pl. 2, fig. 3.
Textularia mayori Cushman – Cushman, 1922, p. 7.
Textularia mayori Cushman – Phleger and Parker, 1951, p. 5, pl. 2, figs. 1-5.
Textularia mayori Cushman – Parker, 1954, p. 491, pl. 2, fig. 11.
Textularia mayori Cushman – Andersen, 1961, p. 22, 23, pl. 1, figs. 6-8.
Textularia mayori Cushman – Denne, 1990, pl. 13, fig. 8.

Morphology: Shell increasing rapidly in breadth; initial end rounded, apertural end truncated; chambers indistinct; spinose projections, with broken tips, frequently present; aperture an elongate opening on the inner margin of the final chamber.

Remarks: Phleger and Parker (1954) noted that the spinose projections were a varible feature. Andersen (1961) illustrated three specimens showing the range of variation in the development of the spinose projections including a spineless variant. However, the spines on Cushman's holotype are so much more pronounced (and texturally distinct from the rest of the shell) than those on our specimens that we cannot be sure of the identity of our species, which does not match the figures of Parker (1954) or Andersen (1961).

Figures:
Plate 177, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 μm.

***Textularia mexicana* Cushman**

Textularia mexicana Cushman, 1922, p. 17, pl. 2, fig. 9.
Textularia mexicana Cushman – Phleger and Parker, 1951, p. 5, pl. 2, figs. 6, 7.
Textularia mexicana Cushman – Andersen, 1961, p. 23, pl. 1, figs. 4a, b.
Textularia mexicana Cushman – Denne, 1990, pl. 13, fig. 9.

Morphology: Shell triangular; periphery sharp; chambers numerous; sutures distinct, raised, coalescing at center of shell to form a high ridge, especially in latter half of the shell; aperture elongate, semicircular slit at the base of the inner margin of the final chamber.

Figures:
Plate 178, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 µm.

Genus *Siphotextularia*

Siphotextularia rolshauseni Phleger and Parker

Siphotextularia rolshauseni Phleger and Parker, 1951, p. 4, pl. 1, figs. 23, 24.
Siphotextularia rolshauseni Phleger and Parker – Parker, 1954, p. 492, pl. 2, fig. 14.

Morphology: Periphery rounded, lobulate; early portion planispirally coiled, later becoming biserial; 4-5 pairs of chambers in biserial portion; sutures distinct, depressed, almost at right angles to central axis; shell wall finely arenaceous, some larger grains; aperture round, on a projecting lip.

Remarks: *Siphotextularia rolshauseni* differs from *S. affinis* in being smaller with a more inflated shell, sutures at right angles to the central axis, chambers that do not overlap, and a smaller aperture.

Figures:
Plate 167, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 2, Alaminos Canyon Core PC15 Sample 10-11 cm, side view.
Scale bars = 50 µm.

Family Pseudogaudryinidae

Genus *Pseudoclavulina*

Pseudoclavulina mexicana (Cushman)

Clavulina humilis Brady var. *mexicana* Cushman, 1922, p. 83, 84, pl. 16, figs. 1-3.
Pseudoclavulina mexicana (Cushman) – Phleger and Parker, 1951, p. 6, pl. 2, figs. 14-16.
Pseudoclavulina mexicana (Cushman) – Parker, 1954, p. 493, pl. 3, fig. 8.
Pseudoclavulina mexicana (Cushman) – Andersen, 1961, p. 27, 28, pl. 2, fig. 12.
Clavulina mexicana (Cushman) – Denne, 1990, pl. 5, fig. 1.
Pseudoclavulina mexicana (Cushman) – Bender, 1995, p. 48, pl. 7, fig. 15; pl. 12, fig. 3.

Morphology: Shell elongate; apertural end subacute; early portion sharply triserial, later becoming uniserial and subcylindrical; sutures indistinct in triserial portion, slightly depressed in uniserial portion; shell wall coarsely agglutinated; aperture at the end of a tubular neck.

Figures:
Plate 138, fig. 1, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view; figs. 2-3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 μm.

***Pseudoclavulina serventyi* (Chapman and Parr)**

Clavulina parisiensis d'Orbigny – Brady, 1884, pl. 48, figs. 14-16.
Clavulina serventyi Chapman and Parr, 1935, p. 5, pl. 1, fig. 7.
Pseudoclavulina serventyi (Chapman and Parr) – Barker, 1960, p. 98, pl. 48, figs. 14-16.
Pseudoclavulina serventyi (Chapman and Parr) – Jones, 1994, p. 53, pl. 48, figs. 14-16.

Morphology: Shell elongate; apertural end rounded; early portion triserial, later becoming uniserial; sutures depressed; shell wall coarsely agglutinated; aperture terminal, consisting of two to three pores.

Remarks: The type figure and the *Challenger* specimens of this species show numerous chambers in the uniserial portion, whereas our specimens have a maximum of 3-4 such chambers.

Figures:
Plate 139, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Pseudogaudryina*

***Pseudogaudryina atlantica* (Bailey)**

Textularia atlantica Bailey, 1851, p. 12, pl., figs. 38-43.
Verneuilina triquetra (Munster) – Brady, 1884, pl. 47, fig. 18 (not figs. 19-20).
Gaudryina atlantica (Bailey) – Cushman, 1922, p. 70, pl. 13, figs. 1-3.
Gaudryina (Pseudogaudryina) atlantica (Bailey) – Phleger and Parker, 1951, p. 6, pl. 2, figs. 13a, b.
Gaudryina (Pseudogaudryina) atlantica (Bailey) – Parker, 1954, p. 493, pl. 3, fig. 7.
Gaudryina atlantica (Bailey) – Barker, 1960, p. 96, pl. 47, fig. 18.
Pseudogaudryina atlantica (Bailey) – Denne, 1990, pl. 11, fig. 1.
Pseudogaudryina atlantica (Bailey) – Jones, 1994, p. 52, pl. 47, fig. 18.

Morphology: Shell elongate, triangular in section; early portion triserial, later portion biserial; triserial portion short, biserial portion triangular in shape; shell wall coarsely agglutinated; aperture an interiomarginal arch.

Remarks: This is the type species of the genus *Pseudogaudryina* Cushman 1936.

Figures:
Plate 140, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, a: side view, b: apertural view.
Scale bars = 50 μm in fig. 1; 100 μm in fig. 2.

2.2.5. Order Miliolida

Superfamily Cornuspiracea

Family Cornuspiridae

Genus *Cornuspira*

***Cornuspira foliacea* (Philippi)**
Orbis foliaceus Philippi, 1844, p. 147, pl. 24, fig. 26.
Cornuspira foliacea (Philippi) – Brady, 1884, p. 199, pl. 11, figs. 5, 6.
Cornuspira foliacea (Philippi) - Cushman, 1929, p. 79, pl. 20. figs. 3-5.
Cornuspira foliacea (Philippi) – Jones, 1994, p. 26, pl. 11, figs. 5, 6.

Morphology: Shell with a proloculus and a coiled, tubular second chamber whose diameter increases progressively (and rapidly in adult stage) toward the terminal aperture; somewhat flattened.

Remarks: This is the type species of the genus *Cornuspira.* In our samples, it is found only attached to tubeworms.

Figures:
Plate 46, fig. 1, Alaminos Canyon tubeworm LS6 hairy rootlet, digital photomicrograph; fig. 2, Alaminos Canyon tubeworm LS6, digital photomicrograph; fig. 3, Alaminos Canyon tubeworm LS7; fig. 4, same specimen as in fig. 2; fig. 5, Alaminos Canyon mussel MAC1; fig. 6, Alaminos Canyon mussel MAC1, attachment side of foraminifer.

***Cornuspira involvens* (Reuss)**

Operculina involvens Reuss, 1850, p. 370, pl. 46, figs. 20a, b.
Cornuspira involvens (Reuss) – Brady, 1884, p. 200, pl. 11, figs. 1-3.
Cornuspira involvens (Reuss) – Cushman, 1929, p. 80-81, pl. 20, figs. 6, 8.
Cornuspira involvens (Reuss) – Barker, 1960, p. 22, fig. 11, figs. 1-3.
Cornuspira involvens (Reuss) – Jones, 1994, p. 26-27, pl. 11, figs. 1-3.

Morphology: Shell with a proloculus and a long, coiled, planispiral second chamber of nearly equal diameter throughout; aperture an opening at the end of the tube.

Remarks: Many living specimens were observed to be encysted, particularly in sample PC15 from Alaminos Canyon (e.g., plate 47, figs. 1, 2, 4). On the other hand, many specimens were found attached to tubeworms (Plate 48).

Figures:
Plate 47, fig. 1, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, side view; fig. 2, living and encysted specimen from Alaminos Canyon Core PC15 Sample 0-1 cm, side view; fig. 3, living and encysted specimen from Alaminos Canyon Core PC15 Sample 0-1 cm, side view; fig. 4, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, side view; fig. 5, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, side view; fig. 6, living and encysted specimen from Alaminos Canyon Core PC15 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Plate 48, fig. 1, Green Canyon tubeworm EC5, digital photomicrograph; fig. 2, same specimen as in fig. 1; fig. 3, Green Canyon tubeworm EC3; fig. 4, Green Canyon tubeworm EC4.

Superfamily Nubeculariacea

Family Nubeculariidae

Genus *Calcituba*

***Calcituba polymorpha* von Roboz**

Calcituba polymorpha von Roboz, 1884, p. 421, figs. 1-16.
Calcituba polymorpha von Roboz – Arnold, 1967, p. 280-304, text-fig. 2a-m, pl. 1, figs. a-u, pl. 2, figs. a-r.

Morphology: Attached, thin, translucent, porcelaneous shell; early chambers in a milioline coil, later chambers extending as irregular (occasionally branching) tubes; aperture terminal.

Remarks: This is the type species of the genus *Calcituba*. It has been previously reported only from a depth of about 1 m in the Gulf of Mexico, but the individuals in our samples are attached to a tubeworm from a depth of 562 m. We ascribe this discrepancy to the poor record of the species in sediments due to the "extreme fragility" of its shell (Arnold, 1967), and to a dearth of observations on attached Foraminifera beyond shelf depths.

Figures:
Plate 32, fig. 1, Green Canyon tubeworm EC5, digital photomicrograph; fig. 2, same specimens as in fig. 1; fig. 3, specimen in fig. 2, surface pits; fig. 4; Green Canyon tubeworm EC5; fig. 5, Green Canyon tubeworm EC5, milioline coils.

Superfamily Miliolacea

Family Spiroloculinidae

Genus *Planispirinoides*

***Planispirinoides bucculentus* var. *placentiformis* (Brady)**

Miliolina bucculenta Brady var. *placentiformis* Brady, 1884, p. 171, pl. 4, figs. 1, 2.
Planispirinoides bucculentus (Brady) var. placentiformis (Brady) – Barker, 1960, p. 8, pl. 4, figs. 1, 2.
Planispirinoides bucculentus var. *placentiformis* (Brady) – Jones, 1994, p. 20, pl. 4, figs. 1-2.

Morphology: Shell asymmetrical, subglobular; periphery rounded; final whorl with three chambers, enclosing all previous whorls; aperture either a crescentic slit near the inner margin of the final chamber, or a long, narrow, curved, transverse slit.

Remarks: Brady (1884) commented that this variety differed from the typical form in its general asymmetry, flattened contour, and irregularity of the segments. Our specimens are not as flattened as those figured by Brady or as globular as Brady's *Miliolina bucculenta* (pl. 114, fig. 3).

Figures:
Plate 126, figs. 1a-c, Green Canyon (Block 272) Core P-54 Sample 0-1 cm, 1a: side view, 1b: apertural view, 1c: side view; figs. 2a-c, Green Canyon (Block 232) Core P-EP12 Sample 0-1 cm, 2a: side view, 2b: apertural view, 2c: side view.
Scale bars = 50 μm.

Family Hauerinidae

Genus *Quinqueloculina*

***Quinqueloculina bosciana* d'Orbigny**

Quinqueloculina bosciana d'Orbigny, 1839b, p. 191, pl. 11, figs. 22-24.
Quinqueloculina bosciana d'Orbigny – Denne, 1990, pl. 11, fig. 14.

Morphology: Shell elongate; basal end broadly rounded; aperture an opening located between the outer margin of the final chamber and the penultimate chamber with a bifid tooth.

Figures:
Plate 149, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: side view, 1c: apertural view.
Scale bars = 50 μm.

Genus *Cribromiliolinella*

Cribromiliolinella subvalvularis (Parr)

Miliolinella valvularis (Reuss) – Brady, 1884, p. 161, pl. 4, figs. 4, 5.
Triloculina subvalvularis Parr, 1950, p. 296, pl. 7, fig. 4.
Cribromiliolinella subvalvularis (Parr) – Loeblich and Tappan, 1987, p. 337, pl. 348, figs. 16-18.

Morphology: Shell ovate in outline; cryptoquinqueloculine, chambers one-half coil in length, with 3 chambers visible; aperture terminal, with a projecting flap, the opening itself irregularly triradiate, occasionally with additional slits.

Remarks: This is the type species of the genus *Cribromiliolinella* of Saidova (1981).

Figures:
Plate 49, figs. 1a-b, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, side view; figs. 3a-c, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, 3a: side view, 3b: side view, 3c: apertural view.
Scale bars = 50 µm.

Genus *Miliolinella*

Miliolinella warreni Andersen

?Miliola oblonga (Montagu) – Flint, 1899, pl. 43, fig. 3.
Miliolinella warreni Andersen, 1961, p. 37-38, pl. 7, figs. 4a-c.

Morphology: Shell elongate, sub-circular in cross-section; three chambers visible; basal end broadly rounded, apertural end truncated; aperture a crescent-shaped slit located between the outer margin of the final chamber and a large, excavated tooth.

Figures:
Plate 105, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: side view, 1c: apertural view.
Scale bars = 50 µm.

Miliolinella sp.

Miliolinella sp.

Remarks: This is a rare *Miliolinella* that we found attached to a tubeworm. The observable features do not permit species-level identification.

Figures:
Plate 106, fig. 1, Mississippi Canyon tubeworm MC1, digital photomicrograph.

Genus *Pyrgo*

Pyrgo lucernula (Schwager)

Biloculina lucernula Schwager, 1866, p. 202, pl. 4, figs. 17a, b (not figs. 14a-c).
Biloculina lucernula Schwager – Brady, 1884, p. 142, pl. 2, figs. 5, 6.
Pyrgo lucernula (Schwager) – Barker, 1960, p. 4, pl. 2, figs. 5, 6.
Pyrgo lucernula (Schwager) – Srinivasan and Sharma, 1980, p. 21, pl. 3, figs. 10, 11 (neotype).
Pyrgo lucernula (Schwager) – Jones, 1994, p. 18, pl. 2, figs. 5, 6.

Morphology: Shell oval in outline, periphery rounded; only two chambers visible; aperture terminal on the end of a short neck, rounded with a bifid tooth.

Remarks: Srinivasan and Sharma (1980) made the distinction between *Triloculina lucernula* and *Pyrgo lucernula*, which were both named as *Biloculina lucernula* by Schwager. *Triloculina lucernula* resembles *Pyrgo lucernula* in the front view but the apertural view reveals a third chamber.

Figures:
Plate 145, fig. 1, De Soto Canyon control sample DGOMB2 S36, front view; fig. 2, Farnella Canyon Core P-61 Sample 0-1 cm, side view; fig. 3, Green Canyon (Block 272) Core P-33 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Pyrgo murrhina (Schwager)

Biloculina murrhina Schwager, 1866, p. 203, pl. 4, fig. 15a-c.
Biloculina depressa d'Orbigny var. *murrhyna* Schwager - Brady, 1884, p. 146, pl. 2, figs. 10, 11.
Biloculina depressa d'Orbigny – Brady, 1884, p. 146, pl. 2, figs. 15.
Pyrgo murrhina (Schwager) – Cushman, 1929, p. 71-72, pl. 19, figs. 6, 7.
Pyrgo murrhina (Schwager) – Phleger and Parker, 1951, p. 7, pl. 3, fig. 11.
Pyrgo murrhina (Schwager) – Parker, 1954, p. 501, pl. 5, fig. 7.
Pyrgo murrhyna (Schwager) – Barker, 1960, p. 4, pl. 2, figs. 10, 11, 15.
Pyrgo murrhina (Schwager) – Srinivasan and Sharma, 1980, p. 22, pl. 3, figs. 6, 7 (neotype).
Pyrgo murrhina (Schwager) – Denne, 1990, pl. 11, fig. 8.
Pyrgo murrhina (Schwager) – Jones, 1994, p. 18-19, pl. 2, figs. 10, 11, 15.

Morphology: Shell circular to oval in outline, periphery extended and carinate, the carina interrupted by a sinus, frequently with two small spines opposite the aperture; aperture with an exserted tubular neck and a bifid tooth.

Remarks: This common deep-sea species exhibits a lot of variability.

Figures:
Plate 146, fig. 1, Alaminos Canyon Boxcore B6 bulk sample, front view; fig. 2, De Soto Canyon control sample DGOMB2 S36, front view.
Scale bars = 50 μm.

Pyrgo nasuta Cushman

Pyrgo nasutus Cushman, 1935, p. 7, pl. 3, figs. 1-4.
Pyrgo cf. *nasutus* Cushman – Phleger and Parker, 1951, p. 7, pl. 3, figs. 12-14.
Pyrgo cf. *nasutus* Cushman – Parker, 1954, pl. 5, fig. 4.
Pyrgo nasuta Cushman – Andersen, 1961, p. 38, pl. 9, figs. 2a-c.
Pyrgo phlegeri Andersen, 1961, p. 38-39, pl. 8, figs. 1a-c, 2a-c.

Morphology: Shell oval in outline, with a carinate periphery that may be serrated; aperture on a slight, compressed neck, convex on the outer dorsal side and concave on the inner side; aperture an elongate curved slit without a tooth.

Remarks: Phleger and Parker (1951) noted that their Gulf of Mexico specimens lack the bend of the test at the base of the aperture that causes the aperture to tip forward as seen in Cushman's fig. 1b. Parker (1954) observed Gulf of Mexico specimens with a less serrate periphery. Andersen (1961) distinguished a new spcies, *P. phlegeri*, from *P. nasuta* on the basis of its non-serrate and more circular periphery and greater breadth. These gradational characters are unreliable for this ditinction, and we follow Culver and Buzas (1981) in considering *P. phlegeri* a synonym of *P. nasuta*.

Figures:
Plate 147, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, a: front view, b: apertural view.
Scale bars = 50 μm.

?*Pyrgo* sp.

Morphology: Shell circular in outline, periphery rounded; only two chambers visible; shell surface agglutinated; aperture terminal on the end of a very slight neck, rounded with a bifid tooth.

Remarks: This extremely rare species has the typical morphology of *Pyrgo*, but with a definitely agglutinated surface. We have not been able to match it with any known *Pyrgo*. The possibilties are: (a) it is a true *Pyrgo* with an agglutinated outer wall, and thus a new species; (b) it is not a hauerinid but a rzehakinid (i.e., an agglutinated form), and thus a new genus and species. So far, we have been able to study a single specimen, and the dilemma remains unsolved.

Figures:
Plate 148, figs. 1a-b, Alaminos Canyon Core PC4 Sample 1-2 cm, 1a: front view, 1b: close up of aperture.
Scale bars = 50 μm.

Genus *Triloculina*

Triloculina tricarinata d'Orbigny

Triloculina tricarinata d'Orbigny, 1826, p. 299.
Triloculina tricarinata d'Orbigny – Parker et al., 1865, pl. 1, fig. 8.
Triloculina tricarinata d'Orbigny – Cushman, 1929, p. 56-57, pl. 13, figs. 3a-c.

Morphology: Shell elongate, triangular in apertural view; periphery sharply angled; three chambers visible, triloculine arrangement; sutures depressed; aperture usually on the end of a cylindrical neck, with a simple or bifid tooth.

Remarks: The aperture in our specimens lacks a neck and has a bifid tooth.

Figures:
Plate 182, figs. 1a-b, Canyon (Block 272) Core P-57 Sample 0-1 cm, 1a: side view, 1b: apertural view; fig. 2, Alaminos Canyon Core PC5 Sample 4-5 cm, 2, side view.
Scale bars = 50 μm.

Genus *Sigmoilinita*

Sigmoilinita elliptica (Galloway and Wissler)

Sigmoilina elliptica Galloway and Wissler, 1927, p. 39, pl. 7, figs. 2a, b.
Sigmoilinita elliptica (Galloway and Wissler) – Denne, 1990, pl. 12, fig. 9.

Morphology: Shell elliptical in side view; five chambers visible; chambers long, tubular, diameter unchanging from end to end; aperture terminal at end of a neck, no tooth.

Remarks: *Sigmoilina tenuis* (Czejak) appears from the type figures to be flat in profile while *S. elliptica* (Galloway and Wissler) is not. Some confusion exists about the generic name. Jones (1994) regards *Sigmoilinita* Seiglie 1965 as a junior synonym of *Spirosigmoilina* Parr 1942 and refers *Sigmoilinita tenuis* (Czjzek), the type species, to *Spirosigmoilina tenuis*. Both genera have initial chambers added in a sigmoiline series, and the later whorls are planispiral. *Sigmoilinita* Seiglie may or may not have a tooth while *Spirosigmoilina* Parr has a tooth according to Loeblich and Tappan (1987). Parr's generic description does not mention the aperture or the presence of a tooth.

Figures:
Plate 163, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: side view, 1c: apertural view; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 2a: side view, 2b: side view.
Scale bars = 50 μm.

Genus *Sigmoilopsis*

Sigmoilopsis schlumbergeri (Silvestri)

Planispirina celata (Costa) – Brady, 1884, p. 197, pl. 8, figs. 1-4.
Sigmoilina schlumbergeri Silvestri, 1904, p. 267.
Sigmoilina schlumbergeri Silvestri – Cushman, 1929, p. 49, pl. 11, figs. 1-3.
Sigmoilina schlumbergeri Silvestri – Phleger and Parker, 1951, p. 8, pl. 4, fig. 6.
Sigmoilina schlumbergeri Silvestri – Parker, 1954, p. 499, pl. 4, fig. 18.
Sigmoilopsis schlumbergeri (Silvestri) – Barker, 1960, p. 16, pl. 8, figs. 1-4.
Sigmoilopsis schlumbergeri (Silvestri) – Andersen, 1961, p. 34, pl. 7, figs. 7a, b.
Sigmoilopsis schlumbergeri (Silvestri) – Denne, 1990, pl. 12, fig. 10.
Sigmoilopsis schlumbergeri (Silvestri) – Jones, 1994, p. 23-24, pl. 8, figs. 1-4.

Morphology: Shell large, longer than wide; chambers arranged in a sigmoid manner with several visible from either side; aperture at the end of a short neck with a tooth; shell wall a calcareous base encrusted with sand grains.

Remarks: This is the type species of the genus *Sigmoilopsis* Finlay 1947.

Figures:
Plate 164, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: side view; fig. 2, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view.
Scale bars = 50 μm.

2.2.6. Order Spirillinida

Family Spirillinidae

Genus *Spirillina*

Spirillina vivipara Ehrenberg

Spirillina vivipara Ehrenberg, 1843, p. 323, 422, pl. 3, fig. 41.
Spirillina vivipara Ehrenberg - Brady, 1884, p. 630, pl. 85, figs. 1-4.
Spirillina vivipara Ehrenberg - Cushman, 1931, p. 3, pl. 1, figs. 1-4.
Spirillina vivipara Ehrenberg - Jones, 1994, p. 92, pl. 85, figs. 1-4.

Morphology: Hyaline shell with a round proloculus and a planispirally coiled, tubular, second chamber, tube width showing gentle increase from juvenile to mature stages; scattered large pores; terminal aperture.

Remarks: This is the type species of the genus *Spirillina*. It has been widely reported from Gulf of Mexico sediments (0-1481 m water depth). In our samples, however, it is found only attached to tubeworms.

Figures:
Plate 168, digital photomicrographs, fig. 1, Mississippi Canyon tubeworm MC3; figs. 2-4, Mississippi Canyon tubeworm EC1.

Plate 169, fig. 1, same specimens as in fig. 3 of plate168; figs. 2-3, Mississippi Canyon tubeworm EC1; fig. 4, Mississippi Canyon tubeworm EC1, attachment side; fig. 5, Mississippi Canyon tubeworm MC2.

Family Patellinidae

Genus *Patellina*

Patellina corrugata Williamson

Patellina corrugata Williamson, 1858, p. 46, pl. 3, 86-89.
Patellina corrugata Williamson – Brady, 1884, p. 634, pl. 86, figs. 1-7.
Patellina corrugata Williamson – Cushman, 1931, p. 11, 12, pl. 2, figs. 6, 7.
Patellina corrugata Williamson – Phleger and Parker, 1951, p. 23, pl. 12, figs. 4a, b.
Patellina corrugata Williamson – Barker, 1960, p. 178, pl. 86, figs. 1-7.
Patellina corrugata Williamson – Andersen, 1961, p. 100, pl. 21, figs. 2a, b.
Patellina corrugata Williamson – Jones, 1994, p. 93, pl. 86, figs. 1-7.

Morphology: Shell planoconvex to concavo-convex; early chambers spirally arranged, later chambers overlapping with a thickened keel; aperture elongate at the inner border of the chamber.

Remarks: This is the type species of the genus *Patellina*.

Figures:
Plate 124, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, dorsal view; figs. 2a-b, Alaminos Canyon Core PC5 Sample 4-5 cm, 2a: dorsal view, 2b: ventral view; fig. 3, Alaminos Canyon Core PC5 Sample 4-5 cm, ventral view.
Scale bars = 50 μm.
Plate 125, fig. 1, Mississippi Canyon tubeworm EC1, digital photomicrograph; fig. 2, Green Canyon tubeworm EC2; fig. 3, Green Canyon tubeworm EC4; fig. 4, Green Canyon tubeworm EC3, specimen attached to *Lamininonion tumidum*.

2.2.7. Order Lagenida

Superfamily Nodosariacea

Family Nodosariidae

Genus *Dentalina*

***Dentalina* sp.**

Morphology: Shell elongate, uniserial, circular in cross-section; chambers gradually increasing in size, sutures slightly depressed; several initial spines; aperture terminal, radiate.

Figures:
Plate 52, figs. 1-2, Garden Banks (Block 427) Core P-EP8 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Pseudoglandulina*

***Pseudoglandulina comatula* (Cushman)**

Nodosaria comata (Batsch) – Brady, 1884, p. 509, pl. 64, figs. 1-5.
Nodosaria comatula Cushman, 1923, p. 83, pl. 14, fig. 5.
Pseudoglandulina comatula (Cushman) – Phleger and Parker, 1951, p. 10, pl. 5, figs. 7-9.
Pseudoglandulina comatula (Cushman) – Parker, 1954, p. 505, pl. 5, fig. 22.
Rectoglandulina comatula (Cushman) – Barker, 1960, p. 134, pl. 64, figs. 1-5.
Pseudonodosaria comatula (Cushman) – Andersen, 1961, p. 71, pl. 17, figs. 9a, b.
Pseudonodosaria comatula (Cushman) – Denne, 1990, pl. 11, fig. 2
Pseudoglandulina comatula (Cushman) – Jones, 1994, p. 76, pl. 64, figs. 1-5.

Morphology: Shell elongate and stout, initial end may be rounded or tapered, sometimes with a short spine; sutures distinct, slightly depressed; surface ornamented by closely-spaced, continuous longitudinal costae that obscure previous sutures; upper part of the final chamber smooth; aperture central, terminal, radiate.

Figures:
Plate 141, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Plectofrondicularia*

***Plectofrondicularia advena* (Cushman)**

Frondicularia inaequalis (Costa) – Brady, 1884, p. 521, pl. 66, figs. 8-12.
Frondicularia advena Cushman, 1923, p. 141, pl. 20, figs. 1-2.

Parafrondicularia advena (Cushman) – Barker, 1960, p. 138, pl. 66, figs. 8-12.
Plectofrondicularia advena (Cushman) – Jones, 1994, p. 78, pl. 66, figs. 8-12.

Morphology: Shell compressed with a subspherical proloculus followed by v-shaped chambers, chambers broadest in the center and then tapering to the pointed outer ends; slight peripheral keel present; sutures distinct and depressed; aperture circular in the center of the final chamber.

Remarks: This is the type species of the genus *Proxifrons* Vella 1963, regarded by Jones (1994) as a junior synonym of *Plectofrondicularia* Liebus 1902. Loeblich and Tappan (1987) list both genera.

Figures:
Plate 131, fig. 1, Mississippi Canyon Core P-69 Sample 0-1 cm, side view; fig. 2, Garden Banks (Block 427) Core P-EP8 Sample 1-2 cm, side view; fig. 3, Mississippi Canyon Core P-IM2 Sample 1-2 cm, side view.
Scale bars = 100 μm in fig. 1; 50 μm in figs. 2 & 3.

Family Vaginulinidae

Genus *Lenticulina*

***Lenticulina calcar* (Linnaeus)**

Nautilus calcar Linneaus, 1767, p. 1162, no. 272.
Cristellaria calcar (Linnaeus) – Brady, 1884, p. 55, pl. 70, figs. 9-12.
Lenticulina calcar (Linneaus) – Barker, 1960, p. 146, pl. 70, figs. 9-12.
Robulus calcar (Linneaus) – Andersen, 1961, p. 48-49, pl. 11, figs. 1-2.
Lenticulina calcar (Linneaus) – Denne, 1990, pl. 8, fig. 2.
Lenticulina calcar (Linneaus) – Jones, 1994, p. 81-82, pl. 70, figs. 9-12.

Morphology: Shell biconvex; peripheral keel present; 4 to 6 chambers in the last whorl; spine projecting from each chamber except the final chamber; sutures slightly curved; apertural face depressed and flat; aperture produced at the angle of the final chamber, radiate with a median slit flanked by two plates directed downward, their inner margins bearing numerous spiny projections.

Figures:
Plate 97, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: edge view showing apertural face; figs. 2-3, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, a: side view, b: edge view showing apertural face.
Scale bars = 50 μm.

***Lenticulina gibba* (d'Orbigny)**

Cristellaria gibba d'Orbigny, 1826, p. 292, no. 17.
Cristellaria gibba d'Orbigny – Brady, 1884, p. 546, pl. 69, figs. 8, 9.
Cristellaria gibba d'Orbigny – Cushman, 1923, p. 105-106, pl. 25, fig. 4.
Lenticulina gibba d'Orbigny – Barker, 1960, p. 144, pl. 69, figs. 8-9.
Lenticulina gibba d'Orbigny – Denne, 1990, pl. 8, fig. 6.
Lenticulina gibba d'Orbigny – Jones, 1994, p. 81, pl. 69, figs. 8-9.

Morphology: Shell biconvex, elongate in side view; periphery acute; sutures flush with the surface; apertural face triangular, aperture radiate at the periphery.

Figures:
Plate 98, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 1a: side view, 1b: edge view showing apertural face, 1c: apertural view; figs. 2a-b, Alaminos Canyon Core PC4 Sample 0-1 cm, 2a: side view, 2b: edge view showing apertural face.
Scale bars = 50 µm.

***Lenticulina pliocaena* Silvestri**

Cristellaria sp. Brady, 1884, pl. 69, fig. 5.
Robulus pliocaenicus (Silvestri) – Barker, 1960, p. 144, pl. 69, fig. 5.
Lenticulina pliocaena (Silvestri) – Jones, 1994, p. 80, pl. 69, fig. 5.

Morphology: Two chambers, first chamber globular, second chamber triangular in cross-section; two prominent longitudinal ribs running from basal spine to apertural end, sometimes a third rib present; sutures depressed; aperture terminal with fissures radiating from a central point.

Remarks: Barker's (1960) identification of *Robulus pliocaenicus* is based on Thalmann (1932, p. 252).

Figures:
Plate 99, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 1a: side view, 1b: edge view showing apertural face, 1c: apertural view.
Scale bars = 50 µm.

***Lenticulina thalmanni* (Hessland)**

Cristellaria rotulata (Lamarck) – Brady, 1884, pl. 69, fig. 13.
Cristellaria rotulata (Lamarck)? – Cushman, 1923, p. 108, pl. 22, fig. 2; pl. 28, figs. 1, 2.
Robulus thalmanni Hessland, 1943, p. 265, pl. 2, fig. 16 (cited Brady, pl. 69, fig. 13 as holotype).
Robulus thalmanni Hessland – Barker, 1960, p. 144, pl. 69, fig. 13.
Lenticulina thalmanii (Hessland) – Jones, 1994, p. 81, pl. 69, fig. 13.

Morphology: Shell biconvex; periphery keeled; less than 8 chambers in the final whorl; sutures distinct, not extending into the center of the shell; large umbonate center; apertural face small, aperture is radiate with a median slit sided by two plates.

Remarks: Hessland cites Brady's pl. 69, fig. 13 as the holotype illustration. Cushman (1923) comments that specimens similar to Brady's fig. 13 are found in the Gulf of Mexico and differ from those he described in having many more chambers and curved sutures. Our specimens have up to 8 chambers in the last whorl, and the sutures may be straight or slightly curved.

Figures:
Plate 100, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, a: side view, b: edge view showing apertural face; fig. 3, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, side view; fig. 4, Alaminos Canyon Core PC4 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Genus *Vaginulinopsis*

Vaginulinopsis subaculeata (Cushman)

Cristellaria aculeata Brady (not d'Orbigny), 1884, p. 555, pl. 71, figs. 4, 5.
Cristellaria subaculeata Cushman, 1923, p. 124, pl. 32, fig. 4; pl. 33, fig. 3; pl. 34, figs. 2, 3.
Cristellaria subaculeata Cushman var. *glabrata* Cushman, 1923, p. 124, pl. 32, fig. 4; pl. 33, fig. 3; pl. 34, figs. 2, 3.
Marginulina subacuealata (Cushman) var. *glabrata* (Cushman) – Phleger and Parker, 1951, p. 9, pl. 5, fig. 4.
Percultazonaria subaculeta (Cushman) – Loeblich and Tappan, 1987, p. 406, pl. 448, figs. 1-3.
Marginulopsis glabrata (Cushman) – Denne, 1990, pl. 8, fig. 12.
Vaginulinopsis subaculeata (Cushman) – Jones, 1994, p. 82, pl. 71, figs. 4, 5.

Morphology: Shell elongate; early portion coiled planispirally, later uncoiled and rectilinear; periphery subacute to carinate; chambers broad and low; sutures marked by lines of raised bead-like nodes; shell wall between the sutures is smooth; apertural face truncate and smooth; aperture projecting and radiate, located at the peripheral angle of the final chamber.

Remarks: Cushman (1923) recognized a variety, named by him as *Cristellaria subaculeata* var. *glabrata*, on the basis a larger proportion of the uncoiled part, a greater development of spines on the periphery and the lack of secondary ornamentation between the sutural lines. As revealed by illustrations of earlier workers, these features vary widely within populations of *Vaginulinopsis subaculeata* in the Gulf of Mexico.
There is some confusion over the generic name of this species. Loeblich and Tappan (1987) named *Cristellaria subaculeata* Cushman 1923 as the type species of a new genus *Percultazonaria* Loeblich and Tappan 1986. They state that it differs from *Vaginulinopsis* Silvestri 1904 in the more prominent early coil and in the elevated, costate, and nodose sutural

ornamentation. Ornamentation is not a dependable clue to generic separation in vaginulinids, and we follow Jones (1994) in considering *Percultazonaria* as a junior synonym of *Vaginulinopsis*.

Figures:
Plate 188, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: edge view showing apertural face, c: apertural view; figs. 3a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 3a: side view, 3b: edge view showing apertural face; fig. 4, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Genus *Saracenaria*

Saracenaria altifrons (Parr)

Cristellaria acutauricularis Fichtel and Moll – Brady, 1884, p. 543, pl. 114, fig. 17.
Lenticulina (Robulus) altifrons Parr, 1950, p. 323, pl. 11, figs. 12a, b.
Lenticulina altifrons Parr – Barker, 1960, p. 236, pl. 114, fig. 17.
Saracenaria (?) sp. Andersen 1961, p. 59, pl. 14, figs. 2a-c.
Saracenaria altifrons (Parr) – Jones, 1994, p. 113, pl. 114, fig. 17.

Morphology: Shell is coiled, 7 chambers in the final whorl, chambers increasing in size; triangular in cross-section; sutures depressed, almost straight; apertural face is long, broad and inflated, aperture terminal, radiate with a median slit.

Figures:
Plate 161, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: edge view showing apertural face, 1c: apertural view.
Scale bars = 50 μm.

Genus *Amphicoryna*

Amphicoryna hirsuta (d'Orbigny)

Nodosaria hirsuta d'Orbigny, 1826, p. 252, no. 7.
Nodosaria papillosa Silvestri? – Brady, 1884, p. 508, pl. 63, figs. 10, 11.
Nodosaria hispida (d'Orbigny) – Brady, 1884, p. 508, pl. 63, figs. 12-16.
Nodosaria hispida (d'Orbigny) – Parker, 1954, p. 505, pl. 6, fig. 1.
Amphicoryna hirsuta (d'Orbigny) – Barker, 1960, p. 132, pl. 63, figs. 10-16.
Amphicoryna hispida (d'Orbigny) – Denne, 1990, pl. 1, fig. 7.
Amphicoryna hirsuta (d'Orbigny) – Jones, 1994, p. 74, pl. 63, figs. 12-15.

Morphology: Shell elongate; early chambers close-set, later chambers connected by the cylindrical neck of the preceding chambers; ornamented with small spines, some delicate costae present on earlier chambers; aperture terminal at the end of a costate and hispid neck.

Figures:
Plate 8, fig. 1, Green Canyon (Block 272) Core P-55 Sample 1-2 cm, side view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view; fig. 3, Garden Banks (Block 427) Core P-EP8 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Family Lagenidae

Genus *Lagena*

***Lagena chrysalis* Heron-Allen and Earland**

Lagena chrysalis Heron-Allen and Earland, 1913, p. 74, pl. 6, fig. 4.
Lagena chrysalis Heron-Allen and Earland – Cushman, 1923, p. 10, pl. 1, fig. 14.

Morphology: Shell chrysalidiform; tapering at both ends but more so at the initial end; final chamber rounded, initial end pointed; aperture simple.

Figures:
Plate 88, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bar = 50 μm.

***Lagena hispida* Reuss**

Lagena hispida Reuss, 1863, p. 335, pl. 6, figs. 77-79.
Lagena hispida Reuss – Brady, 1884, p. 459, pl. 57, figs. 1, 2 (not pl. 57 figs. 3, 4; pl. 59, figs. 2, 5).
Lagena hispida Reuss – Cushman, 1923, p. 26-27, pl. 4, figs. 7, 8.
Lagena hispida Reuss – Barker, 1960, p. 116, pl. 57, figs. 1, 2.
Lagena hispida Reuss – Jones, 1994, p. 63, pl. 57, figs. 1, 2.

Morphology: Shell globular or pyriform in shape; spines distributed uniformly over the shell wall; aperture terminal on a thin, elongate neck with a lip.

Remarks: Jones (1994) has limited *Lagena hispida* to the more elongate forms illustrated as figs. 1 and 2 on Brady's plate 57.

Figures:
Plate 89, fig. 1, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bar = 50 μm.

***Lagena hispidula* Cushman**

Lagena laevis Brady (part) (not *Lagena laevis* (Montagu)), 1884, pl. 56, figs. 10, 11.
Lagena hispidula Cushman, 1913, p. 14, pl. 5, figs. 2, 3.
Lagena hispidula Cushman – Barker, 1960, p. 114, pl. 56, figs. 10, 11, ?13.
Pygmaeoseistron hispidula (Cushman) – Loeblich and Tappan, 1987, p. 416, pl.455, figs. 3-5.
Lagena hispidula Cushman – Jones, 1994, p. 62, pl. 56, figs. 10, 11, ?13.

Morphology: Shell cylindrical in shape; broadly rounded at both ends; shell wall is very finely hispid; aperture is terminal on a thin, elongate neck.

Remarks: This is the type species of the genus *Pygmaeoseistron* Patterson and Richardson in Loeblich and Tappan (1987) but we follow Jones (1994) in considering *Pygmaeoseistron* as a junior synonym of *Lagena* Walker and Jacob (in Kanmacher, 1798).

Figures:
Plate 90, fig. 1, Alaminos Canyon Core PC4 Sample 0-1 cm, side view; fig. 2, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Genus *Procerolagena*

***Procerolagena gracilis* (Williamson)**

Lagena gracilis Williamson, 1848, p. 13, pl. 1, fig. 5.
Lagena gracilis Williamson – Brady, 1884, p. 464, pl. 58, fig. 9 (part).
Lagena distoma Parker and Jones MS., Brady – Brady, 1884, pl. 58, figs. 11-15.
Lagena distoma Parker and Jones MS., Brady – Cushman, 1923, p. 14, 15, pl. 3, figs. 2, 3.
Lagena gracilis Williamson – Cushman, 1923, p. 22, figs. 3, 4.
Lagena gracillima (Seguenza) var. *mollis* Cushman, 1944, p. 21, pl. 3, fig. 3.
Lagena gracilis Williamson – Barker, 1960, p. 119, pl. 58, fig. 9 (part).
Lagena distoma Parker and Jones MS., Brady – Barker, 1960, pl. 58, figs. 11-15.
Procerolagena gracilis Williamson – Jones, 1994, p. 65, pl. 58, figs. 9, ?11-15.

Morphology: Shell elongate, the main body of the shell varying from long and thin to fusiform, tapering at the initial end into an apical spine and at the apertural end into a long thin neck; surface ornamented by slightly raised longitudinal costae varying in number.

Remarks: Jones (1994) regards figs. 9 and 11-15 from pl. 58 of the *Challenger* report as falling within the range of variability of *L. gracilis* Williamson (1848), and also includes *L. gracillima* var. *mollis* Cushman 1944 within that range. The morphology of our specimens fits Jones' concept of *P. gracilis*. *Lagena gracilis* Williamson (1848) is the type species of the genus *Procerolagena* Puri 1954, and Jones (1984) designated a lectotype for this species.

Figures:
Plate 135, fig. 1, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, side view; fig. 2, Green Canyon (Block 272) Core P-54 Sample 1-2 cm, side view; fig. 3, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, side view; fig. 4, Green Canyon (Block 272) Core P-54 Sample 0-1 cm, side view; fig. 5, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 6, Green Canyon (Block 272) Core P-54 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Superfamily Polymorphinacea

Family Polymorphinidae

Genus *Vasiglobulina*

***Vasiglobulina reticulata* Poag**

Globulina caribaea d'Orbigny, 1839b, p. 135, pl. 2, figs. 7, 8.
Globulina caribaea d'Orbigny – Parker, 1954, p. 506, pl. 5, fig. 23.
Vasiglobulina reticulata Poag, 1982, p. 266, figs. 5 G-I, 6 A-I, 7 A-I, 8 A-I, 9 G-I.
Morphology: Shell ovate, globular; circular in section; sutures indistinct; aperture terminal, radiate, may be obscured by a fistulose growth.

Figures:
Plate 191, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view; fig. 2, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Family Ellipsolagenidae

Genus *Oolina*

***Oolina apiopleura* (Loeblich and Tappan, 1953)**

Lagena acuticosta Reuss – Brady, 1884, p. 464, pl. 57, figs. 32; pl. 58, fig. 21 (part).
Lagena acuticosta Reuss – Cushman, 1923, p. 5-6, pl. 1, figs. 1-3.
Lagena apiopleura Loeblich and Tappan, 1953, p. 59, pl. 10, figs. 14, 15.
Lagena elegantissima (Bornemann) – Barker, 1960, p. 118, pl. 57, fig. 32.
Lagena sp. nov.? Barker, 1960, p. 119, pl. 58, fig. 21.
Oolina apiopleura (Loeblich and Tappan) – Jones, 1994, p. 65, 66, pl. 57, fig. 32; pl. 58, fig. 21.

Morphology: Single chambered, pear shaped, with several strong ribs; terminal, rounded aperture; entosolenian tube difficult to see.

Figures:
Plate 111, figs. 1a-b, Alaminos Canyon Core PC5 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 µm.

Oolina globosa **(Montagu)**

Vermiculum globosum Montagu, 1803, p. 523.
Lagena globosa (Montagu) – Brady, 1884, p. 452, pl. 56, figs. 1-3.
Lagena globosa (Montagu) – Cushman, 1923, p. 20, 21, pl. 4, figs. 1, 2.
Lagena globosa (Montagu) – Barker, 1960, p. 114, pl. 56, figs. 1-3.
Oolina globosa (Montagu) – Jones, 1994, p. 61, pl. 56, figs. 1-2, ?3.

Morphology: Shell globular to subspherical; shell wall smooth and unornamented; aperture rounded with an entosolenian tube.

Remarks: This is the type species of the genus *Entolagena* Silvestri 1900 but Jones (1994) notes that this was considered a junior synonym of *Oolina* first and later as of uncertain status by Loeblich and Tappan (1964, 1987).

Figures:
Plate 112, figs. 1-2, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, a: side view, b: apertural view; figs. 3a-b, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, 3a: side view, 3b: apertural view.
Scale bars = 50 µm.

Oolina ovum **(Ehrenberg)**

Miliola ovum Ehrenberg, 1843, p. 166.
Lagena ovum (Ehrenberg) – Brady, 1884, p. 454, pl. 56, fig. 5.
Lagena ovum (Ehrenberg) – Cushman, 1923, p. 44, 45, pl. 8, figs. 9, 10.
Oolina ovum (Ehrenberg) – Barker, 1960, p. 114, pl. 56, fig. 5.
Oolina ovum (Ehrenberg) – Jones, 1994, p. 61, pl. 56, fig. 5.

Morphology: Shell elongate, elliptical, circular in cross-section; both ends rounded; aperture round with a short entosolenian neck.

Plate 113, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 µm.

***Oolina squamosa* (Montagu)**

Vermiculum suamosum Montagu, 1803, p. 526, pl. 14, fig. 2.
Entosolenia squamosa (Montagu) var. α, *catenulata* Jeffreys MS in Williamson, 1848, p. 19, pl. 2, fig. 20.
Lagena catenulata Williamson – Cushman, 1923, p. 9, 10, pl. 1, fig. 11.

Morphology: Shell globular; basal end truncated, apertural end slightly drawn out; shell wall ornamented by raised polygonal reticulations arranged in vertical rows; aperture round.

Figures:
Plate 114, figs. 1a-b, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 μm.

Genus *Fissurina*

***Fissurina fissa* (Heron-Allen and Earland)**

Lagena marginata (Montagu) var. *fissa* Heron-Allen and Earland, 1922, p. 157, pl. 5, figs. 24-25.

Morphology: Shell ovate; carinate periphery, keel increases in breadth over the basal quadrant, deflected just before reaching the aboral extremity and rapidly decreases in breadth and may vanish; aperture terminal, slit-like, within a fissure at the test apex and an entosolenian tube.

Remarks: The keel does not completely disappear in all specimens; in some it just decreases in breadth.

Figures:
Plate 63, figs. 1-3, Alaminos Canyon Core PC4 Sample 0-1 cm, a: side view, b: apertural view.
Scale bars = 50 μm.

***Fissurina* sp. cf. *F. incomposita* (Patterson and Pettis)**

Lagena acuta (Reuss) – Brady, 1884, p. 474, pl. 59, fig. 6.
Lagena marginata (Montagu) var. *spinifera* Earland, 1934, p. 156, pl. 7, figs. 3-4.
Fissurina crebra (Matthes) – Barker, 1960, p. 122, pl. 59, fig. 6.
Lagenosolenia incomposita Patterson and Pettis, 1986, p. 74.
Fissurina incomposita (Patterson and Pettis) – Jones, 1994, p. 67, pl. 59, fig. 6.

Morphology: Shell ovate; narrow peripheral carina, extending into a basal spine; aperture terminal, slit-like, within a fissure at the test apex, entosolenian tube internal.

Remarks: *Lagena marginata* var. *spinifera* Earland 1934, the name assigned by Thalmann (1937), is a primary junior homonym of *L. aspera* var. *spinifera* Chapman 1895. It was renamed *Lagenosolenia incomposita* by Patterson and Pettis (1986), but Jones (1994) regards *Lagenosolenia* as a junior synonym of *Fissurina* Reuss 1850. Our specimens differ from those of Brady (1884) and Earland (1934) by not showing a clear neck and the wide, opaque carina at the apertural end.

Figures:
Plate 64, figs. 1a-b, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 μm.

Genus *Parafissurina*

Parafissurina botelliformis (Brady)

Lagena botelliformis Brady, 1881, p. 60.
Lagena botelliformis Brady – Brady, 1884, p. 454, pl. 56, fig. 6.
Lagena botelliformis Brady – Cushman, 1923, p. 8, 9; pl. 1, fig. 10.
Oolina botelliformis (Brady) – Barker, 1960, p. 114, pl. 56, fig. 6.
Parafissurina botelliformis (Brady) – Jones, 1994, p. 61, pl. 56, fig. 6.

Morphology: Shell elongate, arcuate, cylindrical with rounded ends; shell wall smooth and unornamented; aperture round.

Figures:
Plate 119, figs. 1a-b, Alaminos Canyon Core PC5 Sample 1-2 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Parafissurina kerguelenensis (Parr)

Lagena staphyllearia (Schwager) – Brady, 1884, p. 474, pl. 59, figs. 8-11.
Fissurina kerguelenensis Parr, 1950, p. 305, pl. 8, fig. 7.
Fissurina kerguelenensis Parr – Barker, 1960, p. 122, pl. 59, figs. 8-11.
Fissurina kerguelenensis Parr – Hermelin, 1989, p. 48, pl. 6, figs. 17-18.
Fissurina staphyllearia Schwager – Jones, 1994, p. 67, 68, pl. 59, figs. 8-11.

Morphology: Shell ovate; rounded in cross-section; narrow peripheral carina; 3-10 spines at the basal part of the test; aperture crescentic, dorsal margin projecting above the opening in a hood-like extension; entosolenian tube internal.

Remarks: Parr (1950) states that his *Fissurina kerguelenensis* differs from *F. staphyllearia* Schwager as Schwager's species has a thicker, more inflated test, lacks a keeled periphery, and has a narrower and more produced apertural end. Parr (1950) observed one specimen in which the sides of the aperture are of different heights and noted that in the absence of other specimens this species would have been placed in *Parafissurina*.

Figures:
Plate 120, figs. 1a-b, Alaminos Canyon Core PC4 Sample 0-1 cm, 1a: side view, 1b: apertural view.
Scale bars = 50 μm.

***Parafissurina lateralis* (Cushman)**

Lagena apiculata (Reuss) – Brady, 1884, pl. 56, figs. 17-18.
Lagena lateralis Cushman, 1913, p. 9, pl. 1, fig. 1.
Parafissurina lateralis (Cushman) – Barker, 1960, p. 116, pl. 56, figs. 17, 18.
Parafissurina lateralis (Cushman) – Jones, 1994, p. 62, pl. 56, figs. 17, 18.

Morphology: Shell elongate, somewhat tapering towards apertural end; both ends rounded, basal end may be truncated; aperture crescentic, dorsal margin projecting above the opening in a hood-like extension; entosolenian tube internal.

Figures:
Plate 121, figs. 1-2, Alaminos Canyon Core PC5 Sample 1-2 cm, a: side view, b: apertural view; figs. 3a-b, Alaminos Canyon Core PC4 Sample 0-1 cm, 3a: side view, 3b: apertural view.
Scale bars = 50 μm.

Family Glandulinidae

Genus *Seabrookia*

***Seabrookia earlandi* Wright**

Seabrookia earlandi Wright, 1891, p. 477, pl. 20, figs. 6-7.
Seabrookia earlandi Wright – Denne, 1990, pl. 12, fig. 7.

Morphology: Shell elongate, ovate in outline, somewhat irregular in shape; planoconvex to unevenly biconvex in end view; five chambers; peripheral keel; aperture a terminal slit, bordered by a thick lip; with entosolenian tube.

Figures:
Plate 162, figs. 1a-b, south of Mississippi Canyon control sample DGOMB2 C7, 1a: side view, 1b: apertural view; figs. 2a-b, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, 2a: side view, 2b: apertural view.

2.2.8. Order Buliminida

Superfamily Bolivinacea

Family Bolivinidae

Genus *Bolivina*

Bolivina alata (Seguenza)

Vulvulina alata Seguenza, 1862, p. 115, pl. 2, figs. 5, 5a.
Bolivina beyrichi Reuss var. *alata* (Seguenza) – Brady, 1884, p. 422, pl. 53, figs. 2-4.
Bolivina beyrichi Reuss var. *alata* (Seguenza) – Cushman, 1922, p. 30, 31, pl. 8, fig. 3.
Bolivina alata (Seguenza) – Phleger and Parker, 1951, p. 12, pl. 6, fig. 11.
Bolivina alata (Seguenza) – Barker, 1960, p. 108, pl. 53, figs. 2-4.
Bolivina alata (Seguenza) – Andersen, 1961, p. 92, pl. 20, figs. 9a, b.
Brizalina alata (Seguenza) – Poag, 1981, p. 43, 44, pl. 23, fig. 2, pl. 24, figs. 2a-c.
Bolivina alata (Seguenza) – Denne, 1990, pl. 2, fig. 2.
Brizalina alata (Seguenza) – Jones, 1994, p. 58, pl. 53, figs. 2-4.

Morphology: Periphery sharp, with an imperforate carina extending into a spinose projection at the edge of each chamber; chambers distinct, increasing in size rather abruptly in last few stages; strongly curved sutures; terminal aperture with lips and a tooth.

Remarks: Differs from *B. barbata* in having a wider carina which extends along the entire periphery of the final chamber and forms an apertural lip.

Figures:
Plate 14, figs. 1a-c, Mississippi Canyon Core P-IM2 Sample 0-1 cm, 1a: side view, 1b: edge view, 1c: apertural view; fig. 2, Mississippi Canyon Core P-IM4 Sample 1-2 cm, side view. Carbonate overgrowth visible on the shell; figs. 3a-c, Green Canyon Core P-51 Sample 0-1 cm, 3a: side view, 3b: edge view, 3c: apertural view; fig. 4, Green Canyon Core P-55 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Bolivina albatrossi Cushman

Bolivina albatrossi Cushman, 1922, pt. 3, p. 31, pl. 6, fig. 4.
Bolivina albatrossi Cushman – Phleger and Parker, 1951, p. 12, pl. 6, figs. 15-16.
Bolivina albatrossi Cushman – Parker, 1954, p. 513, pl. 7, fig. 13.
Bolivina albatrossi Cushman – Pflum and Frerichs, 1976, pl. 1, figs. 5-6.
Brizalina albatrossi (Cushman) – Poag, 1981, p. 44, pl. 23, fig. 5; pl. 24, figs. 5a-c.
Bolivina albatrossi Cushman – Denne, 1990, pl. 2, fig. 3.

Morphology: Initial end broadly rounded; periphery rounded; early portion of shell with reticulate surface; last few chambers smooth; terminal aperture with lips and a tooth.

Figures:
Plate 15, figs. 1-2, south of Mississippi Canyon control sample DGOMB2 C7, a: side view, b: edge view, c: apertural view.
Scale bars = 50 µm.

Bolivina barbata Phleger and Parker

Bolivina barbata Phleger and Parker, 1951, p. 13, pl. 6, figs. 12a, b, 13.
Bolivina barbata Phleger and Parker – Parker, 1954, p. 514, pl. 7, fig. 14.
Bolivina barbata Phleger and Parker – Andersen, 1961, p. 93, pl. 20, figs. 6a, b.
Brizalina barbata (Phleger and Parker) – Poag, 1981, p. 44, 45, pl. 23, fig. 1; pl. 24, figs. 1a-c.
Bolivina barbata Phleger and Parker – Denne, 1990, pl. 2, fig. 4.

Morphology: Shell tapering gradually; with a narrow imperforate carina extending into a spinose projection at the edge of each chamber; chambers distinct, increasing gradually in size as added; strongly curved imperforate sutures separating densely perforate chamber walls (see plate 16, fig. 4).

Remarks: Differs from *B. alata* in having much narrower and more numerous chambers, a narrower carina, and imperforate sutural bands. Differs from *B. minima* in having more numerous chambers, more strongly curved, imperforate sutures, and a distinct carina.

Figures:
Plate 16, figs. 1a-c, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, 1a: side view, 1b: edge view, 1c: apertural view. Carbonate overgrowth visible on the shell; fig. 2, Mississippi Canyon Core P-IM4 Sample 1-2 cm, side view. Carbonate overgrowth visible on the shell; figs. 3a-c, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 3a: side view; 3b: edge view, 3c: apertural view; fig. 4, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Bolivina daggarius Parker

Bolivina lanceolata Parker, 1954, p. 514, pl. 7, figs. 17-20.
Not *Bolivina lanceolata* di Napoli, 1952.
Bolivina daggarius Parker, 1955, p. 52.
Brizalina lanceolata (Parker) – Poag, 1981, p. 45, 46, pl. 25, fig. 5; pl. 26, figs. 5a-5c.

Morphology: Shell tapering to a pointed initial end, often with a short spine; periphery acute, sometimes with a narrow keel, especially on the later chambers; sutures slightly limbate, straight, at 45° with the horizontal; coarse perforations in shell wall excluding the inner and upper portion of earlier chambers, a few fine costae present on earlier chambers; aperture narrow, keeled with a serrated tooth.

Remarks: Parker (1954) noted that *B. daggarius* differed from *B. acerosa* Cushman in having a larger size, clear areas on the inner portions of chambers and costae (when present) extending further up the shell. Parker's specimens have a maximum length of 0.6 mm compared with 0.35 – 0.45 mm of *B. acerosa*. Our specimens fit Parker's description and are of a similar size (0.6 mm).

Figures:
Plate 17, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 1a: side view, 1b: edge view, 1c: apertural view.
Scale bars = 50 μm.

***Bolivina goesii* Cushman**

Bolivina goësii Cushman, 1922, p. 34, pl. 6, fig. 5.
Bolivina goësii Cushman – Parker and Phleger, 1951, p. 13, pl. 6, fig. 17.
Bolivina goësii Cushman – Parker, 1954, p. 514, pl. 7, fig. 16.
Brizalina goësii (Cushman) – Poag, 1981, p. 45, pl. 23, fig. 4; pl. 24, figs. 4a-c.
Bolivina goessi Cushman – Denne, 1990, pl. 2, fig. 6.

Morphology: Shell tapering to blunt initial end; narrow peripheral keel; chambers arranged in a chevron pattern; depressed chamber walls flanked by sutural ridges; coarse perforations in the shell wall; aperture elongate with a serrated tooth, surrounded by wide lips.

Figures:
Plate 18, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: edge view, 1c: apertural view.
Scale bars = 50 μm.

***Bolivina* sp. cf. *B. hastata* Phleger and Parker**

Bolivina fragilis Phleger and Parker, 1951, p. 13, pl. 6, figs. 14, 23, 24a, b.
Bolivina hastata Phleger and Parker, 1951, p. 13, pl. 6, figs. 18a, b, 19.
Bolivina fragilis Phleger and Parker – Parker, 1954, p. 514, pl. 7, fig. 15.
Bolivina fragilis Phleger and Parker – Andersen, 1961, p. 93, pl. 20, figs. 8a, b.
Brizalina fragilis (Phleger and Parker) – Poag, 1981, p. 45, pl. 25, fig. 4; pl. 26, figs. 4a-c.
Bolivina fragilis Phleger and Parker – Denne, 1990, pl. 2, fig. 5.
Bolivina hastata Phleger and Parker – Denne, 1990, pl. 2, fig. 7.

Morphology: Periphery acute with a thin keel; chambers distinct; sutures narrow, almost straight; several low costae extending from initial end, which often has a small spine, about one third up the length of the shell.

Remarks: Differs from *B. fragilis* in its smaller size, narrower keel and less curved chambers. More similar to *B. hastata* although the keel in this species extends fully up the shell and there are usually only one costae and the apical end is less ovate.

Figures:
Plate 19, figs. 1a-c, Green Canyon (Block 272) Core P-33 Sample 1-2 cm, 1a: side view, 1b: edge view, 1c: apertural view; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 2a: side view, 2b: edge view; fig. 3, Mississippi Canyon Core P-IM4 Sample 1-2 cm, side view. Carbonate overgrowth visible on the shell.
Scale bars = 50 μm.

Bolivina lowmani Phleger and Parker

Bolivina lowmani Phleger and Parker, 1951, p. 13-14, pl. 6, figs. 20a, b, 21.
Bolivina lowmani Phleger and Parker – Parker, 1954, p. 515, pl. 7, fig. 21.
Brizalina lowmani (Phleger and Parker) – Poag, 1981, p. 46, pl. 25, fig. 3; pl. 26, figs. 3a-c.
Bolivina lowmani Phleger and Parker – Denne, 1990, pl. 2, fig. 8.

Morphology: Initial end slightly tapering to rounded and rather compressed, sometimes slightly twisted, periphery slightly lobulate.

Remarks: A few scattered medium-sized pores were observed on Phleger and Parker's holotype under the light microscope but were not seen on specimens of this study.

Figures:
Plate 20, figs. 1a-c, Alaminos Canyon Core PC5 Sample 1-2 cm, 1a: side view, 1b: edge view, 1c: apertural view; figs. 2a-b, Alaminos Canyon Core PC5 Sample 1-2 cm, 2a: side view, 2b: edge view; fig. 3, Alaminos Canyon Core PC5 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Bolivina minima Phleger and Parker

Bolivina minima Phleger and Parker, 1951, p. 14, pl.7, figs. 22a, 22b, 25.
Bolivina minima Phleger and Parker – Parker, 1954, p. 515, pl. 7, figs. 22, 23.
Brizalina minima (Phleger and Parker) – Poag, 1981, p. 46, 47, pl. 23 fig. 1; pl. 24, figs. 1a-1c.
Bolivina minima Phleger and Parker – Denne, 1990, pl. 2, fig. 9.

Morphology: Gradually tapering with a subacute to broadly rounded initial end; chambers distinct, numerous, frequently with a spinose extension; sutures distinct, slightly curved; between one and three rows of perforations along the lower part of chambers; very small (~ 10 μm) sharp projections across sutures between chambers.

Remarks: Differs from *B. barbata* in the absence of a carina. The presence of spines on chambers is variable in this species. Phleger and Parker (1951) also noted this feature and observed that chamber spines were absent from many specimens.

Figures:
Plate 21, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: edge view; figs. 3a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 3a: side view, 3b: edge view, 3c: apertural view; fig. 4, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Bolivina ordinaria **Phleger and Parker**

Bolivina simplex Phleger and Parker, 1951, p. 14, pl. 7, figs. 4, 5a, b, 6.
Not *Bolivina interjuncta* Cushman var. *simplex* Cushman and Renz, 1941 = *Bolivina simplex* Cushman and Renz of authors.
Bolivina ordinaria Phleger and Parker, 1952, p. 14.
Bolivina ordinaria Phleger and Parker – Parker, 1954, p. 515, pl. 7, fig. 24.
Brizalina ordinaria (Phleger and Parker) – Poag, 1981, p. 47, pl. 23, fig. 6; pl. 24, figs. 6a-c.
Bolivina ordinaria Phleger and Parker – Denne, 1990, pl. 2, fig. 10.

Morphology: Shell compressed and tapering; periphery acute at initial end, more rounded towards apertural end; sutures slightly depressed; one to two rows of pores clustering along the top of sutures, but more extensive in later chambers of larger specimens.

Remarks: The rows of pores make the sutures appear broad, opaque and white under the light microscope.

Figures:
Plate 22, figs. 1a-c, south of Mississippi Canyon control sample DGOMB2 C7, 1a: side view, 1b: edge view, 1c: apertural view; figs. 2-3, south of Mississippi Canyon control sample DGOMB2 C7, side view; fig. 4, Green Canyon (Block 232) Core P-EP12 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Bolivina **sp. cf.** ***B. pusilla*** **Schwager**

Bolivina pusilla Schwager, 1866, p. 254, pl. 7, fig. 101.
Bolivina pusilla Schwager – Parker, 1954, p. 516, pl. 7, fig. 31.
Bolivina pusilla Schwager – Pflum and Frerichs, 1976, pl. 1, fig. 7.
Bolivina pusilla Schwager – Boltovskoy, 1978, pl. 1, figs. 16-18.
Brizalina pusilla (Schwager) – Srinivasan and Sharma, 1980, p. 44, pl. 6, fig. 21 (neotype).
Bolivina pusilla Schwager – Hermelin, 1989, p. 59, 60.
Bolivina pusilla Schwager – Denne, 1990, pl. 2, fig. 11.

Morphology: Elongate shell; wall ornamented with numerous longitudinal striations which sometimes terminate in a spine, last few chambers smooth.

Remarks: The terminating spine was not observed by Srinivasan and Sharma (1980) on the neotype or other Car Nicobar specimens of *B. pusilla*, and is also not seen in Schwager's type illustration. The specimens illustrated by Parker (1954) and Pflum *et al.* (1976) do have a spine, and the specimens from this study match those of Parker (1954) and Pflum *et al.* (1976). *Bolivina* sp. cf. *B. pusilla* differs from *Bolivina hastata* in that the sutures are obscured by the costae, and the chambers appear indistinct.

Figures:
Plate 23, figs. 1a-c, Alaminos Canyon Core PC5 Sample 3-4 cm, 1a: side view, 1b: edge view, 1c: apertural view; fig. 2, Alaminos Canyon Core PC15 Sample A10, side view; fig. 3, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 4, De Soto Canyon control sample DGOMB2 S36, side view.
Scale bars = 50 μm.

Bolivina subaenariensis Cushman

Bolivina aenariensis Brady, 1882, p. 711.
Bolivina aenariensis Brady – Brady, 1884, p. 423, pl. 53, figs. 10, 11.
Bolivina subaenariensis Cushman, 1922, p. 46, 47, pl. 7, fig. 6.
Bolivina subaenariensis Cushman var. *mexicana* Cushman, 1922, p. 47, pl. 8, fig. 1.
Bolivina subaenariensis Cushman var. *mexicana* Cushman – Phleger and Parker, 1951, p. 15, pl. 7, figs. 8-10.
Bolivina subaenariensis mexicana Cushman – Parker, 1954, p. 517, pl. 7, fig. 33.
Bolivina subaenariensis Cushman var. – Barker, 1960, p. 110, pl. 53, figs. 10, 11.
Bolivina mexicana Cushman – Andersen, 1961, p. 94, pl. 20, figs. 7a, b.
Brizalina subaenariensis mexicana (Cushman) – Poag, 1981, p. 48, pl. 25, fig. 1; pl. 26, figs. 1a-c.
Bolivina subaenariensis mexicana Cushman – Denne, 1990, pl. 2, fig. 13.
Bolivina subaenariensis var. *mexicana* Cushman – Jones, 1994, p. 58, pl. 53, figs. 10, 11.

Morphology: Shell compressed; periphery acute, carinate; a few long raised costae run from the apex towards the apertural end; a single spine is present at the apical end; sutures distinct and curved.

Remarks: Cushman (1922) stated that *B. subaenariensis* var. *mexicana* differs from *B. subaenariensis* in (a) having a greater number of costae that run nearly to the apertural end of the test and (b) the more abruptly tapering shell. This difference, however, seems to be gradational, and within the natural range of variability for the species (compare plate-figs. 1a and 3) and, therefore, the varietal name is rejected. This species differs from *B. hastata* in its larger size and more distinct keel and costae.

Figures:
Plate 24, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 1-2 cm, 1a: side view, 1b: edge view, 1c: apertural view; figs. 2-3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view; figs. 4a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 4a: side view, 4b: edge view, 4c: apertural view; figs. 5a-b, Mississippi Canyon Core P-IM4 Sample 1-2 cm, 5a: side view, 5b: edge view. Carbonate overgrowth visible on the shell.
Scale bars = 50 μm.

***Bolivina translucens* Phleger and Parker**

Bolivina translucens Phleger and Parker, 1951, p.15, pl. 7, figs. 13, 14a, b.
Bolivina translucens Phleger and Parker – Parker, 1954, p. 517, fig. 34.
Brizalina translucens (Phleger and Parker) – Poag, 1981, p. 48, pl. 25, fig. 2; pl. 26, figs. 2a-c.
Bolivina translucens Phleger and Parker – Denne, 1990, pl. 2, fig. 14.

Morphology: Shell slightly tapering to a blunt initial end in megalospheric forms and to a subacute end in microspheric forms; numerous chambers; sutures slightly oblique, depressed; lower half of chambers with numerous fine perforations; aperture loop-shaped with a lip on one side and a tooth.

Figures:
Plate 25, figs. 1a-c, Mississippi Canyon Core P-69 Sample 1-2 cm, 1a: side view, 1b: edge view, 1c: apertural view; figs. 2a-b, Mississippi Canyon Core P-69 Sample 0-1 cm, 2a: side view, 2b: edge view; fig. 3, Mississippi Canyon Core P-69 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Superfamily Bolivinitacea

Family Bolivinitiae

Genus *Abditodentrix*

***Abditodentrix pseudothalmanni* (Boltovskoy and Giussani de Kahn)**

Bolivinita pseudothalmanni Boltovskoy and Giussani de Kahn, 1981, p.44.
Abditodentrix asketocomptella Patterson, 1985, p. 140, pl. 1, figs. 1-9.
Abditodentrix pseudothalmanni Boltovskoy and Giussani de Kahn – Loeblich and Tappan, 1987, p. 503, pl. 554, figs. 1-5.
Abditodentrix asketocomptella Patterson – Hermelin, 1989, p. 59, pl. 10, fig. 16.
Abditodentrix pseudothalmanni Boltovskoy and Giussani de Kahn – Denne, 1990, pl. 1 fig. 1.

Morphology: Truncate margins, raised sutures and reticulate surface ornamentation. On some specimens the ridges do not form a complete reticulate pattern; this is normal variation within the population. There is also a variation in thickness, with the more heavily reticulate specimens thicker in size. The aperture is peripheral with an apertural lip on one side and a reduced and infolded toothplate.

Remarks: *Abditodentrix* differs from *Bolivinita* in its surface ornamentation. This ornamentation along with the truncate margin distinguishes it from *Bolivina*. *Latibolivina* displays a similar network of reticulations, but it lacks the truncate margin of *Abditodentrix*. See Hermelin (1989) and Patterson (1985) for additional comments.

Figures:
Plate 1, figs. 1a-c, south of Mississippi Canyon control sample DGOMB2 C7, 1a: side view, 1b: edge view, 1c: top view; fig. 2, Alaminos Canyon Core PC15 Sample 7-8 cm, side view; figs. 3a-c, Mississippi Canyon Core P-69 Sample 1-2 cm, 3a: side view, 3b: edge view, 3c: apertural view; fig. 4, Alaminos Canyon Core PC15 Sample 8-9 cm, side view.
Scale bars = 50 µm; fig. 3c scale bar = 20 µm.

Genus *Bolivinita*

Bolivinita quadrilatera (Schwager)

Textilaria quadrilatera Schwager, 1866, p. 253, pl. 7, fig. 103.
Textularia quadrilatera Schwager – Brady, 1884, p. 358, pl. 42, figs. 8-12.
Bolivina quadrilatera (Schwager) – Cushman, 1922, p. 44, pl. 8, fig. 2.
Bolivinita quadrilatera (Schwager) – Barker, 1960, p. 86, pl. 42, figs. 8-12
Bolivinita quadrilatera (Schwager) – Srinivasan and Sharma, 1980, p. 42, 43, pl. 6, figs. 22, 23 (neotype).
Bolivinita quadrilatera (Schwager) – Jones, 1994, p. 47, pl. 42, figs. 8-12.

Morphology: Quadrate in edge view, edges carinate; seven to eight chambers; occassional costae; aperture suboval with a tooth.

Remarks: Cushman (1922) observed a spine at the initial end of the species but this spine was not noted by Srinivasan and Sharma (1980) in their re-description of the species. They did note that some specimens were more narrowly pointed than the neotype. This is the type species of the genus *Bolivinita* Cushman 1927.

Figures:
Plate 26, figs. 1a-c, Farnella Canyon Core P-61 Sample 0-1 cm, 1a: side view, 1b: edge view, 1c: apertural view.
Scale bars = 50 µm.

Superfamily Cassidulinacea

Family Cassidulinidae

Genus *Cassidulina*

***Cassidulina carinata* Silvestri**

Cassidulina laevigata d'Orbigny var. *carinata* Silvestri, 1896, p. 104, pl. 2, figs. 10 a-c.
Cassidulina laevigata d'Orbigny var. *carinata* Cushman, 1922, p. 124, pl. 25, figs. 6, 7.
Cassidulina neocarinata Thalmann, 1950, p. 44 (new name).
Cassidulina laevigata d'Orbigny – Phleger and Parker, 1951, p. 27, pl. 14, figs. 6a, 6b.
Cassidulina laevigata d'Orbigny var. *carinata* Cushman – Phleger and Parker, 1951, p. 27, pl. 14, figs. 7a, 7b.
Cassidulina neocarinata Thalmann – Parker, 1954, p. 536, pl. 11, fig. 3.
Cassidulina neocarinata Thalmann – Andersen, 1961, p. 113, pl. 25, figs. 4a-c.
Cassidulina neocarinata Thalmann – Denne, 1990, pl. 3, fig. 10.
Cassidulina laevigata d'Orbigny var. *carinata* Silvestri – Jones, 1994, p. 60, pl. 54, figs. 2, 3.

Morphology: Shell compressed; periphery acute with a distinct keel; aperture is a long narrow slit parallel to the periphery.

Remarks: Smaller specimens are very similar to Phleger and Parker's (1951) figures of *Cassidulina laevigata*, whereas larger specimens match their figures of *C. laevigata* var. *carinata*, but theese are all conspecific. An ontogenetic series of such growth forms is shown in plate 34. *C. teretis* Tappan 1951 is a similar species, but our specimens differ from it in having less ovate chambers and in being much smaller. According to Jones (1994), *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman 1922 is "both homonymous and synonymous with *Cassidulina laevigata* d'Orbigny var. *carinata* Silvestri 1896, such that its replacement name *Cassidulina neocarinata* Thalmann 1950 was unnecessary." We agree with this assessment.

Figures:
Plate 33, fig. 1, Mississippi Canyon Core P-69 Sample 0-1 cm, side view showing the aperture; figs. 2a-b, Mississippi Canyon Core P-IM8 Sample 1-2 cm, 2a: side view showing the aperture, 2b: side view; fig. 3, south of Mississippi Canyon control sample DGOMB2 C7, side view showing the aperture; figs. 4a-b, Mississippi Canyon Core P-55 Sample 0-1 cm, 4a: side view showing the aperture, 4b: side view.

Plate 34, ontogenetic series of growth forms, figs. 1-9, Mississippi Canyon Core P-IM8 Sample 1-2 cm, side view showing the aperture; figs. 10-11, Mississippi Canyon Core P-55 Sample 0-1 cm, side view showing the aperture; fig. 12, Mississippi Canyon Core P-69 Sample 0-1 cm, side view showing the aperture.
Scale bars = 50 µm.

Cassidulina curvata Phleger and Parker

Cassidulina curvata Phleger and Parker, 1951, p. 26, pl. 14, figs. 5a-b.
Cassidulina curvata Phleger and Parker – Andersen, 1961, p. 113, pl. 25, figs. 3a-c.
Islandiella curvata (Phleger and Parker) – Poag, 1981, p. 69, 70, pl. 17, fig. 1; pl. 18 figs. 1a, 1b.
Cassidulina curvata Phleger and Parker – Parker, 1954, p. 535, pl. 11, fig. 1.
Cassidulina curvata Phleger and Parker – Denne, 1990, pl. 3, fig. 10.

Morphology: Shell biconvex; periphery rounded, acute with a keel; curved chambers reaching almost to the umbilicus; aperture is somewhat elongate and located close to the periphery.

Remarks: As Phleger and Parker (1951) observed, this species differs from *C. norcrossi* in possessing curving chambers and coarsely perforate shell, and from *C. laevigata* in having a rounded nonlobulate periphery and a less densely perforate shell.

Figures:
Plate 35, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: side view, b: side view, c: edge view showing the aperture.
Scale bars = 50 µm.

Cassidulina obtusa Williamson

Cassidulina obtusa Williamson, 1858, p. 69, pl. 6, figs. 143, 144.
Cassidulina crassa d'Orbigny – Brady, 1884, p. 429, pl. 54, figs. 5.
Cassidulina crassa d'Orbigny – Cushman, 1922, p. 124, p. 124, 125, pl. 26, fig. 7.
Cassidulina crassa d'Orbigny – Phleger and Parker, 1951, p. 26, pl. 14, figs. 4a, 4b.
Cassidulina aff. *crassa* d'Orbigny – Parker, 1954, p. 535, pl. 10, fig. 31.
Cassidulina crassa d'Orbigny – Barker, 1960, p. 110, pl. 54, figs. 5.
Cassidulina crassa d'Orbigny – Denne, 1990, pl. 3, fig. 8.
Cassidulina obtusa d'Orbigny – Jones, 1994, p. 60, pl. 54, fig. 5.

Morphology: Shell compressed; lobulate outline; periphery rounded; aperture long narrow slit parallel to the periphery.

Taxonomic remarks: *Cassidulina crassa* d'Orbigny is similar to *C. obtusa* Williamson but as Williamson (1858) notes, in his description of *C. obtusa*, *C. crassa* has an aperture that is not a simple arcuate slit but bends back upon itself towards the outer portion of the shell. Haynes (1973) commented that *C. crassa* is a large species, up to 1 mm in diameter, and has an aperture almost at right angles to the basal suture. He stated that many North Atlantic references, including Brady's (1884) and Cushman's (1922), to *C. crassa* relate to *C. obtusa*.

Figures:
Plate 36, fig. 1, Alaminos Canyon Core PC4 Sample 0-1 cm, side view showing the aperture; fig. 2, Mississippi Canyon Core P-69 Sample 1-2 cm, side view showing the aperture; fig. 3, south of Mississippi Canyon control sample DGOMB2 C7, side view showing the aperture; fig. 4, De

Soto Canyon control sample DGOMB2 S36, side view; fig. 5, Alaminos Canyon Core PC4 Sample 0-1 cm, side view; fig. 6, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Genus *Cassidulinoides*

Cassidulinoides tenuis Phleger and Parker

Cassidulinoides tenuis Phleger and Parker, 1951, p. 27, figs. 14a, 14b, 15-17.
Cassidulinoides tenuis Phleger and Parker – Parker, 1954, p. 537, pl. 11, fig. 14.
Cassidulinoides tenuis Phleger and Parker – Boltovskoy, 1978, pl. 3, fig. 2.
Rutherfordoides tenuis (Phleger and Parker) – Kohl, 1985, p. 89, 90, pl. 18, figs. 5a-f.
Rutherfordoides tenuis (Phleger and Parker) – Hermelin, 1989, p. 75, pl. 14, figs. 3, 4.
Rutherfordoides tenuis (Phleger and Parker) – Denne, 1990, pl. 12, figs. 4a, b.

Morphology: Initial end often bent; chambers biserially enrolled, later uncoiled, somewhat inflated; sutures depressed; loop-shaped aperture extending from the base of the final chamber almost to the apex of the shell with a toothplate.

Remarks: The shell wall has elongate pores (1 μm long and only a fraction of a μm wide) noted by Hermelin (1989, fig. 4).

Figures:
Plate 37, fig. 1, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view; fig. 2, Green Canyon (Block 272) Core P-51 Sample 1-2 cm, side view; fig. 3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 μm.

Genus *Globocassidulina*

Globocassidulina subglobosa (Brady)

Cassidulina subglobosa Brady, 1881, p. 30; 1884, p. 430, pl. 54, figs. 17a-c.
Cassidulina subglobosa Brady – Cushman, 1922, p. 127, 128, pl. 24, fig. 6.
Cassidulina subglobosa Brady – Phleger and Parker, 1951, p. 27, figs. 11,12,13.
Cassidulina subglobosa Brady – Parker, 1954, p. 536, pl. 11, figs. 4-9.
Cassidulina subglobosa Brady – Barker, 1960, p. 112, pl. 54, figs. 17a-c.
Cassidulina subglobosa Brady – Andersen, 1961, p. 113, pl. 25, figs. 2a-c.
Globocassidulina subglobosa (Brady) – Belford, 1966, p. 149, pl. 25, figs. 11-16, text-figs. 17:1-7, 18:1-4.
Cassidulina subglobosa subglobosa Brady – Boltovskoy, 1978, p. 155, pl. 2, fig. 34.
Islandiella subglobosa (Brady) – Poag, 1981, p. 70-71, pl. 17, fig. 3; pl. 18, figs. 3a-c.

Islandiella sp. aff. *I. subglobosa* (Brady) – Poag, 1981, p. 71, pl. 17, fig. 4; pl. 18, figs. 4a-c.
Globocassidulina subglobosa (Brady) – Hermelin, 1989, p. 74, 75.
Cassidulina subglobosa Brady – Denne, 1990, pl. 3, fig. 12.
Globocassidulina subglobosa (Brady) – Jones, 1994, p. 60, pl. 54, fig. 17.

Morphology: A globose biconvex species with a less convex ventral side and an oblique loop-like aperture on the face of the terminal chamber. The aperture can vary from a loop-like aperture to a V-shaped aperture with a toothplate.

Remarks: Those with V-shaped apertures were placed in *Islandiella* sp. aff. *I. subglobosa* by Poag (1981), but it has been synonymized with *Globocassidulina subglobosa* here. Differs from *Cassidulina obtusa*, which has a more compressed shell and a slit-like aperture.

Figures:
Plate 68, figs. 1a-c, Green Canyon (Block180) Core P-EP15 Sample 0-1 cm, 1a: side view showing the aperture, 1b: side view, 1c: close up of V-shaped aperture; figs. 2-3, south of Mississippi Canyon control sample DGOMB2 C7, side view showing the aperture; fig. 4, south of Mississippi Canyon control sample DGOMB2 C7, side view.
Scale bars = 50 µm.

Superfamily Turrilinacea

Family Turrilinidae

Genus *Eubuliminella*

***Eubuliminella morgani* (Andersen)**

Buliminella morgani Andersen, 1961, p. 87, pl. 19, fig. 10.
Buliminella morgani Andersen – Poag, 1981, p. 51, pl. 33, fig. 1; pl. 34, figs. 1a, 1b.
Buliminella morgani Andersen – Denne, 1990, pl. 3, fig. 4.

Morphology: Multiserial shell with 3-4 chambers in each whorl; sutures depressed; aperture loop-shaped with a small toothplate.

Remarks: This species, endemic to the Gulf of Mexico, has been reported by various authors under *Buliminella*. There is very little similarity, however, between it and the type species of *Buliminella*, *B. elegantissima* (d'Orbigny). We place Andersen's species under *Eubuliminella* Revets 1993, because its features fit well the morphology of that genus. *Eubuliminella*, unlike *Buliminella*, is tetraserial or pentaserial, at least in the early part, and possesses an aperture with a toothplate.

Figures:
Plate 62, figs. 1a-b, Mississippi Canyon Core P-69 Sample 1-2 cm, 1a: side view, 1b: apertural view; fig. 2, Mississippi Canyon Core P-IM2 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Family Stainforthiidae

Genus *Stainforthia*

***Stainforthia complanata* (Egger)**

Virgulina schreibersiana Czjzek – Brady, 1884, p. 414, pl. 52, figs. 1-3.
Virgulina schreibersiana Czjzek var. *complanata* Egger, 1893, p. 292, pl. 8, figs. 91, 92.
Virgulina complanata Egger – Phleger and Parker, 1951, p. 19, pl. 9, figs. 1a, 1b, 2a, 2b, 3a, 3b.
Virgulina complanata Egger – Parker, 1954, p. 512, pl. 7, fig. 6.
Virgulina davisi Chapman and Parr – Barker, 1960, p. 106, pl. 52, figs. 1-3.
Virgulina complanata Egger – Andersen, 1961, p. 91, pl. 20, figs. 2a, b.
Stainforthia complanata (Egger) – Denne, 1990, pl. 13, fig. 3.
Fursenkoina complanata (Egger) – Jones, 1994, p. 56, pl. 52, figs. 1-3.

Morphology: Initial end pointed, often with an apical spine; chambers triserially arranged in early stages, later becoming biserial; large loop-shaped aperture.

Remarks: Members of the genus *Fursenkoina* are biserial throughout and are therefore distinct from this species which is triserial in its early stages, although this is not obvious in all specimens. Loeblich and Tappan (1987) describe the genus of *Stainforthia* as triserial in its early stages and twisted biserial later.

Figures:
Plate 171, fig. 1, Alaminos Canyon Core PC5 Sample 0-1 cm, side view; fig. 2, Alaminos Canyon Core PC5 Sample 1-2 cm, side view; fig. 3, Alaminos Canyon Core PC15 Sample 10-11 cm, side view; fig. 4, Mississippi Canyon Core P-IM2 Sample 0-1 cm, side view; fig. 5, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

***Stainforthia compressa* (Bailey)**

Bulimina compressa Bailey, 1851, p. 12, pl. 12, figs. 35-37.
Virgulina compressa (Bailey) – Cushman, 1922, p. 116, pl. 24, figs. 2-3.
Virgulina compressa (Bailey) – Phleger and Parker, 1951, p. 19, pl. 9, figs. 4a, b, 5a, b.
Fursenkoina compressa (Bailey) – Denne, 1990, pl. 6, fig. 8.

Morphology: Shell elongate, slightly tapered, apical end rounded; early chambers arranged triserially, later chambers arranged biserially; sutures depressed; aperture elongate with a serrate toothplate.

Remarks: As with *Stainforthia complanata* this species is not a member of the genus *Fursenkoina*. This species is triserial in its early stages, later becoming biserial.

Figures:
Plate 172, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Stainforthia pontoni **(Cushman)**

Virgulina pontoni Cushman, 1932, p. 17, pl. 3, fig. 7.
Virgulina pontoni Cushman – Phleger and Parker, 1951, p. 19, pl. 9, figs. 9a, b, 10a, b.
Virgulina pontoni Cushman – Andersen, 1961, p. 92, pl. 20, fig. 3.
Fursenkoina pontoni Cushman – Denne, 1990, pl. 6, fig. 10.

Morphology: Shell elongate, tapering, apical end rounded; early chambers arranged triserially, later chambers arranged biserially; chambers overlapping; sutures greatly depressed; aperture is elongate with a toothplate.

Remarks: See the comments about generic assignation for the two previous species belonging to genus *Stainforthia*. *Stainforthia pontoni* differs from *S. compressa* in its smaller size, more tapered profile and greatly overlapping chambers.

Figures:
Plate 173, fig. 1, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view; fig. 3, from Green Canyon (Block 272) Core P-55 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Superfamily Buliminacea

Family Buliminidae

Genus *Bulimina*

Bulimina aculeata **d'Orbigny**

Bulimina aculeata d'Orbigny, 1826, p. 269, no. 7.
Bulimina aculeata d'Orbigny – Brady, 1884, p. 406, pl. 51, figs. 7-9.
Bulimina aculeata d'Orbigny – Cushman, 1922, p. 96-98, pl. 22, figs. 1, 2.
Bulimina aculeata d'Orbigny – Phleger and Parker, 1951, p. 15, pl. 7, fig. 20.
Bulimina aculeata d'Orbigny – Parker, 1954, p. 510, pl. 6, fig. 19.
Bulimina aculeata d'Orbigny – Barker, 1960, p. 104, pl. 51, figs. 7-9.
Bulimina aculeata d'Orbigny – Pflum and Frerichs, 1976, pl. 1, fig. 8.
Bulimina aculeata d'Orbigny – Poag, 1981, p. 48-49, pl. 21, fig. 1; pl. 22, figs. 1a, 1b.
Bulimina aculeata d'Orbigny – Denne, 1990, pl. 2, fig. 17.
Bulimina aculeata d'Orbigny – Jones, 1994, p. 56, pl. 51, figs. 7-9.

Morphology: Tapering shell broadest at apertural end; many long spines fringing the lower portion of the uppermost chambers and covering the bottom chambers; aperture with partial lip.

Figures:
Plate 27, figs. 1a-b, south of Mississippi Canyon control sample DGOMB2 C7, 1a: side view, 1b: apertural view; figs. 2-3, south of Mississippi Canyon control sample DGOMB2 C7, side view.
Scale bars = 50 μm; except in plate 27, fig. 1b, scale bar is 20 μm.

Bulimina alazanensis Cushman

Bulimina alazanensis Cushman, 1927, p. 161, pl. 25, fig. 4.
Bulimina alazanensis Cushman – Phleger and Parker, 1951, p. 16, pl. 7, figs. 24, 29.
Bulimina alazanensis Cushman – Parker, 1954, p. 510, pl. 6, fig. 21.
Bulimina rostrata alazanensis Cushman – Pflum and Frerichs, 1976, pl. 1, fig. 9.
Bulimina alazanensis Cushman – Poag, 1981, p. 49, pl. 21, fig. 3; pl. 22, figs. 3a, 3b.
Bulimina alazanensis Cushman – Denne, 1990, pl. 2, fig. 18.

Morphology: Chambers and sutures obscured by prominent longitudinal costae that extend down the shell ending in spinose projections; aperture with partial lip.

Figures:
Plate 28, figs. 1a-b, south of Mississippi Canyon control sample DGOMB2 C7, 1a: side view, 1b: apertural view; figs. 2-3, south of Mississippi Canyon control sample DGOMB2 C7, side view.
Scale bars = 50 μm; except in fig. 1b scale bar is 10 μm.

Bulimina marginata d'Orbigny

Bulimina marginata d'Orbigny, 1826, p. 269, pl. 7, figs. 27, 28.
Bulimina marginata d'Orbigny – Brady, 1884, p. 405, pl. 51, figs. 3-5.
Bulimina marginata d'Orbigny – Cushman, 1922, p. 91, 92, pl. 21, figs. 4, 5.
Bulimina marginata d'Orbigny – Phleger and Parker, 1951, p. 16, pl. 7, figs. 27, 28.
Bulimina marginata d'Orbigny – Parker, 1954, p. 510, pl. 6, fig. 20.
Bulimina marginata d'Orbigny – Barker, 1960, p. 104, pl. 51, figs. 3-5.
Bulimina marginata d'Orbigny – Andersen, 1961, p. 88, pl. 19, figs. 14-16.
Bulimina marginata d'Orbigny – Poag, 1981, p. 49, pl. 21, fig. 2; pl. 22, figs. 2a, 2b.
Bulimina marginata d'Orbigny – Denne, 1990, pl. 2, fig. 19.
Bulimina marginata d'Orbigny – Jones, 1994, p. 55, pl. 51, figs. 3-5.

Morphology: Slightly tapered; numerous inflated smooth chambers; later chambers overhanging earlier chambers, with protruding short spines; aperture with a distinct rim.

Remarks: This is the type species of the genus *Bulimina* d'Orbigny 1826.

Figures:
Plate 29, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: close up of aperture; figs. 2a-b, Green Canyon (Block 272) Core P-33 Sample 1-2 cm, 2a: side view, 2b: close up of aperture; fig. 3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 μm; except in figs. 1b and 2b scale bars are 20 μm.

***Bulimina mexicana* Cushman**

Bulimina inflata Seguenza – Brady, 1884, p. 406, pl. 51, figs. 10-13.
Bulimina inflata Seguenza var. *mexicana* Cushman, 1922, p. 95, pl. 21, fig. 2.
Bulimina striata d'Orbigny var. *mexicana* Cushman – Phleger and Parker, 1951, p. 16, pl. 7, figs. 26, 32.
Bulimina striata mexicana Cushman – Parker, 1954, p. 511, pl. 6, fig. 24.
Bulimina costata d'Orbigny? – Barker, 1960, p. 104, pl. 51, figs. 11, 13.
Bulimina striata d'Orbigny var. *mexicana* Cushman – Barker, 1960, p. 104, pl. 51, figs. 10, 12.
Bulimina striata mexicana Cushman – Poag, 1981, p. 50, pl. 21, fig. 4; pl. 22, figs. 4a, 4b.
Bulimina mexicana Cushman – Hermelin, 1989, p. 63, pl. 11, fig. 6.
Bulimina mexicana Cushman – Denne, 1990, pl. 2, fig. 21.
Bulimina mexicana Cushman – Jones, 1994, p. 56, pl. 51, figs. 10-13.

Morphology: Shell expanding from the apex with the final three or four chambers forming about half of the shell; final chambers relatively smooth, otherwise shell wall ornamented with costae that terminate in prominent spines overhanging the previous chambers; loop-shaped aperture with lip.

Remarks: The costae on the specimens from this study seem to be less pronounced than those on the figures of Cushman (1927) and Phleger and Parker (1951). Hermelin (1989) discusses the differences between *Bulimina inflata* Seguenza and *Bulimina striata* d'Orbigny and considers *Bulimina mexicana* Cushman to be a separate taxon. The differences between *Bulimina spicata* Phleger and Parker 1951 and *B. mexicana* are unclear; they may be the same species. *Bulimina mexicana* differs from *B. marginata* in having costae ornamenting the shell wall. The spines of *B. marginata* are restricted to the edge of the chamber overhang and do not extend up the chamber walls.

Figures:
Plate 30, figs. 1a-b, Farnella Canyon Core P-61 Sample 0-1 cm, 1a: side view, 1b: apertural view; figs. 2a-b, south of Mississippi Canyon control sample DGOMB2 C7, 2a: side view, 2b: apertural view; fig. 3, Farnella Canyon Core P-61 Sample 0-1 cm, side view.
Scale bars = 50 μm; except in figs. 1b and 2b scale bars are 20 μm.

Genus *Praeglobobulimina*

***Praeglobobulimina ovata* (d'Orbigny)**

Bulimina ovata d'Orbigny, 1846, p. 185, pl. 11, figs. 13, 14.
Bulimina ovata d'Orbigny – Brady, 1884, p. 400, pl. 50, figs. 13a, b.
Bulimina affinis d'Orbigny – Cushman, 1922, p. 103, 104, pl. 20, fig. 6.
Bulimina affinis d'Orbigny – Phleger and Parker, 1951, p. 15, pl. 7, figs. 21, 22.
Globobulimina affinis (d'Orbigny) – Parker, 1954, p. 511, pl. 6, fig. 25; pl. 7, figs. 1, 2.
Bulimina notovata Chapman – Barker, 1960, p. 102, pl. 50, figs. 13a, b.
Bulimina affinis d'Orbigny – Andersen, 1961, p. 88, pl. 19, figs. 11a, b.
Globobulimina affinis (d'Orbigny) – Denne, 1990, pl. 6, fig. 13.
Praeglobobulimina ovata (d'Orbigny) – Jones, 1994, p. 54, pl. 50, figs. 13a, b.

Morphology: Conical in shape, often with an acutely pointed apical end; sutures slightly depressed; aperture loop-shaped with a folded and crenulate toothplate (see plate 133, fig. 1b).

Figures:
Plate 133, figs. 1a-b, Farnella Canyon Core P-61 Sample 0-1 cm, 1a: side view, 1b: apertural view (partial blockage of the aperture caused by secondary growth of calcite); fig. 2, Farnella Canyon Core P-61 Sample 0-1 cm, side view; figs. 3a-b, Mississippi Canyon Core P-69 Sample 0-1 cm, 3a: side view, 3b: apertural view; fig. 4, Alaminos Canyon Core PC15 Sample 11-12 cm, side view.
Scale bars = 50 μm in 1a, 2, 3a, and 4; 20 μm in 1b and 3b.

***Praeglobobulimina ovula* (d'Orbigny)**

Bulimina ovula d'Orbigny, 1839a, p. 51, pl. 1, figs. 10-11.
Globobulimina ovula (d'Orbigny) – Denne, 1990, pl. 6, fig. 14.

Morphology: Ovate in shape; broadly rounded apical end with 1-3 short three spines; loop-shaped aperture with a folded toothplate.

Figures:
Plate 134, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 1a: side view, 1b: apertural view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Family Uvigerinidae

Genus *Uvigerina*

Uvigerina auberiana d'Orbigny

Uvigerina auberiana d'Orbigny, 1839b, p. 106, pl. 2, figs. 23, 24.
Uvigerina proboscidea Schwager, 1866, p. 250, pl. 7, fig. 96.
Uvigerina auberiana d'Orbigny – Cushman, 1923, p. 163, pl. 42, figs. 3, 4.
Uvigerina auberiana d'Orbigny – Parker, 1954, p. 519, pl. 7, fig. 38, pl. 8, fig. 1.
Uvigerina proboscidea Schwager – Boltovskoy, 1978, pl. 8, figs. 22, 23.
Uvigerina auberiana d'Orbigny – Hermelin, 1989, p. 64, 65, pl. 12, figs. 4, 5.
Uvigerina auberiana d'Orbigny – Denne, 1990, pl. 14, fig. 4.

Morphology: Shell initially triserial, later biserial; small spines randomly distributed over the shell surface but more common on the early chambers; aperture terminal on a neck with a collar.

Remarks: Hermelin (1989) noted that many small, finely pitted uvigerinid species have been described in the literature and most seem to be conspecific with *U. auberiana* and should be regarded as junior synonyms.

Figures:
Plate 184, fig. 1, Alaminos Canyon Core PC15 Sample 9-10 cm, side view; fig. 2, Alaminos Canyon Core PC15 Sample 8-9 cm, side view; fig. 3, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Uvigerina bellula Bandy

Uvigerina auberiana d'Orbigny var. *laevis* Goës, 1896, p. 51.
Uvigerina auberiana d'Orbigny var. *laevis* Goës – Cushman, 1923, p. 163.
Uvigerina auberiana d'Orbigny var. *laevis* Goës – Phleger and Parker, 1951, p. 18, pl. 8, figs. 12-14.
Uvigerina laevis Goës – Parker, 1954, p. 520, pl. 8, fig. 4.
Uvigerina bellula Bandy – Andersen, 1961, p. 90, pl. 20, fig. 15.
Uvigerina laevis Goës – Poag, 1981, p. 86, pl. 27, fig. 4; pl. 28, figs. 4a, b.
Uvigerina laevis Goës – Denne, 1990, pl. 14, fig. 8.

Morphology: Elongate with triserially arranged chambers; shell wall mostly smooth with a few small spines or warts; terminal aperture located at the end of a neck with a distinct lip.

Remarks: Bandy (1956) created the name *Uvigerina bellula* to replace *Uvigerina auberiana* d'Orbigny var. *laevis* Goës 1896 (= *U. laevis* Goës of later authors) because *U. laevis* Ehrenberg 1845 is a different species and has priority (i.e., the name *laevis* is preoccupied and not available). *Uvigerina bellula* differs from *U. auberiana* in having a smoother shell surface and less inflated and more elongate chambers.

Figures:
Plate 185, fig. 1, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view; fig. 2, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Uvigerina flintii Cushman

Uvigerina flintii Cushman, 1923, p. 165, pl. 42, fig. 13.
Uvigerina flintii Cushman – Phleger and Parker, 1951, p. 18, pl. 8, figs. 15-16.
Uvigerina flintii Cushman – Parker, 1954, p. 520, pl. 8, fig. 2.
Uvigerina flintii Cushman – Andersen, 1961, p. 89, pl. 20, fig. 17.
Uvigerina flintii Cushman – Pflum and Frerichs, 1976, pl. 7, fig. 9.
Uvigerina flintii Cushman – Poag, 1981, p. 86, pl. 27, fig. 5; pl. 28, figs. 5a, b.
Uvigerina flintii Cushman – Denne, 1990, pl. 14, fig. 5.

Morphology: Elongate to ovate in shape; coiled triserially; sutures depressed and partially hidden by ornamentation; shell wall ornamented by longitudinal costae which cross the sutures and often fuse with the costae of later chambers; terminal aperture at the end of a spirally costate neck.

Figures:
Plate 186, fig. 1, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, side view; figs. 2-3, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, side view.
Scale bars = 50 μm.

Uvigerina peregrina Cushman

Uvigerina peregrina Cushman, 1923, p. 166, pl. 42, figs. 7-10.
Uvigerina peregrina Cushman – Phleger and Parker, 1951, p. 18, pl. 8, figs. 22, 24-26.
Uvigerina peregrina Cushman – Parker, 1954, p. 521, pl. 8, fig. 5.
Uvigerina peregrina mediterranea Hofker – Pflum and Frerichs, 1976, pl. 8, fig. 1.
Uvigerina peregrina peregrina Cushman – Pflum and Frerichs, 1976, pl. 8, fig. 2, 3.
Uvigerina peregrina dirupta Todd – Pflum and Frerichs, 1976, pl. 8, fig. 4, 5.
Uvigerina peregrina Cushman – Hermelin, 1989, p. 66, pl. 12, figs. 6-8.
Uvigerina peregrina Cushman – Denne, 1990, pl. 14, fig. 10.
Uvigerina peregrina dirupta Todd – Denne, 1990, pl. 14, fig. 11.

Morphology: Triserial; shell wall ornamented with plate-like costae which do not continue across the chambers, hispid ornamentation also apparent in many specimens; terminal aperture present at the end of a neck with a distinct lip.

Remarks: Hermelin (1989) notes that some workers separate various species of *Uvigerina* and subspecies of *U. peregrina* on the basis of the portion of the hispid or costate ornamentation covering the test. This is now recognized to be related to ecophenotypic variation, and, therefore, his concept of *U. peregrina* includes most uvigerinids with a costate or aligned hispid ornamentation (Hermelin, 1989). We have followed Hermlin in this regard.

Figures:
Plate 187, figs. 1-4, Mississippi Canyon Core P-69 Sample 1-2 cm, side view; fig. 5, south of Mississippi Canyon control sample DGOMB2 C7, side view.
Scale bars = 50 μm.

Genus *Trifarina*

***Trifarina bradyi* Cushman**

Rhabdogonium tricarinatum Brady, 1884, p. 525, pl. 67, figs. 1-3.
Trifarina bradyi Cushman, 1923, p. 99, pl. 22, figs. 3-9.
Trifarina bradyi Cushman – Phleger and Parker, 1951, p. 18, pl. 8, figs. 10, 11.
Trifarina bradyi Cushman – Parker, 1954, p. 522, pl. 8, fig. 9.
Trifarina bradyi Cushman – Barker, 1960, p. 140, pl. 67, figs. 1-3.
Trifarina bradyi Cushman – Denne, 1990, pl. 13, fig. 12.
Trifarina bradyi Cushman – Jones, 1994, p. 78, 79, pl. 67, figs. 1-3.

Morphology: Triserial in early stages, later uniserial, often slightly twisted, triangular in cross-section and carinate; terminal aperture at the end of a neck with a lip.

Remarks: This is the type species of the genus *Trifarina* Cushman 1923.

Figures:
Plate 180, figs. 1-2, Green Canyon Core P-51 Sample 1-2 cm, side view; fig. 3, Green Canyon Core P-51 Sample 0-1 cm, side view.
Scale bars = 50 μm.

***Trifarina jamaicensis* (Cushman and Todd)**

Angulogerina jamaicensis Cushman and Todd, 1945, p. 53, pl. 8, figs. 3.
Angulogerina jamaicensis Cushman and Todd – Parker, 1954, p. 521, 522, pl. 8, fig. 8.
Angulogerina jamaicensis Cushman and Todd – Denne, 1990, pl. 1, fig. 11.

Morphology: Triserial throughout, with pronounced but discontinuous costae and short spines.

Figures:
Plate 181, fig. 1, Mississippi Canyon Core P-69 Sample 1-2 cm, side view; fig. 2, Green Canyon (Block 272) Core P-33 Sample 1-2 cm, side view; fig. 3, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view.
Scale bars = 50 µm.

Superfamily Fursenkoinacea

Family Fursenkoinidae

Genus *Fursenkoina*

***Fursenkoina seminuda* (Natland)**

Virgulina seminuda Natland, 1938, p. 145, pl. 5, fig. 12.
Virgulina tessellata Phleger and Parker, 1951, p. 19, pl. 9, figs. 15a, 15b, 16a, 16b.
Virgulina tessellata Phleger and Parker – Parker, 1954, p. 513, pl. 7, fig. 12.
Fursenkoina seminuda (Natland) – Denne, 1990, pl. 6, fig. 10.

Morphology: Fusiform shell; sinuous axial suture; lower part of the chambers is semi-opaque (see plate 65, figs. 1a and 2a).

Remarks: Phleger and Parker (1951) noted that *V. tessellata* differed from *V. seminuda* in being less elongate, having a more rounded initial end and fewer chambers. These differences are within the limits of natural variation and thus *V. tessellata* is a junior synonym.

Figures:
Plate 65, figs. 1a-c, Mississippi Canyon Core P-69 Sample 0-1 cm, 1a: side view, 1b: edge view, 1c: apertural view; figs. 2a-d, Mississippi Canyon Core P-69 Sample 1-2 cm, 2a: side view, 2b: edge view, 2c: apertural view, 2d: top view.
Scale bars = 50 µm in figs. 1a-b and 2a-b, d; 20 µm in figs. 1c and 2c.

Genus *Rutherfordoides*

***Rutherfordoides mexicanus* (Cushman)**

Virgulina mexicana Cushman, 1922, p. 120, pl. 23, fig. 8.
Virgulina mexicana Cushman – Phleger and Parker, 1951, p. 19, pl. 9, figs. 6a, b, 7a, b, 8a, b.
Virgulina mexicana Cushman – Parker, 1954, p. 512, pl. 7, figs. 7, 8.
Virgulina mexicana Cushman – Andersen, 1961, p. 91, pl. 20, figs. 4a-c.
Fursenkoina mexicana (Cushman) – Poag, 1981, p. 65, 66, pl. 33, fig. 7; pl. 34, figs. 7a, b.
Rutherfordoides mexicana (Cushman) – Denne, 1990, 12, figs. 3a, b.

Morphology: Biserial with bent initial end; oblique chambers, broad and low on dorsal side; strongly overlapping and inflated on ventral side; elongate aperture.

Figures:
Plate 158, figs. 1a-b, Mississippi Canyon Core P-69 Sample 1-2 cm, 1a: side view, 1b: apertural view; figs. 2a-b, Mississippi Canyon Core P-IM2 Sample 0-1 cm, 2a: side view, 2b: side view; figs. 3a-b, Mississippi Canyon Core P-69 Sample 0-1 cm, 3a: side view, 3b: apertural view; figs. 4a-b, Mississippi Canyon Core P-IM2 Sample 0-1 cm, 4a: side view, 4b: side view.
Scale bars = 50 μm.

Superfamily Stilostomellacea

Family Stilostomellidae

Genus *Siphonodosaria*

***Siphonodosaria calomorpha* (Reuss)**

Nodosaria calomorpha Reuss, 1866, p. 129, pl. 3, figs. 15-19.
Nodosaria calomorpha Reuss – Brady, 1884, p. 497, pl. 61, fig. 7.
Nodosaria calomorpha Reuss – Cushman, 1923, p. 67, pl. 12, fig. 13.
Nodosaria calomorpha Reuss – Barker, 1960, p. 128, pl. 61, figs. 23-27.
Glandulonodosaria calomorpha (Reuss) – Jones, 1994, p. 72, pl. 61, figs. 23-26, ?27.
Siphonodosaria calomorpha (Reuss) – Denne, 1990, p. 324

Morphology: Shell elongate; frequently arcuate; both ends broadly rounded; 3-5 chambers; aperture a simple opening.

Figures:
Plate 166, figs. 1a-b, Alaminos Canyon Core PC4 Sample 0-1 cm, 1a: side view, 1b: apertural view; figs. 2-3, Alaminos Canyon Core PC5 Sample 1-2 cm, side view.
Scale bars = 50 μm.

2.2.9. Order Rotaliida

Superfamily Discorbacea

Family Bagginidae

Genus *Neocrosbyia*

***Neocrosbyia minuta* (Parker)**

Valvulineria minuta Parker, 1954, p. 527, pl. 9, figs. 4, 5, 6.
Neocrosbyia minuta (Parker) – Denne, 1990, pl. 9, fig. 2.

Morphology: Shell concavo-convex; rounded periphery; deep umbilicus on ventral side; 7-8 chambers in final whorl, chambers increasing gradually in size, inflated, more so on ventral side; small, narrow flap extending a short way into the umbilicus, previous flaps, appearing as small angular or rounded projections, can be seen in the umbilicus, especially in earlier whorls (e.g., plate 108, figs. 1b and 2b); sutures distinct, slightly curved, depressed, more so on ventral side; aperture a slit running from the periphery to the umbilicus, sometimes extending onto dorsal side (e.g., plate 108, figs. 3a and 4).

Figures:
Plate 108, figs. 1a-b, Alaminos Canyon Core PC-5 Sample 1-2 cm, 1a: dorsal view, 1b: ventral view showing umbilical projections; figs. 2a-b, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 2a: dorsal view, 2b: ventral view showing umbilical projections; figs. 3a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 3a: dorsal view, 3b: ventral view with umbilical projections obscured by detritus, 3c: edge view showing apertural slit; fig. 4, Alaminos Canyon Boxcore B19.1 Sample 0-1 cm, dorsal view.
Scale bars = 50 μm.

Genus *Valvulineria*

***Valvulineria glabra* Cushman**

Valvulineria vilardeboana (d'Orbigny) var. *glabra* Cushman, 1927, p. 161, pl. 4, figs. 5, 6.
Valvulineria sp. Parker, 1948, p. 240, pl. 4, figs. 13a, b.
Valvulineria laevigata Phleger and Parker, 1951, p. 25, pl. 13, figs. 11a, 11b, 12a, 12b.
Rotamorphina laevigata (Phleger and Parker) – Parker, 1954, p. 537, pl. 11, figs. 10, 11.
Rotamorphina glabra (Cushman) – Andersen, 1961, p. 114, pl. 23, figs. 2a-c.
Quadrimorphina laevigata (Phleger and Parker) - Denne, 1990, pl. 11, fig. 13.

Morphology: Shell biconvex, composed of 2 to 2½ whorls; 5 chambers in final whorl; chambers increasing in size; sutures slightly depressed, more so on ventral side, slightly curved; periphery rounded; aperture interiomarginal to umbilical hidden beneath a lobe-like plate with serrations extending from the final chamber over the umbilical area.

Remarks. *Valvulineria glabra* was considered to be larger than *V. laevigata* by Phleger and Parker (1951). However, this size difference was considered to be inconsequential by Andersen (1961) who observed specimens spanning the size range between the two species. Therefore *V. laevigata* is synonymized with *V. glabra*.

Figures:
Plate 189, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view showing apertural opening; fig. 2, Mississippi Canyon Core P-69 Sample 0-1 cm, dorsal view; figs. 3a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 3a: dorsal view, 3b: ventral view; fig. 4, south of Mississippi Canyon control sample DGOMB2 C7, ventral view; fig. 5, Green Canyon Core P-51 Sample 1-2 cm, ventral view.

Carbonate overgrowth visible on the shell.
Scale bars = 50 μm.

Valvulineria mexicana Parker

Valvulineria cf. *araucana* (d'Orbigny) – Phleger and Parker, 1951 (not *Rosalina araucana* d'Orbigny, 1839a), p. 25, pl. 13, figs. 7a, b, 8a, b.
Valvulineria mexicana Parker, 1954, p. 526-527, pl. 9, figs. 1-3.
Valvulineria mexicana Parker – Andersen, 1961, p. 104, pl. 23, figs. 1a-c.

Morphology: Shell biconvex; periphery rounded; 6-7 chambers in final whorl; chambers increasing in size, later chambers inflated on ventral side, especially towards the umbilicus (e.g., plate-fig. 3a); sutures depressed, particularly on ventral side near the umbilicus, curved on dorsal side; shell wall coarsely perforate with more perforations on later chambers, perforations frequently aligned along sutures on dorsal side; aperture interiomarginal to umbilical, covered by large lobe-like flap extending from the final chamber over the umbilical area, the flap from the penultimate chamber often visible below and to one side of it (e.g., plate 190, figs. 1b and 2b), flaps of earlier chambers occasionally visible (e.g., plate 190, fig. 3b).

Remarks: This species differs from *V. glabra* in its larger size, more inflated chambers on ventral side and visibility of earlier chamber flaps in the umbilical area.

Figures:
Plate 190, figs. 1-2, Mississippi Canyon Core P-61 Sample 0-1 cm, a: dorsal view, b: ventral view; figs. 3a-b, Mississippi Canyon Core P-61 Sample 0-1 cm, 3a: edge view showing apertural opening, 3b: ventral view.
Scale bars = 50 μm.

Family Eponididae

Genus *Eponides*

Eponides turgidus Phleger and Parker

Eponides turgidus Phleger and Parker, 1951, p. 22, pl. 11, figs. 9a, b.
Eponides turgidus Phleger and Parker – Parker, 1954, p. 530, pl. 9, figs. 22, 23.
Eponides turgidus Phleger and Parker – Poag, 1981, p. 65, pl. 1, fig.4; pl. 2, figs. 4a, 4b.
Alabaminella turgida Phleger and Parker – Denne, 1990, pl. 1, figs. 3a, 3b.

Morphology: Rounded periphery; sutures slightly depressed on dorsal side, more depressed on ventral side; closed umbilicus on ventral side; aperture a low arched opening, covered by a flap, midway between the umbilicus and the periphery with small pustules around it.

Remarks: In some specimens the periphery is lobulate, the spire is higher, and the sutures are more depressed (compare plate figures 2 and 3). This species was placed in the genus *Alabaminella* by Denne (1990). However, it does not possess a minute slitlike aperture which is a feature of *Alabaminella* and therefore it is retained in *Eponides*. This is a small species and Sen Gupta *et al.* (1987) noted that it was almost absent from the >125 µm and >250 µm fractions of an Antarctic Bottom Water assemblage in the Equatorial North Atlantic, although smaller specimens were common.

Figures:
Plate 61, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view; figs. 2-3, Alaminos Canyon Core PC-5 Sample 1-2 cm, dorsal view; fig. 4, Alaminos Canyon Core PC-5 Sample 1-2 cm, ventral view.
Scale bars = 50 µm.

Genus *Ioanella*

Ioanella tumidula (Brady)

Truncatulina tumidula Brady, 1884, p. 666, pl. 95, figs. 8a-d.
Eponides tumidulus (Brady) – Phleger and Parker, 1951, p. 21, pl. 11, figs. 7a, 7b, 8a, 8b.
Eponides tumidulus (Brady) – Parker, 1954, p. 529, pl. 9, figs. 19, 24.
"Eponides" cf. *"E" tumidulus* (Brady) – Andersen, 1961, p. 103, pl. 24, figs. 5a-c.
Eponides tumidulus (Brady) – Pflum and Frerichs, 1976, pl. 2, figs. 4, 5.
Eponides tumidulus (Brady) – Poag, 1981, p. 64, 65, pl. 1, fig. 2; pl. 2, figs. 2a, 2b.
Ioanella tumidula (Brady) – Loeblich and Tappan, 1987, p. 549, 550, pl. 595, figs. 4-9.
Ioanella tumidula (Brady) – Denne, 1990, pl. 7, fig. 8.

Morphology: Lobulate outline; dorsal side inflated with depressed sutures; umbilicus open on ventral side, umbilicus surrounded by secondary apertures (plate 85, figs. 1b, 2); aperture low, arched, open from umbilicus to edge.

Remarks: This species was placed in genus *Ioanella* Saidova by Loeblich and Tappan (1987) on the basis of the secondary apertures surrounding the umbilicus (plate 85, figs. 1b, 2) which differentiate it from *Eponides turgidus*.

Figures:
Plate 85, figs. 1a-b, Farnella Canyon Core P-61 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view; fig. 2, Farnella Canyon Core P-61 Sample 0-1 cm, ventral view.
Scale bars = 50 µm.

Family Rosalinidae

Genus *Gavelinopsis*

Gavelinopsis translucens (Phleger and Parker)

“Rotalia” translucens Phleger and Parker, 1951, p. 24, pl. 12, figs. 11a, 11b, 12a, 12b.
“Rotalia” translucens Phleger and Parker – Parker, 1954, p. 531, pl. 10, figs. 3, 7.
Gavelinopsis translucens (Phleger and Parker) – Denne, 1990, pl. 6, figs. 12a, 12b.

Morphology: Shell small and biconvex; periphery acute with a keel; sutures on dorsal side flush with the surface and are indistinct on SEM images; last two or more sutures on ventral side depressed; umbilical plug present on ventral side; shell wall finely perforate on dorsal side and more coarsely perforate on ventral side; aperture present midway between periphery and umbilicus.

Remarks: Plate 67, figs. 2a and 2b show encrusting barite rosettes on shell walls.

Figures:
Plate 67, figs. 1a-b, Mississippi Canyon Core P-73 Sample 1-2 cm, 1a: dorsal view, 1b: ventral view; figs. 2a-b, Mississippi Canyon Core P-73 Sample 3-4 cm, 2a: dorsal view, 2b: ventral view; figs. 3a-b, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 3a: dorsal view, 3b: ventral view.
Scale bars = 50 μm.

Superfamily Siphoninacea

Family Siphoninidae

Genus *Siphonina*

Siphonina pulchra Cushman

Siphonina pulchra Cushman, 1919, p. 42, pl. 14, figs. 7a-c.
Siphonina pulchra Cushman – Cushman, 1931, p. 69, pl. 14, figs. 2, 3.
Siphonina pulchra Cushman – Phleger and Parker, 1951, p. 24, pl. 12, figs. 15a, b.
Siphonina pulchra Cushman – Parker, 1954, p. 532, pl. 10, fig. 11, 12.
Siphonina pulchra Cushman – Andersen, 1961, p. 104, pl. 24, figs. 2a-c.
Siphonina pulchra Cushman – Denne, 1990, pl. 12, fig. 12a-b.

Morphology: Shell almost circular in outline, biconvex; periphery subacute; carinate juveniles but keel frequently absent or only partially developed in adult specimens; about 5 chambers in last whorl; shell wall perforate; aperture on a short neck with a lip.

Remarks: Contradicting the original description of *S. pulchra* by Cushman (1919) that "*S. pulchra* has no fimbriated periphery and practically no keel," the Jamaican specimen illustrated by Cushman (1931, pl. 14, fig. 3) clearly shows a fimbriated edge zone. The carina in *S. pulchra* is a variable feature with young stages carinate (Cushman, 1931) but not as well developed as in *S. bradyana*. The development of the carina in our specimens is variable.

Figures:
Plate 165, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view showing aperture; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 2a: dorsal view, 2b: ventral view; fig. 3, juvenile from Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, dorsal view.
Scale bars = 50 µm.

Superfamily Discorbinellacea

Family Pseudoparrellidae

Genus *Epistominella*

***Epistominella exigua* (Brady)**

Pulvinulina exigua Brady, 1884, p. 696, pl. 103, figs. 13, 14.
Pseudoparrella exigua (Brady) – Phleger and Parker, 1951, p. 28, pl. 15, figs. 6a, 6b, 7a, 7b.
Epistominella exigua (Brady) – Parker, 1954, p. 533, pl. 10, figs. 22, 23.
Epistominella exigua (Brady) – Poag, 1981, p. 63, pl. 5, fig. 4, pl. 6, figs. 4a-c.
Epistominella exigua (Brady) – Boltovskoy, 1978, pl. 3, figs. 37, 38.
Epistominella exigua (Brady) – Hermelin, 1989, p. 67, 68.
Epistominella exigua (Brady) – Denne, 1990, pl. 5, fig. 11.
Alabaminoides exiguus (Brady) – Jones, 1994, p. 103, pl. 103, figs. 13-14.

Morphology: Shell biconvex; sutures straight and flush with the surface, indistinct in SEM images.

Remarks: This is a small species and Hermelin (1989) noted that it is often excluded or under-represented in studies that use the >125 µm or larger size fraction. Sen Gupta *et al.* (1987) found reduced abundances of *E. exigua* in the >250 µm fraction of an Antarctic Bottom Water assemblage from the equatorial North Atlantic.

Figures:
Plate 59, figs. 1-2, Mississippi Canyon Core P-69 Sample 0-1 cm, a: dorsal view, b: ventral view; figs. 3a-b, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 3a: dorsal view, 3b: edge view showing the aperture.
Scale bars = 50 µm.

Epistominella vitrea **Parker**

Epistominella vitrea Parker *in* Parker et al., 1953, p. 9, pl. 4, figs. 34-36, 40, 41.
Epistominella vitrea Parker – Parker, 1954, p. 534, pl. 10, figs. 20, 26.
Epistominella vitrea Parker – Andersen, 1961, p. 104, 105, pl. 24, figs. 1a-c.
Epistominella vitrea Parker – Poag, 1981, p. 63, 64, pl. 5, fig. 3; pl. 6, figs. 3a, 3b.
Epistominella vitrea Parker – Denne, 1990, pl. 7, figs. 12a, b.

Morphology: Shell biconvex, lobate periphery; sutures curved and depressed on dorsal side, almost straight and depressed on ventral side, difficult to see in SEM figures.

Remarks: *Epistominella vitrea* Parker differs from *E. exigua* in having curved and depressed sutures.

Figures:
Plate 60, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view showing the aperture.
Scale bars = 50 µm.

Family Discorbinellidae

Genus *Laticarinina*

Laticarinina pauperata **(Parker and Jones)**

Pulvinulina repanda Fichtel and Moll var. *menardii* d'Orbigny subvar. *pauperata* Parker and Jones, 1865, p. 395, pl. 16, figs. 50, 51.
Laticarinina pauperata (Parker and Jones) – Galloway and Wissler, 1927.
Laticarinina pauperata (Parker and Jones) – Phleger and Parker, 1951, p. 32, pl. 18, fig. 3.
Laticarinina pauperata (Parker and Jones) – Parker, 1954, p. 540, pl. 12, fig. 3.
Laticarinina halphora (Stache) – Barker, 1960, p. 214, pl. 104, figs. 3-11.
Laticarinina pauperata (Parker and Jones) – Pflum and Frerichs, 1976, pl. 1, fig. 10.
Laticarinina pauperata (Parker and Jones) – van Morkhoven et al., 1986, p. 89, 90, pl. 26, figs. 1a-c.
Laticarinina halophora (Stache) – Hermelin, 1989, p.68, 69.
Laticarinina pauperata (Parker and Jones) – Denne, 1990, pl. 7, fig. 16.
Laticarinina pauperata (Parker and Jones) – Jones, 1994, p. 104, pl. 104, figs. 3-11.

Morphology: Shell biconvex to planoconvex in edge view, dorsal side flattened, broad thin keel around the periphery.

Remarks: Hermelin (1989) followed Barker (1960) in using the name *Laticarinina halophora* (Stache) for this species, remarking that *L. halophora* and Brady's *L. pauperata* were identical. However, Hornibrook (1971) has shown that *Robulina halophora* Stache belongs to the nodosariid genus *Planularia*.

Figures:
Plate 96, fig. 1, Alaminos Canyon Boxcore B6 bulk sample, dorsal view; figs. 2-3, De Soto Canyon control sample DGOMB2 S36, dorsal view.
Scale bars = 50 µm.

Superfamily Planorbulinacea

Family Planulinidae

Genus *Planulina*

***Planulina ariminensis* d'Orbigny**

Planulina ariminensis d'Orbigny, 1826, p. 280, pl. 14, figs. 1-3, 3bis; Modèles, no. 49.
Anomalina ariminensis (d'Orbigny) – Brady, 1884, p. 674, pl. 93, figs. 10, 11.
Planulina ariminensis d'Orbigny – Cushman, 1931, p. 110.
Planulina ariminensis d'Orbigny – Phleger and Parker, 1951, p. 32, pl. 18, figs. 4a, b.
Planulina ariminensis d'Orbigny – Parker, 1954, p. 540, pl. 11, figs. 27, 30.
Planulina ariminensis d'Orbigny – Barker, 1960, p. 192, pl. 93, figs. 10, 11.
Planulina ariminensis d'Orbigny – Poag, 1981, p. 75, pl. 43, fig. 3; pl. 44, figs. 3a, b.
Planulina ariminensis d'Orbigny – van Morkhoven et al., 1986, p. 38, 40, pl. 10, figs. 1-4.
Planulina ariminensis d'Orbigny – Denne, 1990, pl. 10, figs. 7a, b.
Planulina ariminensis d'Orbigny – Jones, 1994, p. 98, pl. 93, figs. 10-11.

Morphology: Shell planispiral, somewhat evolute on both sides; periphery truncate, sides of the test flattened and almost parallel; chambers distinct; sutures strongly curved, papillate, more frequently on ventral side; aperture peripheral extending onto dorsal side.

Remarks: The sutures in some of our specimens are not as strongly curved as most mentioned and figured in the literature. This is the type species by subsequent designation of the genus *Planulina* d'Orbigny 1826.

Figures:
Plate 127, figs. 1a-c, Green Canyon (Block 272) Core P-55 Sample 1-2 cm, 1a: ventral view, 1b: dorsal view, 1c: peripheral view; figs. 2a-c, Garden Banks (Block 427) Core P-EP8 Sample 1-2 cm, 2a: ventral view, 2b: dorsal view, 2c: peripheral view; fig. 3, Green Canyon (Block 272) Core P-51 Sample 0-1 cm, dorsal view.
Scale bars = 50 µm.

Plate 128, digital photomicrographs, fig. 1, Mississippi Canyon tubeworm MC2; fig. 2, Green Canyon tubeworm EC4; fig. 3, Green Canyon tubeworm EC5; fig. 4, Mississippi Canyon tubeworm MC5.

Plate 129, fig. 1, Mississippi Canyon tubeworm MC3, specimen attached to hydroid (arrow), digital photomicrograph; fig. 2, same specimen as arrow in fig. 1; fig. 3, same specimen as fig. 1 of plate 128; fig. 4, Mississippi Canyon tubeworm MC4, attachment side.

***Planulina foveolata* (Brady)**

Anomalina foveolata Brady, 1884, p. 674, pl. 94, figs. 1a-c.
Planulina foveolata (Brady) – Cushman, 1931, p. 111, pl. 20, figs. 2, 3.
Planulina foveolata (Brady) – Phleger and Parker, 1951, p. 33, pl. 18, figs. 9a, b, 10a, b.
Planulina foveolata (Brady) – Parker, 1954, p. 540, pl. 11, figs. 25, 26.
Planulina foveolata (Brady) – Barker, 1960, p. 194, pl. 94, fig. 1.
Planulina faveolata (Brady) – Andersen, 1961, p. 125, pl. 29, figs. 4a-c.
Planulina foveolata (Brady) – van Morkhoven et al., 1986, p. 26, 28, pl. 5, figs. 1-3.
Planulina foveolata (Brady) – Poag, 1981, p. 76, pl. 43, fig. 1; pl. 44, figs. 1a, 1b.
Planulina foveolata (Brady) – Denne, 1990, pl. 10, figs. 9a, b.
Planulina foveolata (Brady) – Jones, 1994, p. 98, pl. 94, fig. 1.

Morphology: Shell planispiral, somewhat evolute on both sides, plano-convex; periphery rounded; chambers distinct, 9 to 11 in the last whorl; sutures curved, strongly raised on ventral side; aperture peripheral, extending onto dorsal side.

Remarks: The shells of our specimens are frequently not pristine and in some cases not well-preserved. This accounts for the holes and broken chambers in the SEM images.

Figures:
Plate 130, figs. 1-2, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, a: ventral view, b: dorsal view, c: peripheral view; figs. 3a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 3a: ventral view, 3b: dorsal view.
Scale bars = 50 μm.

Family Cibicididae

Genus *Cibicides*

***Cibicides lobatulus* (Walker and Jacob)**

Nautilus lobatulus Walker and Jacob, in Kanmacher, 1798, p. 642, pl. 14, fig. 36.
Truncatulina lobatula Walker and Jacob – Brady, 1884, p. 660, pl. 92, fig. 10; pl. 93, figs. 1, 4, 5; pl. 115, figs. 4, 5.
Cibicides lobatula (Walker and Jacob) – Cushman, 1931, p. 118, pl. 21, fig. 3.
Cibicides lobatulus (Walker and Jacob) – Barker, 1960, p. 190, pl. 92, fig. 10; p. 192, pl. 93, figs. 1, 4, 5; p. 236, pl. 115, figs. 4, 5.
Cibicides lobatulus (Walker and Jacob) – Jones, 1994, p. 97, pl. 92, fig. 10; pl. 93, figs. 1, 4, 5; p. 114, pl. 115, figs. 4, 5.

Morphology: Shell planoconvex; periphery acute with a thickened keel; dorsal side typically adherent, dorsal side falttened or concave, ventral side convex; sutures sigmoidal, depressed on ventral side and flush on dorsal side; aperture peripheral extending onto dorsal side.

Remarks: *Lobatula* Fleming 1828, based on this species, is regarded as a valid genus by Loeblich and Tappan (1987). There is, however, no distinguishing character on which *Lobatula* can be unequivocally separated from *Cibicides*; we agree with Jones (1994) that *Lobatula* is a junior synonym of *Cibicides*.

Figures:
Plate 39, figs. 1a-b, Alaminos Canyon Core PC15 Sample 8-9 cm, 1a: ventral view, 1b: dorsal view.
Scale bars = 50 μm.

Cibicides wuellerstorfi (Schwager)

Anomalina wuellerstorfi Schwager, 1866, p. 258, pl. 7, figs. 105, 107.
Truncatulina wuellerstorfi (Schwager) – Brady, 1884, p. 662, pl. 93, figs. 8, 9.
Planulina wuellerstorfi (Schwager) – Cushman, 1931, p. 110, 111; pl. 19, figs. 5, 6.
Planulina wuellerstorfi (Schwager) – Phleger and Parker, 1951, p. 33, pl. 18, figs. 11a, 11b; pl. 19, figs. 1a, 1b, 2a, 2b, 3a, 3b.
Cibicides wuellerstorfi (Schwager) – Parker, 1954, p. 544, pl. 13, figs. 3, 6.
Planulina bradii Tolmachoff – Barker, 1960, p. 192, pl. 93, fig. 8.
Planulina wuellerstorfi (Schwager) – Barker, 1960, p. 192, pl. 93, fig. 9.
Cibicides wuellerstorfi (Schwager) – Pflum and Frerichs, 1976, pl. 4, figs. 2-4.
Cibicides wuellerstorfi (Schwager) – Srinivasan and Sharma, 1980, p. 56, 57, pl. 8, figs. 11-13 (neotype).
Cibicides wuellerstorfi (Schwager) – Poag, 1981, p. 52, pl. 3, fig. 1; pl. 4, figs. 1a, 1b.
Planulina wuellerstorfi (Schwager) – van Morkhoven et al., 1986, p. 48-50, pl. 14, figs. 1-2.
Cibicidoides wuellerstorfi (Schwager) – Hermelin, 1989, p. 87.
Cibicides wuellerstorfi (Schwager) – Sen Gupta, 1989, p. 706, pl. 1, figs. 1-7; pl. 2, figs. 1-6; pl. 3, figs. 1-6; pl. 4, figs. 1-7.
Cibicides wuellerstorfi (Schwager) – Denne, 1990, pl. 4, figs. 1a, 1b.
Cibicidoides wuellerstorfi (Schwager) – Jones, 1994, p. 98, pl. 93, figs. 8, 9.

Morphology: Shell planoconvex to slightly biconvex (in a small minority); periphery with a thickened keel; sutures strongly sigmoidal on both sides, raised to flush with the surface on dorsal side, raised with some surface roughening on ventral side; sutures meet near central plug on ventral side; central plug more pronounced in variants (plate 40, fig. 3); aperture peripheral extending onto dorsal side.

Remarks: There has been considerable confusion over the generic placement of *Anomalina wuellerstorfi* Schwager 1866. It has generally been assigned to *Planulina* d'Orbginy 1826, *Cibicides* Dénys de Montfort 1808, or *Cibicidoides* Thalmann 1939. In addition, it is the type species of the genus *Fontbotia* González-Donoso and Linares 1970 (based on a misunderstanding of the wall structure). *Fontbotia* is regarded by Sen Gupta (1989) as a junior synonym of *Cibicides* Dénys de Montfort 1808 and by Jones (1994) as a junior synonym of *Cibicidoides* Thalmann 1939. *Anomalina wuellerstorfi* is not a member of *Planulina* as only the final whorl is visible on ventral side, and it is not a member of *Cibicidoides* as it is mainly plano-convex and not biconvex (Sen Gupta, 1989). All significant features of this species are characteristic of *Cibicides* Dénys de Montfort 1808 (Sen Gupta, 1989).

Figures:
Plate 40, figs. 1a-c, Farnella Canyon Core P-61 Sample 0-1 cm, 1a: ventral view, 1b: dorsal view, 1c: edge view; figs. 2a-b, Farnella Canyon Core P-61 Sample 0-1 cm, 2a: ventral view, 2b: dorsal view; fig. 3, juvenile from De Soto Canyon control sample DGOMB2 S36, ventral view. Scale bars = 50 μm.

Plate 41, fig. 1, Alaminos Canyon tubeworm LS4, digital photomicrograph.

Genus *Cibicidoides*

***Cibicidoides pachyderma* (Rzehak)**

Truncatulina pachyderma Rzehak, 1886, p. 87, pl. 1, figs. 5a-c.
Truncatulina ungeriana (d'Orbigny) – Brady, 1884, p. 664, pl. 94, figs. 9a-c.
Not *Rotalina ungeriana* d'Orbigny, 1826 and 1846.
Cibicides pseudoungeriana (Cushman) – Cushman, 1931, p. 123-124, pl. 22, figs. 3-7.
Cibicides aff. *floridanus* (Cushman) – Phleger and Parker, 1951, p. 30, pl. 16, figs. 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b.
Cibicides aff. *floridanus* (Cushman) – Parker, 1954, p. 541, pl. 12, figs. 5, 9.
Cibicides cf. *pseudoungerianus* (Cushman) – Pflum and Frerichs, 1976, pl. 2, fig. 9.
Cibicidoides "floridanus" forma *bathyalis* Poag, 1981, p. 53, pl. 29, fig. 1; pl. 30, figs. 1a, 1b.
Cibicidoides "floridanus" forma *sublittoralis* Poag, 1981, p. 53, 54, pl. 29, fig. 2; pl. 30, figs. 2a, 2b.
Cibicidoides pachyderma (Rzehak) – van Morkhoven et al., 1986, p. 68-70, pl. 22, figs. 1a-c.
Cibicidoides pachydermus bathyalis (Poag) – Denne, 1990, pl. 4, figs. 5a, 5b.
Cibicidoides pachydermus sublittoralis (Poag) – Denne, 1990, pl. 4, figs. 6a, 6b.

Morphology: Shell biconvex; periphery moderately to sharply carinate; 10-12 chambers in final whorl; sutures flush to slightly depressed on ventral side, flush on dorsal side, gently curved in smaller specimens, more sharply curved in larger specimens; coarsely perforate shell wall on dorsal side; flat to slightly convex umbonal boss; aperture an interiomarginal arch with a lip, continuing onto dorsal side.

Remarks: Specimens of *C. pachyderma* differ from similar-size specimens of *C. robertsonianus* in its more sharply curved sutures. The only difference between *Cibicides* and *Cibicidoides* is in the shape of the shell—planoconvex in the former and biconvex in the latter, and this is a gradational feature in some species. Thus, the placement of *Cibicidoides* in a separate family (Paralleloididae) by Loeblich and Tappan (1987) is not justified; we keep it in the Cibicididae.

Figures:
Plate 42, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 1-2 cm, 1a: ventral view, 1b: dorsal view, 1c: edge view; figs. 2a-b, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, 2a: ventral view, 2b: dorsal view; fig. 3, Alaminos Canyon Core PC4 Sample 0-1 cm, ventral view; figs. 4a-c, Green Canyon (Block 272) Core P-55 Sample 1-2 cm, 4a: ventral view, 4b: dorsal view, 4c: edge view.
Scale bars = 50 µm.

Plate 43, digital photomicrographs, fig. 1, Mississippi Canyon tubeworm MC1, d – dislodged specimen (dorsal surface), s – attachment scar; figs. 2a-c, specimen in fig. 1, 2a: ventral surface before cleaning, 2b: dorsal surface, 2c: ventral surface after cleaning.

Cibicidoides robertsonianus **(Brady)**

Truncatulina robertsoniana Brady, 1881, p. 65; 1884, p. 664-665, pl. 95, figs. 4a-c.
Cibicides robertsonianus (Brady) – Phleger and Parker, 1951, p. 31, pl. 16, figs. 10a, 10b, 11a, 11b, 12a, 12b, 13a, 13b.
Cibicides robertsonianus (Brady) – Parker, 1954, p. 543, pl. 13, figs. 2, 5.
Cibicides robertsonianus (Brady) – Barker, 1960, p. 196, pl. 95, fig. 4.
Cibicides robertsonianus (Brady) – Pflum and Frerichs, 1976, pl. 3, figs. 3-5.
Cibicidoides robertsonianus (Brady) – Poag, 1981, p. 54, 55, pl. 5, fig. 1; pl. 6, figs. 1a, 1b.
Cibicidoides robertsonianus (Brady) – van Morkhoven et al., 1986, p. 41-43, pl. 11, figs. 1a-c.
Cibicidoides robertsonianus (Brady) – Hermelin, 1989, p. 86.
Cibicidoides robertsonianus (Brady) – Denne, 1990, pl. 4, figs. 7a, 7b.
Cibicidoides robertsonianus (Brady) – Jones, 1994, p. 99, pl. 95, fig. 4.

Morphology: Shell planoconvex to biconvex; periphery angular and slightly lobulate; not entirely involute ventral side with visible earlier whorls; sutures gently curved, flush with surface, final two may be slightly depressed; coarsely perforate shell wall on dorsal side; aperture an interiomarginal arch with a lip, continuing onto dorsal side.

Remarks: The imperforate keel mentioned in Hermelin (1989) and van Morkhoven et al. (1986) is not present in all our specimens.

Figures:
Plate 44, figs. 1a-d, Alaminos Canyon Core PC4 Sample 1-2 cm, 1a: ventral view, 1b: dorsal view, 1c: ventral view, digital photomicrograph, 1d: dorsal view, digital photomicrograph.

Plate 45, figs. 1a-c, Garden Banks (Block 427) Core P-EP8 Sample 1-2 cm, 1a: ventral view, 1b: dorsal view, 1c: edge view showing apertural opening; figs. 2a-b, Green Canyon (Block 272) Core P-55 Sample 1-2 cm, 2a: ventral view, 2b: dorsal view.
Scale bars = 50 µm.

Superfamily Asterigerinacea

Family Epistomariidae

Genus *Nuttallides*

***Nuttallides decorata* (Phleger and Parker)**

Pseudoparrella (?) *decorata* Phleger and Parker, 1951, p. 28, pl. 15, figs. 4a, b, 5a, b.
Epistominella decorata (Phleger and Parker) – Parker, 1954, p. 533, pl. 10, figs18, 19.
Alabamina decorata (Phleger and Parker) – Pflum and Frerichs, 1976, pl. 6, figs. 8, 9.
Nuttallides decorata (Phleger and Parker) – Poag, 1981, p. 74, pl. 5, fig. 2; pl. 6, figs. 2a, 2b.
Nuttallides decorata (Phleger and Parker) – Denne, 1990, pl. 9, figs. 9a, 9b.

Morphology: Shell biconvex, trochospiral; periphery subacute to rounded; 2½ whorls visible on dorsal side; 5 to 6 chambers in last whorl; sutures depressed and slightly curved; pores visible around the edge of some specimens on ventral side (see plate 110, fig. 5) and on the last whorl on dorsal side; shell wall ornamented with raised processes, occassionally clustered and coalescing on dorsal side of the species.

Remarks: Raised processes ornamenting the shell walls give this species a roughened appearance under the light microscope.

Figures:
Plate 110, figs. 1, 3, 5, Alaminos Canyon Core PC15 Sample A10, 1: dorsal view, 3: dorsal view, 5: ventral view; figs. 2, 4, Alaminos Canyon Core PC15 Sample A8, 2: dorsal view, 4: ventral view; fig. 6, Alaminos Canyon Core PC4 Sample 0-1 cm, cross-sectional view showing pyrite framboids filling the calcareous shell indicative of a reducing environment.
Scale bars = 50 µm.

Superfamily Nonionacea

Family Nonionidae

Genus *Nonionella*

***Nonionella iridea* Heron-Allen and Earland**

Nonionella iridea Heron-Allen and Earland, 1932, p. 438, pl. 16, figs. 14-16.

Morphology: Shell coiled; periphery rounded, slightly lobulate; 8-9 chambers present, only 6-7 exposed on one side, chambers with a flaplike projection slightly overhanging the umbilicus; proloculus appears as a central boss; sutures depressed, curved; aperture an interiomarginal arch extending onto ventral side.

Remarks: Heron-Allen and Earland in their original (1932) description of this species note that it consists of 12-14 chambers. However, their type figure shows 9 chambers on dorsal side and 7 chambers visible on ventral side. Our specimens have 8 to 9 chambers, and in all other respects match the description of Heron-Allen and Earland (1932); hence we use the name *N. iridea*.

Figures:

Plate 109, figs. 1, 3, south of Mississippi Canyon control sample DGOMB2 C7, a: dorsal view, b: ventral view, c: edge view; figs. 2a-b, south of Mississippi Canyon control sample DGOMB2 C7, 2a: dorsal view, 2b: edge view.
Scale bars = 50 µm.

Genus *Laminononion*

Laminononion tumidum (Cushman and Edwards)

Nonionina stelligera (d'Orbigny) – Brady, 1884, p. 728, pl. 109, fig. 5.
Astrononion tumidum Cushman and Edwards, 1937, p. 33, pl. 3, fig. 17.
Astrononion tumidum Cushman and Edwards – Barker, 1960, pl. 109, fig. 5.
Astrononion (Laminononion) tumidum Cushman and Edwards – Hornibrook, 1964, p. 335.
Astrononion tumidum Cushman and Edwards – Denne, 1990, pl. 1, fig. 15.
Astrononion tumidum Cushman and Edwards – Jones, 1994, p. 107, pl. 109, fig. 5.

Morphology: Shell planispiral; periphery broadly rounded; 6-7 chambers in final whorl; sutures depressed; large rhomboidal to subtriangular plate extending from lateral ends of the chamber across the umbilical margin to attach to the posterior border, opening along the posterior peripheral margin; aperture an interiomarginal, equatorial slit.

Remarks: This is the type species of the subgenus *Astrononion* (*Laminononion*) Hornibrook 1964; this subgenus was raised to the rank of genus (*Laminononion*) by Loeblich and Tappan, 1987.

Figures:
Plate 94, fig. 1, Green Canyon (Block 272) Core P-55 Sample 0-1 cm, side view.
Scale bar = 50 µm.

Plate 95, fig. 1, Mississippi Canyon tubeworm EC1, digital photomicrograph; fig. 2, Green Canyon tubeworm EC5; fig. 3, Mississippi Canyon tubeworm EC1.

Genus *Melonis*

Melonis affinis (Reuss)

Nonionina affine Reuss, 1851, p. 72, pl. 5, figs. 32a-b.
Nonionina barleeana Williamson, 1858, p. 32, pl. 3, figs. 68-69.
Nonionina umbilicatula (Montagu) – Brady, 1884, p. 726, pl. 109, figs. 8-9.

Nonion barleeanum (Williamson) – Cushman, 1930, p. 11, pl. 4, fig. 5.
Nonion formosum (Seguenza) – Phleger et al., 1953, p. 30, pl. 6, fig. 5.
Nonion formosum (Seguenza) – Parker, 1954, p. 506, pl. 6, fig. 3.
Gavelinonion barleeanum (Williamson) – Barker, 1960, p. 224, pl. 109, figs. 8-9.
"Nonion" barleeanus (Williamson) – Andersen, 1961, p. 82, 83, pl. 18, figs. 6a, b.
Melonis barleeanus (Williamson) – Pflum and Frerichs, 1976, pl. 7, figs. 5, 6.
Nonion affine (Reuss) – Boltovskoy, 1978, p. 162, pl. 5, figs. 1-2.
Melonis barleeanum (Williamson) – Hermelin, 1989, p. 88, pl. 17, fig. 12.
Melonis barleeanum (Williamson) – Denne, 1990, pl. 8, fig. 16.
Melonis affinis (Reuss) – Van Marle, 1991, p. 186-187, pl. 20, figs. 1-3.
Melonis affinis (Reuss) – Jones, 1994, p. 107-108, pl. 109, figs. 8-9.

Morphology: Shell planispiral, involute with deeply excavated umbilici; periphery broadly rounded; usually more than 10 chambers in the final whorl; sutures flush with the surface, curved; walls coarsely perforate; aperture a low arch extending from umbilicus to umbilicus.

Remarks: Van Marle (1991) noted that *Melonis barleeanum* (Williamson) is a junior synonym of *Melonis affinis* (Reuss) with which we agree. *Melonis affinis* differs from *M. pompilioides* in being more compressed in edge view.

Figure:
Plate 103, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 2a: side view: 2b: apertural view.
Scale bars = 50 µm.

***Melonis pompilioides* (Fichtel and Moll)**

Nautilus pompilioides Fichtel and Moll, 1798, p. 31, pl. 2, figs. a-c.
Nonionina pompilioides (Fichtel and Moll) – Brady, 1884, p. 727, pl. 109, figs. 10-11.
Nonion pompilioides (Fichtel and Moll) – Cushman, 1930 (part), p. 4, pl. 1, figs. 7-8, 10-11.
Nonion pompilioides (Fichtel and Moll) – Phleger and Parker, 1951, p. 11, pl. 5, figs. 19, 20.
Nonion pompilioides (Fichtel and Moll) – Parker, 1954, p. 506, 507, pl. 6, fig. 4.
Melonis sphaeroides Voloshinova, 1958, p. 153, pl. 3, figs. 1a, 1b.
Melonis pompilioides (Fichtel and Moll) – Voloshinova, 1958, p. 158, pl. 3, figs. 8-9.
Nonion (?) *pompilioides* (Fichtel and Moll) – Barker, 1960, p. 224, pl. 109, figs. 10-11.
Melonis pompilioides (Fichtel and Moll) – Pflum and Frerichs, 1976, pl. 7, figs. 7, 8.
Nonion pompilioides (Fichtel and Moll) – Boltovskoy, 1978, pl. 5, figs. 3-4.
Melonis pompilioides (Fichtel and Moll) – Hermelin, 1989, p. 88, 89, pl. 17, figs. 13-14.
Melonis pompilioides (Fichtel and Moll) – van Morkhoven, Berggren and Edwards, 1986, p. 72-80, pl. 23A, figs. 1-2; pl. 23C, figs. 1a-d; pl. 23D, figs. 1a-d, pl. 23E, figs. 1a-c.
Melonis pompilioides (Fichtel and Moll) – Jones, 1994, p. 108, pl. 109, figs. 10-11.

Morphology: Shell planispiral, involute with deeply excavated umbilici; periphery broadly rounded; 8 to 10 chambers in the final whorl; sutures flush with the surface; walls coarsely perforate; aperture a low arch extending from umbilicus to umbilicus.

Remarks: *Melonis pompilioides* differs from *M. affinis* in a being a broader species in edge view. These two species also occur as two separate populations with no intergradation. *Melonis pompilioides* is found in the deeper water locations of Alaminos and Farnella Canyons and *M. affinis* occurs in the shallower Green Canyon and Garden Banks. Parker and Phleger (1951) also observed this depth separation. They stated that there were two forms of *Nonion pompilioides*, a typical form and a more compressed form that resembles *N. barleeanum* and is confined to shallower depths. Hermelin (1989) noted several different species names that appear to be ecophenotypic variants and therefore junior synonyms of *M. pompilioides*. He stated that more investigation is required before it can be decided if *M. barleeanum* and *M. pompilioides* are ecophenotypic variants. We have kept *M. barleeanum* (= *M. affinis* in this study) and *M. pompilioides* separated as two species. There remains some uncertainty surrounding Cushman's (1930) figured specimens of *N. pompilioides* from the Atlantic. Those resembling our figured specimens are recognized by us as *M. pompilioides*; the thinner specimens (Cushman, 1930; pl. 1 fig. 9, pl. 2, figs. 1-2) belong to a different species.

Figures:
Plate 104, figs. 1, 3, Alaminos Canyon Core PC5 Sample 2-3 cm, 1: side view, 3: apertural view; fig. 2, Alaminos Canyon Core PC5 Sample 4-5 cm, side view.
Scale bars = 50 μm.

Genus *Pullenia*

***Pullenia bulloides* (d'Orbigny)**

Nonionina bulloides d'Orbigny, 1826, p. 293, model no. 2 (nomen nudum).
Nonionina bulloides d'Orbigny, 1846, p. 107, pl. 5, figs. 9-10.
Pullenia sphaeroides (d'Orbigny) – Brady, 1884, p. 615-616, pl. 84, figs. 12-13.
Pullenia bulloides (d'Orbigny) – Phleger and Parker, 1951, p. 29, pl. 15, fig. 11.
Pullenia bulloides (d'Orbigny) – Parker, 1954, p. 538, pl. 11, fig. 17.
Pullenia bulloides (d'Orbigny) – Barker, 1960, p. 174, pl. 84, figs. 12-13.
Pullenia bulloides (d'Orbigny) – Andersen, 1961, p. 115, pl. 25, figs. 8a, b.
Pullenia bulloides (d'Orbigny) – Papp and Schmid, 1985, p. 45, pl. 34, figs. 6-9 (lectotypes).
Pullenia bulloides (d'Orbigny) – Hermelin, 1989, p. 78, 79, pl. 15, figs. 4-5.
Pullenia bulloides (d'Orbigny) – Denne, 1990, pl. 11, figs. 5a, b.
Pullenia bulloides (d'Orbigny) – Jones, 1994, p. 92, pl. 84, figs. 12-13.

Morphology: Shell planispiral, involute, sphaeroidal; 4 chambers in the last whorl; sutures flush with surface to slightly depressed; aperture an interiomarginal slit extending from one umbilicus to the other, with a lip.

Remarks: *Nonionina bulloides* d'Orbigny 1846 is the type species of the genus *Pullenia* Parker and Jones (in Carpenter et al., 1862. It has been lectotypified by Papp and Schmid (1985).

Figures:
Plate 143, figs. 1a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: side view, 1b: apertural view; figs. 2a-b, Alaminos Canyon Boxcore B19.1 Sample 0-1 cm, 2a: side view, 2b: apertural view.
Scale bars = 50 µm.

Pullenia quinqueloba **(Reuss)**

Nonionina quinqueloba Reuss, 1851, p. 71, pl. 5, fig. 31.
Pullenia quinqueloba (Reuss) – Brady, 1884, p. 616, pl. 84, figs14, 15.
Pullenia subcarinata (d'Orbigny) – Heron-Allen and Earland, 1932, p. 403-404, pl. 13, figs. 14-18.
Pullenia quinqueloba (Reuss) – Phleger and Parker, 1951, p. 29, pl. 15, figs. 12, 13.
Pullenia quinqueloba (Reuss) – Parker, 1954, p. 538, pl. 11, fig. 16.
Pullenia subcarinata (d'Orbigny) – Barker, 1960, p. 174, pl. 84, figs. 14, 15.
Pullenia subcarinata (d'Orbigny) – Andersen, 1961, p. 115, pl. 25, figs. 9a, b.
Pullenia subcarinata subcarinata (d'Orbigny) – Boltovskoy, 1978, p. 167, pl. 6, figs. 21-22.
Pullenia subcarinata quinqueloba (Reuss) – Boltovskoy, 1978, p. 166, pl. 6, figs. 23, 24.
Pullenia subcarinata (d'Orbigny) – Hermelin, 1989, p. 79, 80, pl. 15, figs. 6, 7.
Pullenia subcarinata (d'Orbigny) – Denne, 1990, pl. 11, figs. 6a, 6b.
Pullenia quinqueloba (Reuss) – Jones, 1994, p. 92, pl. 84, figs. 14-15.

Morphology: Shell planispiral, involute, compressed; 5 to 6 chambers in the last whorl; sutures slightly depressed and slightly curved; aperture an interiomarginal slit extending from one umbilicus to the other, with a lip.

Remarks: *Pullenia quinqueloba* differs from *P. bulloides* in having more compressed shape and a greater number of chambers in the final whorl.

Figures:
Plate 144, figs. 1a-b, Mississippi Canyon Core P-69 Sample 0-1 cm, 1a: side view, 1b: apertural view; fig. 2, Alaminos Canyon Core PC4 Sample 1-2 cm, side view; fig. 3, Alaminos Canyon Boxcore B19.1 Sample 0-1 cm, side view; fig. 4, Alaminos Canyon Core PC15 Sample 12-13 cm, side view; fig. 5, Alaminos Canyon Core PC15 Sample 7-8 cm, side view.
Scale bars = 50 µm.

Genus *Haynesina*

***Haynesina germanica* (Ehrenberg)**

Nonionina germanica Ehrenberg, 1840, p. 23.
Nonionina germanica Ehrenberg – Ehrenberg, 1841, pl. 2, fig. 1a-g.
Nonionina depressula (Walker and Jacob) – Brady, 1884, p. 725, 726, pl. 109, fig. 6a, b.
Nonion germanicum (Ehrenberg) – Cushman, 1930, p. 8, pl. 3, figs. 5a, b, ?4a, b.
Nonion depressulum (Walker and Jacob) – Barker, 1960, p. 224, pl. 109, figs. 6a, b.
Haynesina germanica (Ehrenberg) – Banner and Culver, 1978, p. 191-200, pl. 4, figs. 1-6; pl. 5, figs. 1-8; pl. 6, figs. 1-7; pl. 7, figs. 1-6; pl. 8, figs. 1-10; pl. 9, figs. 1-11, 15, 17, 18.

Morphology: Shell planispiral, involute with depressed umbilici; periphery rounded; 8-10 chambers in the final whorl, chamber walls bending inward posteriorly and fusing with preceding septal face; sutures curved, depressed, deeply incised near umbilicus; prominent tubercles along sutures and over umbilicus; primary aperture a low interiomarginal arch, occasionally obscured by abundant pustules; intercameral apertures present.

Figures:
Plate 76, fig. 1, Green Canyon (Block 272) Core P-57 Sample 1-2 cm, side view; fig. 2, Green Canyon (Block 272) Core P-54 Sample 0-1 cm, side view; fig. 3, Mississippi Canyon Core P-IM4 Sample 1-2 cm, side view.

Superfamily Chilostomellacea

Family Chilostomellidae

Genus *Chilostomella*

***Chilostomella oolina* Schwager**

Chilostomella oolina Schwager, 1878, p. 527, pl. 1, fig 16.
Chilostomella ovoidea Reuss – Brady, 1884 (part), p. 436, pl. 55, figs. 12-14, 17-18 (not 15-16, 19-23).
Chilostomella oolina Schwager – Phleger and Parker, 1951, p. 29, pl. 15, fig. 10.
Chilostomella oolina Schwager – Parker, 1954, p. 537, pl. 11, fig. 15.
Chilostomella oolina Schwager – Barker, 1960, p. 112, pl. 55, figs. 12-14, 17-18.
Chilostomella oolina Schwager – Andersen, 1961, p. 114, pl. 25, fig. 7.
Chilostomella oolina Schwager – Hermelin, 1989, p. 76, pl. 14, fig. 5.
Chilostomella oolina Schwager – Denne, 1990, pl. 3, fig. 13.
Chilostomella oolina Schwager – Jones, 1994, p. 61, pl. 55, figs. 12-14, 17-18.

Morphology: Shell elongate; ends broadly rounded; chambers coiled, each 180° apart from the preceding chamber; last formed chamber comprising more than half the test; aperture a narrow slit at the suture between the ultimate and penultimate chambers.

Remarks: Our specimens are fragile and often have holes in the final chamber.

Figures:
Plate 38, fig. 1, Farnella Canyon Core P-61 Sample 0-1 cm, side view; fig. 2, Mississippi Canyon Core P-IM4 Sample 1-2 cm, side view. Carbonate overgrowth visible on shell.
Scale bars = 50 μm.

Family Osangulariidae

Genus *Osangularia*

Osangularia culter (Parker and Jones)

Planorbulina farcta (Fichtel and Moll) var. *ungeriana* (d'Orbigny) subvar. *culter* Parker and Jones, 1865, p. 421, pl. 19, figs. 1a-c.
Truncatulina culter (Parker and Jones) – Brady, 1884, p. 668, pl. 96, figs. 3a-c.
Parrella cultur (Parker and Jones) – Phleger and Parker, 1951, p. 23, pl. 12, figs. 3a, 3b.
Osangularia cultur (Parker and Jones) – Parker, 1954, p. 530, 531, pl. 9, figs. 29, 30.
Osangularia bengalensis (Schwager) – Barker, 1960, p. 198, pl. 96, figs. 3a-c.
Osangularia culter (Parker and Jones) – Hermelin, 1989, p. 84, pl. 16, figs. 11-13.
Osangularia culter (Parker and Jones) – Denne, 1990, pl. 10, figs. 1a, 1b.
Osangularia bengalensis (Schwager) – Jones, 1994, p. 100, pl. 96, fig. 3.

Morphology: Shell biconvex; periphery with an irregular, jagged keel; sutures depressed and curved on ventral side and flush and straight to curved on dorsal side; aperture an interiomarginal slit along the base of the ultimate chamber on ventral side and may be obscured by detritus; additional aperture bending at an oblique angle up the apertural face and surrounded by a lip.

Remarks: Hermelin (1989) regards *Osangularia bengalensis* (Schwager, 1866) as a junior synonym of *O. culter*. Some confusion exists regarding the separation of *O. bengalensis* and *O. culter*. However, as Revets (1996) demonstrates, *O. bengalensis* of Schwager has multiple secondary openings on the apertural face and has been placed under the genus *Cribroparrella*. These secondary openings are not present in our specimens (e.g., plate 117, figs. 1b and 2b) or in Brady's specimen.

Figures:
Plate 117, figs. 1a-b, Mississippi Canyon Core P-69 Sample 1-2 cm, 1a: ventral view, 1b: edge view; figs. 2a-b, south of Mississippi Canyon control sample DGOMB2 C7, 2a: ventral view, 2b: edge view; figs. 3-4, De Soto Canyon control sample DGOMB2 S36, dorsal view.
Scale bars = 50 μm.

***Osangularia rugosa* (Phleger and Parker)**

Pseudoparrella (?) *rugosa* Phleger and Parker, 1951, p. 28, 29, pl. 15, figs. 8a, 8b, 9a, 9b.
Epistominella rugosa (Phleger and Parker) – Parker, 1954, p. 533, pl. 10, figs. 24, 25.
Osangularia rugosa (Phleger and Parker) – Pflum and Frerichs, 1976, pl. 7, figs. 2-4.
Osangularia rugosa (Phleger and Parker) – Denne, 1990, pl. 10, figs. 2a, 2b.

Morphology: Shell biconvex; 7 to 8 chambers in final whorl, later ones can be inflated; sutures straight to curved, sometimes raised on dorsal side, later ones depressed on ventral side; walls with small raised processes giving a roughened effect; medium-sized pores mostly restricted to the periphery; periphery angular with a thickened keel; aperture low, arched, open from the umbilicus to periphery along the base of the ultimate chamber on ventral side.

Figures:
Plate 118, figs. 1a-c, Mississippi Canyon Core P-73 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view; figs. 2a-b, Alaminos Canyon Core PC4 Sample 0-1 cm, 2a: ventral view, 2b: edge view; fig. 3, Mississippi Canyon Core P-73 Sample 0-1 cm, ventral view.
Scale bars = 50 μm.

Family Oridorsalidae

Genus *Oridorsalis*

***Oridorsalis umbonatus* (Reuss)**

Rotalina umbonata Reuss, 1851, p. 75, pl. 5, figs. 35a-c.
Pulvinulina umbonata (Reuss) – Brady, 1884, p. 695, 696, pl. 105, figs. 2a-c.
Truncatulina tenera Brady, 1884, p. 665, pl. 95, figs. 11a-c.
Pulvinulina umbonata (Reuss) – Heron-Allen and Earland, 1932, p. 430, pl. 15, figs. 16-18.
Eponides umbonatus (Reuss) – Phleger and Parker, 1951, p. 22, pl. 11, figs. 10a, 10b, 13a, 13b, 14a, 14b.
Pseudoeponides umbonatus (Reuss) – Parker, 1954, p. 530, pl. 9, figs. 20, 21.
Eponides (?) *tenera* (Brady) – Barker, 1960, p. 196, pl. 95, fig. 11.
Eponides umbonatus (Reuss) – Barker, 1960, p. 216, pl. 105, fig. 2.
Oridorsalis umbonatus (Reuss) – Todd, 1965, p. 23, pl. 6, fig. 2.
Oridorsalis umbonatus (Reuss) – Boltovskoy, 1978, pl. 5, figs. 5, 6.
Oridorsalis tener tener (Brady) – Pflum and Frerichs, 1976, pl. 6, figs. 2-4.
Oridorsalis tener umbonatus (Reuss) – Pflum and Frerichs, 1976, pl. 6, figs. 5-7.
Oridorsalis umbonatus (Reuss) – Hermelin, 1989, p. 81, 82, pl. 16, figs. 1-5.
Oridorsalis umbonatus (Reuss) – Denne, 1990, pl. 9, figs. 14a, 14b.
Oridorsalis umbonata (Reuss) – Jones, 1994, p. 99, pl. 95, fig. 11.
Oridorsalis umbonata (Reuss) – Jones, 1994, p. 104, pl. 105, fig. 2.

Morphology: Shell biconvex, periphery angular, last chambers slightly lobulate; sutures flush with surface or slightly depressed, radial and slightly curved on dorsal side and sinusoidal on ventral side; aperture an interiomarginal slit extending from the umbilical area to periphery, with lip and pustules surrounding it. Supplementary openings at the base of the suture on dorsal side (plate 116, figs. 3a, 4) and occasionally following the base of the last formed chamber on dorsal side (plate 116, fig. 1a) and along the suture between the ultimate and penultimate chambers on ventral side (plate 116, figs. 1b, 2).

Remarks: Two forms of this species are observed in the study samples. One form is typical (e.g., plate 116, figs. 1a-c, 2 and 4), the other is represented by much smaller specimens (e.g., plate 116, figs. 3a-c). Phleger and Parker (1951) and Parker (1954) also observed these smaller specimens, whose features, except for size, are almost identical to the typical form. As noted by Phleger and Parker (1951), such smaller specimens may be the *"Truncatulina tenera*" of Brady (1884, pl. 95 fig. 11). Parker (1954) did not observe supplementary apertures in her small specimens, and Barker (1960) could not find supplementary apertures on any of his Pacific material. However, Jones (1994) placed Brady's *Truncatulina tener* specimen (pl. 95, fig. 11) in *Oridorsalis umbonata* stating that Brady's figured specimens lack the supplementary spiral sutural apertures characteristic of *Oridorsalis* Andersen, although these features are developed in some unfigured *Challenger* specimens. Supplementary apertures are difficult to see under the light microscope in such small specimens but are obvious in SEM micrographs (e.g., plate 116, fig. 3a). Hence, in agreement with Hermelin (1989), we consider *Oridorsalis tener* to be a junior synonym of *O. umbonatus*.

Figures:
Plate 116, figs. 1a-c, Farnella Canyon Core P-61 Sample 0-1 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view; fig. 2, Farnella Canyon Core P-61 Sample 0-1 cm, ventral view; figs. 3a-c, Alaminos Canyon Core PC5 Sample 1-2 cm, 3a: dorsal view, 3b: ventral view, 3c: edge view; fig. 4, Farnella Canyon Core P-61 Sample 0-1 cm, dorsal view.
Scale bars = 50 μm.

Family Heterolepidae

Genus *Anomalinoides*

***Anomalinoides globulosus* (Chapman and Parr)**

Anomalina grosserugosa (Guembel) – Brady, 1884, p. 673, pl. 94, figs. 4-5.
Anomalina globulosa Chapman and Parr, 1937, p. 117, pl. 9, fig. 27.
Anomalina globulosa Chapman and Parr – Barker, 1960, p. 194, pl. 94, figs. 4-5.
Anomalinoides globulosus (Chapman and Parr) - van Morkhoven et al., 1986, p. 36-38, pl. 9, figs. 1-3.
Anomalinoides globulosus (Chapman and Parr) – Hermelin, 1989, p. 84-85, pl. 17, figs. 1, 5.
Cibcidoides globulosus (Chapman and Parr) – Jones, 1994, p. 98, pl. 94, figs. 4-5.

Morphology: Shell trochospiral, umbilcus depressed; 6-7 chambers in final whorl; chambers globular, increasing in size; sutures depressed, curved; wall coarsely perforate, especially on ventral side; aperture a low interiomarginal slit extending from the periphery to the umbilicus, with a distinct lip.

Figures:
Plate 9, figs. 1a-c, Garden Banks (Block 427) Core P-EP8 Sample 1-2 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view showing apertural opening.
Scale bars = 50 μm.

Plate 10, fig. 1, Green Canyon tubeworm EC5, digital photomicrograph.

***Anomalinoides mexicanus* Parker**

Anomalinoides mexicana Parker, 1954, p. 539, pl. 11, figs. 21-23.

Morphology: Shell involute, trochospiral; broadly rounded periphery, early portion non-lobulate, later portion slightly lobulate; 7-8 chambers in final whorl; sutures flush with surface, later ones slightly depressed, slightly curved; wall finely perforate; aperture a low interiomarginal slit extending from the periphery to the umbilicus, with a distinct lip.

Figures:
Plate 11, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 1-2 cm, 1a: ventral view, 1b: dorsal view, 1c: edge view showing apertural opening.
Scale bars = 50 μm.

Family Gavelinellidae

Genus *Gyroidinoides*

***Gyroidinoides* sp. cf. *G. polius* (Phleger and Parker)**

Eponides polius Phleger and Parker, 1951, p. 21, pl. 11, figs. 1a, b, 2a, b.
Eponides polius Phleger and Parker - Parker, 1954, p. 528-529, pl. 9, figs. 11, 12.
Eponides polius Phleger and Parker – Poag, 1981, p. 64, pl. 1, fig. 1; pl. 2, figs. 1a, 1b.
Gyroidinoides polius (Phleger and Parker) – Denne, 1990, pl. 7, figs. 2a, b.

Morphology: Shell biconvex; periphery slightly lobulate; about 3 whorls in adult, 9-11 chambers in final whorl; sutures on dorsal side slightly curved to sharply angled, sutures on ventral side slightly depressed and almost straight; aperture a narrow slit-like opening between periphery and umbilicus on ventral side and covered by an apertural flap.

Remarks: Parker (1954) notes that this species has “sutural” foramina, and Poag (1981) notes an arch in the aperture at the peripheral end. Neither of these features is apparent in our specimens.

Figures:
Plate 73, figs. 1a-c, Alaminos Canyon Core PC-5 Sample 3-4 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view; figs. 2a-b, south of Mississippi Canyon control sample DGOMB2 C7, 2a: dorsal view, 2b: ventral view; fig. 3, south of Mississippi Canyon control sample DGOMB2 C7, ventral view.
Scale bars = 50 µm.

Gyroidinoides sp. cf. *G. regularis* (Phleger and Parker)

Eponides regularis Phleger and Parker, 1951, p. 21, pl. 11, figs. 3a, 3b, 4a-c.
Eponides regularis Phleger and Parker – Parker, 1954, p. 529, pl. 9, figs. 16, 17.
Neoeponides regularis (Phleger and Parker) – Andersen, 1961, p. 103, pl. 24, figs. 5a-c.
Eponides regularis Phleger and Parker – Pflum and Frerichs, 1976, pl. 2, figs. 1-3.
Eponides regularis Phleger and Parker – Poag, 1981, p. 64, pl. 1, fig. 3; pl. 2, figs. 3a, 3b.
Hansenisca regularia (Phleger and Parker) – Denne, 1990, pl. 7, figs. 5a, b.

Morphology: Shell biconvex; nonlobulate periphery; about 4 whorls in adult, 8 or 9 chambers in final whorl; sutures on dorsal side slightly curved; aperture a low, arched opening between periphery and umbilicus on ventral side; pustules present below the aperture.

Remarks: Our specimens are smaller and more biconvex than the holotype and have less sharply angled sutures on dorsal side. The pustules below the aperture are not seen on the holotype or in Poag's figures.

Figures:
Plate 74, figs. 1a-c, Alaminos Canyon Core PC-4 Sample 1-2 cm, 1a: dorsal view, 1b: ventral view, 1c: edge view; fig. 2, Alaminos Canyon Core PC-4 Sample 0-1 cm, dorsal view; figs. 3a-c, Alaminos Canyon Core PC-13 Sample 1-2 cm, 3a: dorsal view, 3b: ventral view, 3c: edge view; fig. 4, Green Canyon (Block 272) Core P-57 Sample 0-1 cm, ventral view. Carbonate overgrowth visible on the shell.
Scale bars = 50 µm.

Genus *Discanomalina*

Discanomalina semipunctata (Bailey)

Rotalina semipunctata Bailey, 1851, p. 11, figs. 17-19.
Anomalina polymorpha Costa, 1856, p. 252, pl. 21, figs. 17-19.
Anomalina polymorpha Costa - Brady, 1884, p. 676, pl. 97, figs. 3-6.
Anomalina semipunctata (Bailey) - Cushman, 1931, p. 106, pl. 18, figs. 1-2.
Discanomalina japonica Asano, 1951, p. 13, figs. 3-5.
Discanomalina japonica Asano - LeRoy and Levinson, 1974, p. 16, pl. 9, figs. 3-5.

Discanomalina semipunctata (Bailey) - Medioli and Scott, 1978, p. 298-300, pl. 1, figs. 1-20, pl. 2, figs. pl. 2, figs. 1-20.
Discanomalina semipunctata (Bailey) - Jones, 1994, p. 100, pl. 97, figs. 3-6.

Morphology: Shell (in our specimens) attached by ventral side and irregular in form; frequently with one or more spine-like projections from the rounded margin; surface coarsely perforate; broad ventral aperture.

Remarks: This is the type species of the genus *Discanomalina*. As demonstrated by Medioli and Scott (1978), it has been reported under multiple names from various seas. Its habit is known to be free or attached (Medioli and Scott, 1978; Loeblich and Tappan, 1987). All individuals in our samples, however, are attached to hydroid stalks growing on tubeworms. The curved and concave ventral side of *D. semipunctata,* illustrated and described by various authors (e.g., Cushman, 1931), is probably related to attachment to comparable tubular surfaces. The species has previously been found in Pleistocene sediments from the Gulf of Mexico (LeRoy and Levinson, 1974), but ours is the first report of a living population.

Figures:
Plate 55, digital photomicrographs, figs. 1, 2, Mississippi Canyon tubeworm MC5, specimens attached to hydroids; figs. 3, 4, Mississippi Canyon tubeworm MC3, specimens attached to hydroids.

Plate 56, fig. 1, Mississippi Canyon tubeworm MC3, specimen attached to hydroid; figs. 2, 3, Mississippi Canyon tubeworm MC5, specimens attached to hydroids; figs. 4, 5, Mississippi Canyon tubeworm MC3, specimens attached to hydroids, attachment side.

Genus *Gyroidina*

Gyroidina bradyi (Trauth)

Truncatulina dutemplei (d'Orbigny) – Brady, 1884, p. 665, pl. 95, figs. 5a-c.
Not *Rotalina dutemplei* d'Orbigny, 1846.
Truncatulina bradyi Trauth, 1918, p. 235.
Cibicides hyalina Hofker, 1951, p. 359, figs. 244-245.
Cibicides bradyi (Trauth) – Barker, 1960, p. 196, pl. 95, fig. 5.
Cibicides bradyi (Trauth) – Pflum and Frerichs, 1976, pl. 3, figs. 6, 7.
Cibicides bradyi (Trauth) – Boltovskoy, 1978, pl. 3, figs. 6-8.
Cibicidoides bradyi (Trauth) – Corliss, 1979, p. 9-10, pl. 3, figs. 1-3.
Cibicidoides bradyi (Trauth) – van Morkhoven et al., 1986, p. 100-102, pl. 30, figs. 1-2.
Cibicidoides bradyi (Trauth) – Hermelin, 1989, p. 85, 86, pl. 17, figs. 2-4.
Gyroidina bradyi (Trauth) – Jones, 1994, p. 99, pl. 95, fig. 5.

Morphology: Shell planoconvex to slightly biconvex; rounded periphery and no keel; sutures depressed on ventral, flush on dorsal side; dorsal side coarsely perforate; aperture extends onto dorsal side.

Remarks: Phleger and Parker (1951) in their description of *Cibicidoides robertsonianus* mention a complete gradation between the typical form of that species and a much smaller form with a rounded periphery which appears to be close to the species described by Brady as *Truncatulina dutemplei*, and called Cibicides/Cibicidoides bradyi by most later workers. Both Hermelin (1989) and van Morkhoven et al. (1986) distinguish *C. robertsonianus* from *C. bradyi* by noting the larger test, more angular periphery and imperforate keel of *C. robertsonianus*. Jones (1994) lists *C. bradyi* as *Gyroidina bradyi*, as *Gyroidina* differs from *Cibicidoides* in possessing an aperture more or less restricted to the umbilical side rather than in an equatorial position. The extent of the apertural slit is somewhat more variable in our specimens, but we follow Jones in placing the species under *Gyroidina*.

Figures:
Plate 71, figs. 1a-c, Green Canyon (Block 272) Core P-57 Sample 1-2 cm, 1a: ventral view, 1b: dorsal view, 1c: edge view; fig. 2, Alaminos Canyon Core PC4 Sample 1-2 cm, ventral view; figs. 3a-b, Alaminos Canyon Core PC4 Sample 0-1 cm, 3a: ventral view, 3b: edge view; figs. 4a-b, Green Canyon (Block 272) Core P-33 Sample 0-1 cm, 4a: ventral view, 4b: dorsal view; fig. 5, Green Canyon (Block 272) Core P-57 Sample 1-2 cm, ventral view.
Scale bars = 50 μm.

***Gyroidina orbicularis* (sensu Parker, Jones, and Brady)**

Rosalina orbicularis Parker, Jones, and Brady, 1865.
Rotalia orbicularis d'Orbigny – Brady, 1884, p. 706, pl. 107, figs. 5a-c, pl. 115, figs. 6a-c.
Rotalia orbicularis d'Orbigny – Cushman, 1915, p. 68, 69, pl. 29, figs. 3a-c, text-figs. 62a-c.
Gyroidina orbicularis d'Orbigny – Phleger and Parker, 1951, p. 22, pl. 11, figs. 11a, 11b, 12a, 12b.
Gyroidina orbicularis d'Orbigny – Parker, 1954, p. 528, pl. 9, figs. 13, 18.
Gyroidina orbicularis d'Orbigny – Pflum and Frerichs, 1976, pl. 5, figs. 5-7.
Gyroidinoides orbicularis d'Orbigny – Hermelin, 1989, p. 83, 84, pl. 16, figs. 7-9.
Gyroidinoides orbicularis d'Orbigny – Denne, 1990, pl. 7, figs. 4a, 4b.
Gyroidina orbicularis (sensu Parker, Jones, and Brady) – Jones, 1994.

Morphology: Shell unequally biconvex, ventral side is strongly convex, dorsal side is slightly convex, sutures radial and flush with the surface on dorsal side, spiral suture is slightly channeled, last few sutures on ventral side depressed and slightly recurved, aperture interiomarginal slit extending almost from the periphery to the umbilicus with a lip.

Remarks: This is a widely distributed species with a long history of nomenclatural confusion (see Jones, 1994), primarily because the features of d'Orbigny's original *Gyroidina orbicularis* are unknown. The name, with d'Orbigny as the author, has been used by numerous workers, but they have actually followed the concept of Parker et al. (1865) and Brady (1884) regarding the diagnostic characters of the species. Pending a thorough study of its comparative morphology, and possibly the designation of a new name, we follow the safe procedure of Jones (1994) in calling the species "*Gyroidina orbicularis* (sensu Parker, Jones, and Brady)".

Figures:
Plate 72, figs. 1-2, Alaminos Canyon Core PC5 Sample 2-3 cm, a: dorsal view, b: ventral view, c: edge view showing aperture.
Scale bars = 50 μm.

2.2.10. Order Robertinida

Superfamily Ceratobuliminacea

Family Epistominidae

Genus *Hoeglundina*

***Hoeglundina elegans* (d'Orbigny)**

Rotalina (Turbinulina) elegans d'Orbigny, 1826, p. 276, (not *Rotalia elegans*, Ibid., p. 272, no. 6).
Pulvinulina partschiana (d'Orbigny) – Brady, 1884, p. 699, pl. 105, figs. 3a-c.
Pulvinulina elegans (d'Orbigny) – Brady, 1884, p. 699, pl. 105, figs. 4-6.
Epistomina elegans (d'Orbigny) – Cushman, 1931, p. 65, 66, pl. 13, figs. 6a-c.
Höglundina elegans (d'Orbigny) – Phleger and Parker, 1951, p. 22, pl. 12, figs. 1a, b.
Höglundina elegans (d'Orbigny) – Parker, 1954, p. 531, pl. 10, figs. 4, 8.
Hoglündina elegans (d'Orbigny) – Barker, 1960, p. 216, pl. 105, figs. 3-6.
Epistomina elegans (d'Orbigny) – Andersen, 1961, p. 112, pl. 28, figs. 4a-c.
Hoeglundina elegans (d'Orbigny) – Poag, 1981, p. 69, pl. 19, fig. 3; pl. 20, figs. 3a, b, c.
Hoeglundina elegans (d'Orbigny) – van Morkhoven, Berggren and Edwards, 1986, p. 97, 98, pl. 29, figs. 1a, b, 2a, b.
Hoeglundina elegans (d'Orbigny) – Denne, 1990, pl. 7, figs. 7a, b.
Hoeglundina elegans (d'Orbigny) – Jones, 1994, p. 104, 105, pl. 105, figs. 3-6.

Morphology: Shell biconvex; typically 7-9 chambers in final whorl; sutures limbate, flush with surface; aperture an arched slit that extends the breadth of the chamber within and parallel to the periphery on ventral side; apertures of earlier chambers may remain open or be secondarily closed and visible as scars along the periphery.

Remarks: This is the type species of the genus *Hoeglundina* Brotzen 1948.

Figures:
Plate 77, figs. 1a-c, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 1a: ventral view, 1b: dorsal view, 1c: side view showing aperture; figs. 2a-b, Green Canyon (Block 180) Core P-EP15 Sample 0-1 cm, 2a: ventral view, 2b: dorsal view; fig. 3, Alaminos Canyon Core PC15 Sample 6-7 cm, ventral view.
Scale bars = 50 μm.

Superfamily Robertinacea

Family Robertinidae

Genus *Robertina*

***Robertina subcylindrica* (Brady)**

Bulimina subcylindrica Brady, 1881, p. 56.
Bulimina subcylindrica Brady – Brady, 1884, p. 404, pl. 50, figs. 16a, b.
Robertina subcylindrica (Brady) – Cushman and Parker, 1936, p. 95, 96, pl. 16, figs. 10a, b.
Robertina subcylindrica (Brady) – Barker, 1960, p. 102, pl. 50, figs. 16a, b.
Robertina subcylindrica (Brady) – Jones, 1994, p. 55, pl. 50, figs. 16a, b.

Morphology: Shell is subcylindrical and elongate in shape; 4 pairs of chambers in final whorl; aperture is slitlike from the base of the final chamber.

Figures:
Plate 156, fig. 1, Alaminos Canyon Core PC4 Sample 0-1 cm, front view.
Scale bar = 50 µm.

Genus *Robertinoides*

***Robertinoides bradyi* (Cushman and Parker)**

Bulimina subteres Brady, 1881, p. 55.
Bulimina subteres Brady – Brady, 1884, p. 404, pl. 50, figs. 18a, b.
Robertina bradyi Cushman and Parker, 1936, p. 99, 100, pl. 16, figs. 9a, b.
Robertinoides bradyi (Cushman and Parker) – Barker, 1960, p. 102, pl. 50, figs. 18a, b.
Robertinoides bradyi (Cushman and Parker) – Andersen, 1961, p. 86, pl. 19, fig. 4.
Robertinoides bradyi (Cushman and Parker) – Denne, 1990, pl. 11, fig. 21.
Robertinoides bradyi (Cushman and Parker) – Jones, 1994, p. 55, pl. 50, figs. 18a, b.

Morphology: Test tapering towards initial end; 4-5 pairs of chambers in final whorl; sutures slightly depressed in most specimens; aperture elongate from the base of the final chamber; supplementary aperture present, elongate and short.

Figures:
Plate 157, figs. 1-2, Alaminos Canyon Boxcore B6 bulk sample, front view; fig. 3, Alaminos Canyon Core Sample 0-1 cm, front view.
Scale bars = 50 µm.

3. FORAMINIFERA IN SEDIMENT SAMPLES

3.1. Identified Species

A total of 177 species—60 agglutinated, 13 porcelaneous, and 104 hyaline—have been identified from the sediment samples. In addition, 8 species were found only on tubeworm surfaces. Table 3-1 lists the species alphabetically within each of the three primary morphological groups. The species indicated with superscripts 1 and 2 were utilized in the cluster analyses. All species in our samples, except *Heronallenia* sp., *Miliolinella subrotunda* (Seguenza), *Neoconorbina terquemi* (Rzehak), *Procerolagena gracillima* (Seguenza), and *Trochamminoides coronatus* (Brady) are illustrated in the plates of the Atlas (Appendix) and discussed in the systematics section (Chapter 2). The excluded species are rare; we could not find specimens that were suitable for illustrations.

Twenty-one modern species found in the course of this study were previously unreported from the Gulf of Mexico. Two of these, *Deuterammina rotaliformis* and *Discanomalina semipunctata*, were found only on tubeworms; *D. semipunctata* has been previously reported from Pleistocene sediments of the Gulf. The rest were found only in the sediment samples; these are: *Ammobaculites catenulatus, Barbourinella atlantica, Cribromiliolinella subvalvularis, Fissurina fissa, Glomospira irregularis, Lagena chrysalis, Lagenammina laguncula, L. tubulata, Lenticulina pliocaena, Nonionella iridea, Orectostomina camposi, Parafissurina kerguelenensis, Parvigenerina arenacea, Planispirinoides bucculentus* var. *placentiformis, Portatrochammina antarctica, Pseudoclavulina serventyi, Robertina subcylindrica, Saccammina helenae,* and *Saracenaria altifrons*.

3.2. Rose-Bengal-Stained Foraminifera

Approximate estimates of living populations were obtained by counting Rose-Bengal-stained specimens. Although widely used, the reliability of Rose Bengal stain for distinguishing between living and dead foraminiferal specimens is in some doubt (Bernhard and Sen Gupta, 1999; Bernhard et al., 2006). It has been shown that less than half of the Rose-Bengal-stained Foraminifera in certain samples from bathyal marine sediments may be living when collected (Bernhard et al., 2006). The main criticism of Rose Bengal is that it is a non-vital stain and will adhere to dead as well as living cytoplasm (Bernhard, 1988, 1989; Corliss and Emerson, 1990; Jorissen et al., 1995), and therefore will mark recently dead specimens in addition to living specimens. Thus, dependence on Rose Bengal leads to overestimation of the abundance of living hyaline Foraminifera. In contrast, because the stain can be difficult to see in opaque specimens (Bernhard, 2000), the number of living agglutinated and miliolid Foraminifera may be underestimated. Despite such problems, however, Rose Bengal has been used in numerous studies to recognize Foraminifera collected alive (e.g., Corliss, 1985; Lutze and Altenbach, 1991; Gooday, 1993, 1996; Gooday and Rathburn, 1999; Rathburn et al., 2000; Rathburn et al., 2003). The consensus is that a conservative use, with only deeply stained foraminiferal shells, should yield a reasonable estimate of living assemblages (Lutze and Altenbach, 1991; Gooday and Rathburn, 1999; Rathburn et al., 2003), especially for comparative studies of seep and non-seep assemblages.

Table 3-1

Geographic Occurrence of Species

SPECIES	AREA							
	1	2	3	4	5	6	7	8
AGGLUTINATED SPECIES								
Adercotryma glomeratum	X			X	X	X	X	
Ammobaculites catenulatus	X							
Ammobaculites filiformis				X		X	X	
Ammodiscus tenuis	X	X			X	X	X	
Ammolagena clavata	X	X	X	X		X	X	X
Ammoscalaria tenuimargo							T	
Archimerismus subnodosus	X	X	X			X	X	X
Barbourinella atlantica	X							
Buzasina ringens						X	X	
Cribrostomoides subglobosus		X						
Cystammina pauciloculata		X					X	X
Deuterammina rotaliformis		T			T			
Discammina compressa	X	X	X				X	
Dorothia scabra						X	X	
Eggerella bradyi		X	X	X	X	X	X	X
Gaudryina minuta	X	X	X	X	X	X	X	
Glomospira gordialis		X					X	
Glomospira irregularis		X		X	X	X	X	
Haplophragmoides sp. cf. *H. kirki*	X	X	X		X			
Hormosina pilulifera		X		X	X	X		
Hormosinella distans		X	X	X		X		
Hormosinella guttifera		X	X	X	X			
Hyperammina friabilis		X					X	
Hyperammina laevigata		X	X	X	X	X		
Hyperammina sp.	X	X	X		X	X	X	
Karreriella bradyi	X	X		X		X		
Karrerulina apicularis	X	X				X	X	
Lagenammina difflugiformis	X	X	X	X	X	X		
Lagenammina laguncula		X						
Lagenammina tubulata		X	X		X	X	X	
Lituotuba lituiformis				X		X	X	
Martinottiella communis	X	X	X				X	X

Areas: 1, Shallow Green Canyon (245 m); 2, Deep Green Canyon (562-696 m); 3, Garden Banks (640 m); 4, South of Mississippi Canyon (~1000 m); 5, Mississippi Canyon (620 m, 1067-1081 m); 6, De Soto Canyon (1850 m); 7, Alaminos Canyon (2218-2227 m); 8, Farnella Canyon (2918 m).

T = found exclusively on tubeworms (and not in sediments).

Superscripts 1 and 2 indicate species used in cluster analyses 1 and 2, respectively.

Table 3-1. Geographic Occurrence of Species (continued).

SPECIES	AREA							
	1	2	3	4	5	6	7	8
AGGLUTINATED SPECIES								
Multifidella nodulosa	X							
Orectostomina camposi	X							
Paratrochammina challengeri						X	X	
Parvigenerina arenacea	X	X						
Portatrochammina antarctica	X	X		X	X	X	X	X
Prolixoplecta parvula		X	X		X	X	X	
Psammosphaera fusca		X			X			
Pseudoclavulina mexicana	X							
Pseudoclavulina serventyi	X							
Pseudogaudryina atlantica	X							
Pseudotrochammina sp.	X	X						
Reophax agglutinatus						X	X	
Reophax scorpiurus		X	X			X	X	
Rhabdammina abyssorum							X	
Rhabdammina discreta		X					X	
Rhizammina algaeformis		X	X				X	
Rhizammina indivisa		X	X	X	X	X		
Saccammina helenae						X	X	
Saccorhiza ramosa	X	X	X	X	X	X	X	X
Siphotextularia rolshauseni						X	X	X
Spiroplectammina sp.	X	X				X	X	
Subreophax monile		X			X			
Tetrataxiella sp.	X							
Textularia foliacea occidentalis	X							
Textularia mexicana	X							
Textularia sp. cf. *T. mayori*	X							
Textulariella barrettii	X							
Trochamminoides coronatus	X	X	X			X	X	
Usbekistania charoides	X	X	X	X	X	X	X	X
Veleroninoides jeffreysii					T			
Veleroninoides wiesneri		X	X	X	X	X	X	
PORCELANEOUS SPECIES								
Calcituba polymorpha		T						
Cornuspira foliacea							T	

Areas: 1, Shallow Green Canyon (245 m); 2, Deep Green Canyon (562-696 m); 3, Garden Banks (640 m); 4, South of Mississippi Canyon (~1000 m); 5, Mississippi Canyon (620 m, 1067-1081 m); 6, De Soto Canyon (1850 m); 7, Alaminos Canyon (2218-2227 m); 8, Farnella Canyon (2918 m).

T = found exclusively on tubeworms (and not in sediments).

Superscripts 1 and 2 indicate species used in cluster analyses 1 and 2, respectively.

Table 3-1. Geographic Occurrence of Species (continued).

SPECIES	AREA							
	1	2	3	4	5	6	7	8
PORCELANEOUS SPECIES								
Cornuspira involvens[1, 2]		X		X			X	
Cribromiliolinella subvalvularis [1, 2]		X			X		X	
Miliolinella subrotunda[1, 2]		X						
Miliolinella warreni	X							
Miliolinella sp.		T			T			
Planispirinoides bucculentus var. *placentiformis*[1, 2]		X						
Pyrgo lucernula		X				X	X	X
Pyrgo murrhina		X		X		X	X	
Pyrgo nasuta	X							
?*Pyrgo* sp.							X	
Quinqueloculina bosciana	X							
Sigmoilinita elliptica[1, 2]	X	X		X	X			
Sigmoilopsis schlumbergeri[1, 2]	X	X	X	X				
Triloculina tricarinata		X					X	
HYALINE SPECIES								
Abditodentrix pseudothalmanni[1, 2]		X	X	X	X		X	
Amphicoryna hirsuta	X	X	X					
Anomalinoides globulosus		T	X					
Anomalinoides mexicanus	X	X						
Bolivina alata		X	X		X			
Bolivina albatrossi[1, 2]	X	X	X	X	X	X	X	X
Bolivina barbata[1, 2]	X	X						
Bolivina daggarius	X							
Bolivina goesii	X							
Bolivina sp. cf. *B. hastata*	X	X						
Bolivina lowmani[1, 2]	X	X	X	X	X	X	X	X
Bolivina minima[2]	X		X	X				
Bolivina ordinaria[1, 2]	X	X	X	X	X	X		
Bolivina sp. cf. *B. pusilla*						X	X	
Bolivina subaenariensis[1, 2]	X	X			X			
Bolivina translucens[1, 2]	X	X	X	X	X	X		
Bolivinita quadrilatera								X

Areas: 1, Shallow Green Canyon (245 m); 2, Deep Green Canyon (562-696 m); 3, Garden Banks (640 m); 4, South of Mississippi Canyon (~1000 m); 5, Mississippi Canyon (620 m, 1067-1081 m); 6, De Soto Canyon (1850 m); 7, Alaminos Canyon (2218-2227 m); 8, Farnella Canyon (2918 m).

T = found exclusively on tubeworms (and not in sediments).

Superscripts 1 and 2 indicate species used in cluster analyses 1 and 2, respectively.

Table 3-1. Geographic Occurrence of Species (continued).

SPECIES	AREA							
	1	2	3	4	5	6	7	8
HYALINE SPECIES								
Bulimina aculeata[1, 2]	X	X	X	X	X	X	X	
Bulimina alazanensis[1, 2]		X	X	X	X	X		
Bulimina marginata[1, 2]	X	X	X					
Bulimina mexicana[1, 2]	X	X	X	X	X	X	X	X
Cassidulina carinata[1, 2]	X	X	X	X	X		X	X
Cassidulina curvata[1, 2]	X	X	X		X			
Cassidulina obtusa[1, 2]	X	X	X	X	X	X	X	X
Cassidulinoides tenuis	X	X			X			
Chilostomella oolina		X	X		X			X
Cibicides lobatulus							X	
Cibicides wuellerstorfi[1, 2]						X	X	X
Cibicidoides pachyderma[1, 2]	X	X	X	X	X		X	X
Discanomalina semipunctata					T			
Cibicidoides robertsonianus	X	X	X			X	X	
Dentalina sp.			X					
Epistominella exigua[1, 2]	X	X	X	X	X	X	X	X
Epistominella vitrea[1, 2]	X	X	X		X		X	
Eponides turgidus[1, 2]	X	X	X	X	X	X	X	X
Eubuliminella morgani	X				X		X	
Fissurina fissa							X	
Fissurina sp. cf. *F. incomposita*		X			X			
Fursenkoina seminuda[1, 2]		X	X		X	X	X	
Gavelinopsis tranlucens[1, 2]	X	X	X	X	X			
Globocassidulina subglobosa[1, 2]	X	X	X	X	X	X	X	X
Gyroidina bradyi[1, 2]	X	X	X	X	X	X	X	X
Gyroidina orbicularis (sensu lato)[1, 2]	X	X	X	X	X	X	X	X
Gyroidinoides sp. cf. *G. polius*[1, 2]	X	X		X	X		X	X
Gyroidinoides sp. cf. *G regularis*[1, 2]	X	X	X	X	X	X	X	
Haynesina germanica		X			X			
Heronallenia sp.							X	
Hoeglundina elegans[1, 2]	X	X		X		X	X	X

Areas: 1, Shallow Green Canyon (245 m); 2, Deep Green Canyon (562-696 m); 3, Garden Banks (640 m); 4, South of Mississippi Canyon (~1000 m); 5, Mississippi Canyon (620 m, 1067-1081 m); 6, De Soto Canyon (1850 m); 7, Alaminos Canyon (2218-2227 m); 8, Farnella Canyon (2918 m).

T = found exclusively on tubeworms (and not in sediments).

Superscripts 1 and 2 indicate species used in cluster analyses 1 and 2, respectively.

Table 3-1. Geographic Occurrence of Species (continued).

SPECIES	AREA							
	1	2	3	4	5	6	7	8
HYALINE SPECIES								
Ioanella tumidula[1, 2]		X				X	X	X
Lagena chrysalis							X	
Lagena hispida							X	
Lagena hispidula		X			X		X	
Laminononion tumidum		X			T			
Laticarinina pauperata		X	X		X	X	X	X
Lenticulina calcar[1, 2]	X	X	X					
Lenticulina gibba	X	X						
Lenticulina pliocaena	X	X	X	X				
Lenticulina thalmanni	X	X					X	
Melonis affinis	X		X					
Melonis pompilioides							X	X
Neoconorbina terquemi		X		X	X		X	
Neocrosbyia minuta	X	X	X				X	
Nonionella iridea[1, 2]		X	X	X	X	X		
Nuttallides decorata[1, 2]						X	X	X
Oolina apiopleura							X	
Oolina globosa[1, 2]		X			X		X	
Oolina ovum	X	X			X		X	
Oolina squamosa		X						
Oridorsalis umbonatus[1, 2]	X	X	X	X	X	X	X	X
Osangularia culter[1, 2]		X	X	X	X	X	X	
Osangularia rugosa[1, 2]	X	X	X	X	X	X	X	X
Parafissurina botelliformis	X	X		X			X	
Parafissurina kerguelenensis							X	X
Parafissurina lateralis		X					X	
Patellina corrugata[1, 2]		X			X		X	X
Planulina ariminensis		X	X					
Planulina foveolata	X							
Plectofrondicularia advena			X		X			
Praeglobobulimina ovata[1, 2]	X	X			X		X	X
Praeglobobulimina ovula	X	X						

Areas: 1, Shallow Green Canyon (245 m); 2, Deep Green Canyon (562-696 m); 3, Garden Banks (640 m); 4, South of Mississippi Canyon (~1000 m); 5, Mississippi Canyon (620 m, 1067-1081 m); 6, De Soto Canyon (1850 m); 7, Alaminos Canyon (2218-2227 m); 8, Farnella Canyon (2918 m).

T = found exclusively on tubeworms (and not in sediments).

Superscripts 1 and 2 indicate species used in cluster analyses 1 and 2, respectively.

Table 3-1. Geographic Occurrence of Species (continued).

SPECIES	AREA							
	1	2	3	4	5	6	7	8
HYALINE SPECIES								
Procerolagena gracilis[1, 2]		X			X		X	
Procerolagena gracillima		X			X		X	
Pseudoglandulina comatula	X							
Pullenia bulloides	X	X	X			X	X	
Pullenia quinqueloba[1, 2]	X	X	X	X	X	X	X	
Robertina subcylindrica							X	
Robertinoides bradyi		X				X	X	
Rutherfordoides mexicanus[1, 2]	X	X	X	X	X			X
Saracenaria altifrons	X							
Seabrookia earlandi[1,2]	X	X	X	X	X	X	X	
Siphonina pulchra[1, 2]	X	X	X					
Siphonodosaria calomorpha	X	X		X			X	
Spirillina vivipara					T			
Stainforthia complanata	X	X	X	X	X	X	X	
Stainforthia compressa	X	X						
Stainforthia pontoni	X	X						
Trifarina bradyi[1, 2]	X	X	X	X				
Trifarina jamaicensis		X			X			
Uvigerina auberiana	X	X	X					X
Uvigerina bellula	X							
Uvigerina flintii[1, 2]	X							
Uvigerina peregrina[1, 2]	X	X	X	X	X	X	X	X
Vaginulinopsis subaculeata	X	X	X					
Valvulineria glabra	X	X	X	X	X	X		
Valvulineria mexicana[1, 2]		X	X				X	X
Vasiglobulina reticulata	X	X						

Areas: 1, Shallow Green Canyon (245 m); 2, Deep Green Canyon (562-696 m); 3, Garden Banks (640 m); 4, South of Mississippi Canyon (~1000 m); 5, Mississippi Canyon (620 m, 1067-1081 m); 6, De Soto Canyon (1850 m); 7, Alaminos Canyon (2218-2227 m); 8, Farnella Canyon (2918 m).

T = found exclusively on tubeworms (and not in sediments).

Superscripts 1 and 2 indicate species used in cluster analyses 1 and 2, respectively.

About 80 species in our samples caught the Rose Bengal stain. Of these, only 32 species are represented by more than one or two Rose-Bengal-stained specimens in more than two samples, and 8 such species are present in more than 2% of the samples. Also, only three stained species constitute >2% of the calcareous assemblage (Table 3-2). Several of these species are important at multiple sites. These include *Cornuspira involvens*, *Eponides turgidus*, *Nuttallides decorata*, *Saccorhiza ramosa*, *Hyperammina* sp., and *Portatrochammina antarctica*. The Rose-Bengal-stained *Eponides turgidus* and *Nuttallides decorata* individuals are mostly confined to non-seep samples. Stained *Cornuspira involvens* specimens are restricted to bacterial mat seep samples and are most abundant in samples ACP15a and ACP15b (Table 3-2). Stained specimens of *Portatrochammina antarctica* are also abundant in ACP15a (23 individuals), comprising 9% of the total assemblage. Small numbers of Rose-Bengal-stained *Portatrochammina antarctica* are found in several other samples, mostly from bacterial mat substrates. Rose-Bengal-stained specimens of *Saccorhiza ramosa* are limited to non-seep samples, while stained *Hyperammina* sp. specimens are found in both seep and non-seep samples. Of the 27 benthic Foraminifera individuals present in ACP10a, 19 are Rose-Bengal-stained *Hyperammina* sp. specimens.

The percentage of Rose-Bengal-stained Foraminifera in most bacterial mat samples is less than 5%, with some notable exceptions. In sample ACP15a (orange bacterial mat), 83% of the total specimens were stained, with encysted *Cornuspira involvens* (the sole calcareous species in the sample, 183 specimens) constituting 71%. The percentage of stained individuals (all *C. involvens*) decreased in ACP15b to 24% of the total and 32% of the calcareous assemblage. The other two samples with anomalously high numbers of Rose-Bengal-stained individuals include ACP10a and GCP54a. Sample ACP10a has 19 stained *Hyperammina* sp. specimens that comprise 70% of the total Foraminifera. Twenty-two percent of the calcareous Foraminifera in GCP54a caught the stain; they comprise 83% of all stained individuals in the sample. In all, 13% of all Foraminifera in GCP54a were stained by Rose Bengal. These stained individuals belong mainly to *Cribromiliolinella subvalvularis*, *Bulimina marginata, Portatrochammina antarctica, Cornuspira involvens*, and *Planispirinoides bucculentus var. placentiformis*.

3.3. Species Richness

The diversity of benthic Foraminifera, as represented by species richness (number of species in a sample), is high in the majority of samples analyzed in this study. Much variablity in species richness is observed in Green Canyon, Mississippi Canyon, and Alaminos Canyon samples (Table 3-3, Fig. 3.1). GCP15a and GCP15b, the two samples from shallow Green Canyon, have the highest species richness of 133 and 152, respectively. Samples from deep Green Canyon and Garden Banks show species richness values between 46 and 102. In the deeper locations of Mississippi Canyon and Alaminos Canyon, however, several samples have lower values, with ranges of 20-74 for Mississippi Canyon and 0-114 for Alaminos Canyon; species richness seems to be more erratic at these deeper sites. The samples with the lowest diversities at any site are the those from bacterial mats, but there are also four non-mat samples in Alaminos Canyon with very low diversiy (Fig. 3.1). Those four samples are probably from sites of active seepage (see later).

Table 3-2

Counts of Rose-Bengal-Stained Individuals for the 32 Species That Contribute More Than One or Two Stained Individuals at More Than One Site

Species in which Rose-Bengal-stained individuals represent greater than 2% of the assemblage at a site are in bold; species for which Rose-Bengal-stained individuals represent greater than 2% of the calcareous assemblage are in underlined bold. Total counts for all specimens (stained and unstained) are given in the last two rows.

SPECIES	AC P15a	AC P15b	AC P04a	AC P05a	AC P05b	AC P10a	AC P11a	AC P12b	AC B07a	AC B08a
Bolivina albatrossi										
Bolivina ordinaria										
Bulimina aculeata										
Bulimina marginata										
Cassidulina carinata										
Globocassidulina subglobosa										
Hoeglundina elegans										1
Cibicides wuellerstorfi						1			2	
Epistominella exigua										
Eponides turgidus				15	4					
Gavelinopsis translucens										
Nuttallides decorata			14	8						1
Oridorsalis umbonatus				1			2			
Osangularia culter										
Osangularia rugosa										
Cornuspira involvens	183	14							2	
Cribromiliolinella subvalvularis										
Planispirinoides bucculentus var. placentiformis										
***Hyperammina* sp.**				2		19				
Lagenammina difflugiformis										
Lagenammina tubulata										
Rhizammina algaeformis					4					
Saccorhiza ramosa				8						
Rhizammina indivisa										
Adercotryma glomerata										
Ammodiscus tenuis	4								1	
Gaudryina minuta										
Reophax scorpiurus										
Usbekistania charoides										
Portatrochammina antarctica	23		1				1	3	2	
Trochamminoides coronatus									1	
Unidentified trochamminids	3								4	
Total calcareous individuals	183	44	1290	261	1056	2	5	0	26	2
Total individuals	257	59	1324	515	2450	27	8	11	456	291

Table 3-2. Counts of Rose-Bengal-Stained Individuals for the 32 Species That Contribute More Than One or Two Stained Individuals at More Than One Site (continued).

Species in which Rose-Bengal-stained individuals represent greater than 2% of the assemblage at a site are in bold; species for which Rose-Bengal-stained individuals represent greater than 2% of the calcareous assemblage are in underlined bold. Total counts for all specimens (stained and unstained) are given in the last two rows.

SPECIES	AC B09a	AC B19a	DC B-S36	MC P02a	MC P02b	MC P04b	MC P08a	MC P08b	MC B-C7	FC P61a
Bolivina albatrossi					3					
Bolivina ordinaria						4				
Bulimina aculeata			1		1					
Bulimina marginata										
Cassidulina carinata				1		2		1		
Globocassidulina subglobosa		2								
Hoeglundina elegans		3	1							
Cibicides wuellerstorfi										
Epistominella exigua		2	3		1	3	2	2		
Eponides turgidus		42	5	2	3					
Gavelinopsis translucens				1						
Nuttallides decorata		33	1							
Oridorsalis umbonatus		1	1							
Osangularia culter								3		
Osangularia rugosa							1	1		
Cornuspira involvens									1	
Cribromiliolinella subvalvularis						2				
Planispirinoides bucculentus var. placentiformis										
***Hyperammina* sp.**		1								
Lagenammina difflugiformis			1						4	
Lagenammina tubulata			4							
Rhizammina algaeformis		2								
Saccorhiza ramosa		47	13						4	6
Rhizammina indivisa									5	
Adercotryma glomerata			6							
Ammodiscus tenuis										
Gaudryina minuta			3						1	
Reophax scorpiurus		1	3							
Usbekistania charoides			4							
Portatrochammina antarctica	4	1		1					2	
Trochamminoides coronatus		1	4							
Unidentified trochamminids		2	6		1					
Total calcareous individuals	4	932	2246	340	410	106	78	243	444	438
Total individuals	631	1642	1070	465	460	314	186	4721	962	558

Table 3-2. Counts of Rose-Bengal-Stained Individuals for the 32 Species That Contribute More Than One or Two Stained Individuals at More Than One Site (continued).

Species in which Rose-Bengal-stained individuals represent greater than 2% of the assemblage at a site are in bold; species for which Rose-Bengal-stained individuals represent greater than 2% of the calcareous assemblage are in underlined bold. Total counts for all specimens (stained and unstained) are given in the last two rows.

SPECIES	GC P33a	GC P33b	GC P51a	GC P54a	GC P54b	GC P55a	GC P57a	GC P57b	GC P12a
Bolivina albatrossi						2	2		
Bolivina ordinaria				2					
Bulimina aculeata	3								
Bulimina marginata				7					
Cassidulina carinata				1					
Globocassidulina subglobosa						1	1		
Hoeglundina elegans			1						1
Cibicides wuellerstorfi									
Epistominella exigua	1					1	3		
Eponides turgidus			1				5	2	
Gavelinopsis translucens				1			1	1	
Nuttallides decorata									
Oridorsalis umbonatus									
Osangularia culter									
Osangularia rugosa				1					
Cornuspira involvens				5					
Cribromiliolinella subvalvularis			1	10	10				
Planispirinoides bucculentus var. placentiformis				3					
***Hyperammina* sp.**		3					3	1	
Lagenammina difflugiformis									
Lagenammina tubulata							1		
Rhizammina algaeformis									
Saccorhiza ramosa									
Rhizammina indivisa									
Adercotryma glomerata									
Ammodiscus tenuis									
Gaudryina minuta									
Reophax scorpiurus							1		
Usbekistania charoides									
Portatrochammina antarctica	2			6	1				
Trochamminoides coronatus									
Unidentified trochamminids									
Total calcareous individuals	180	199	237	139	110	284	501	410	293
Total individuals	458	434	288	275	288	400	623	520	298

Table 3-3

Species richness (S) and Assemblage Density (AD) in Sediment Samples

LOCATION	SAMPLES	DEPTH (m)	S (calc)	S (agg)	S (total)	AD
Green Canyon (shallow)	GCP15a	245	84	49	133	86
	GCP15b		112	40	152	382
Garden Banks	GBP08a	640	46	21	67	66
	GBP08b		67	18	85	83
Green Canyon (deep)	GCP12a	569	44	4	48	8
	GCP12b		45	5	50	13
	GCP33a	664	46	17	63	48
	GCP33b		53	14	67	23
	GCP51a	696	52	11	63	8
	GCP51b		50	9	59	7
	GCP54a	675	37	15	52	7
	GCP54b		27	19	46	8
	GCP55a	689	63	30	93	166
	GCP55b		60	30	90	185
	GCP57a	675	68	34	102	65
	GCP57b		60	38	98	27
Mississippi Canyon	MCP04a	1072	22	5	27	2
	MCP04b		37	9	46	8
	MCP08a	1071	18	2	20	5
	MCP08b		20	1	21	6
	MCP73a	1070	18	6	24	30
	MCP73b		16	4	20	40
	MCP02a	1067	48	18	66	48
	MCP02b		53	16	69	48
	MCP69a	1081	38	21	59	46
	MCP69b		44	30	74	84
South of Mississippi Canyon	MCB-C7	1076	57	33	90	174
De Soto Canyon	DCB-S36	1848	64	50	114	102
Alaminos Canyon	ACP01a	2226	8	0	8	0.2
	ACP01b		26	0	26	3
	ACP04a	2227	72	6	78	34
	ACP04b		47	5	52	43
	ACP13a	2221	16	1	17	1
	ACP13b		32	0	32	5
	ACB07a	2227	9	8	17	9
	ACB08a		2	13	15	12
	ACB09a		4	7	11	52
	ACP10a	2219	2	4	6	0.7
	ACP10b		1	0	1	0.03
	ACP11a		3	2	5	0.2
	ACP11b		0	0	0	0
	ACP12a		0	1	1	0.02
	ACP12b		0	3	3	0.6
	ACP15b	2221	6	4	10	2
	ACP15a		1	9	10	7
	ACP05a	2225	30	30	60	13
	ACP05b		73	41	114	64
	ACB19a	2219	55	32	87	134
Farnella Canyon	FCP61a	2918	53	21	74	29

S (calc) = number of calcareous species; S (agg) = number of agglutinated species; S (total) = total number of species; AD = number of individuals/cm^3.

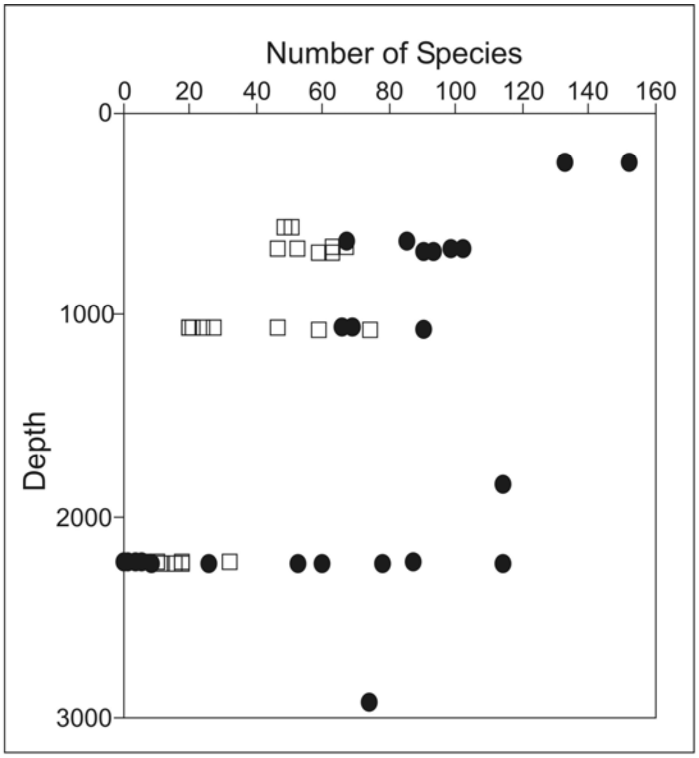

Figure 3.1. Species richness (number of species) in surface and near-surface samples plotted against water depths. Open squares, samples from bacterial mat substrates; closed circles, others.

High species richness values have been observed previously from non-seep sites in the northwestern Gulf of Mexico (Gibson and Buzas, 1973; Denne, 1990; Jones and Sen Gupta, 1995). Gibson and Buzas (1973), using data from Phleger (1951), noted species richness values of 10-50 at depths comparable to those of our samples, and Denne (1990) recorded species richness values of 38-51. Jones and Sen Gupta (1995) observed species richness values of 20-60 at depths of 1500-2500 m. None of these studies recorded the high species richness values seen in our study (Table 3-3). Judging by our observation on species present on tubeworms and in sediments at the base of tubeworm bushes, it is likely that the species richness in some of our sediment samples is elevated by post-mortem mixing of foraminiferal shells. This problem is discussed more fully in Chapter 4.

3.4. Assemblage Density

Assemblage densities (Table 3-3, Fig. 3.2) were measured by calculating the number of individuals per cm^3 of the surface or near-surface sediment. There is a slight trend towards decreasing densities with increasing depths. Six samples, none from a bacterial mat substrate, show assemblage densities greater than 100. The highest density (382) is observed in sample GCP15b from shallow Green Canyon.

3.5. Cluster Analyses Results

Surface samples. The Q-mode CA dendrogram for surface sample data for calcareous species (Fig. 3.3) shows two major clusters, A and B, and one outlier sample (ACP15). The two clusters are bathymetrically distinct. Cluster A includes deepest-bathyal samples from Alaminos Canyon (2219-2227 m water depth), Farnella Canyon (2918 m), and De Soto Canyon (1848 m). Cluster B includes shallower bathyal samples from Green Canyon (245 m, 569 m, 664-696 m), Garden Banks (640 m), Mississippi Canyon (1067-1081 m), and a location south of Mississippi Canyon (1076 m). Several minor clusters (A1, B1, etc.) can be recognized within these two large clusters. Table 3-4 lists the samples and the species with 5% or greater mean abundance in these clusters; Figure 3.4 also shows the relative abundances of the more important species in the minor clusters.

Surface and near-surface samples. In the combined data set for calcareous species in surface and near-surface samples, the 0-1 cm samples are indicated by the suffix "a" (e.g., ACP05a) and the 1-2 cm samples by the suffix "b" (e.g., ACP05b). Here too, two major clusters (X and Y) are recognized (Fig. 3.5), although the number of samples and that of minor clusters (X1, Y1, etc.) are larger. Table 3-5 lists the samples and the species with 5% or greater mean abundance in these clusters; Fig. 3.6 shows the relative abundances of the more important species in the minor clusters.

Cluster X, as with cluster A, consists of samples from Alaminos Canyon (2219-2227 m) and two other samples, DCB-S36 from De Soto Canyon (1848 m) and FCP61 from Farnella Canyon (2918 m). Samples in cluster Y are from Mississippi Canyon (1067-1081 m), south of Mississippi Canyon (1076 m), Garden Banks (640 m), and Green Canyon (245 m, 568-696 m). All near-surface samples belong to the same minor clusters as their matching surface samples.

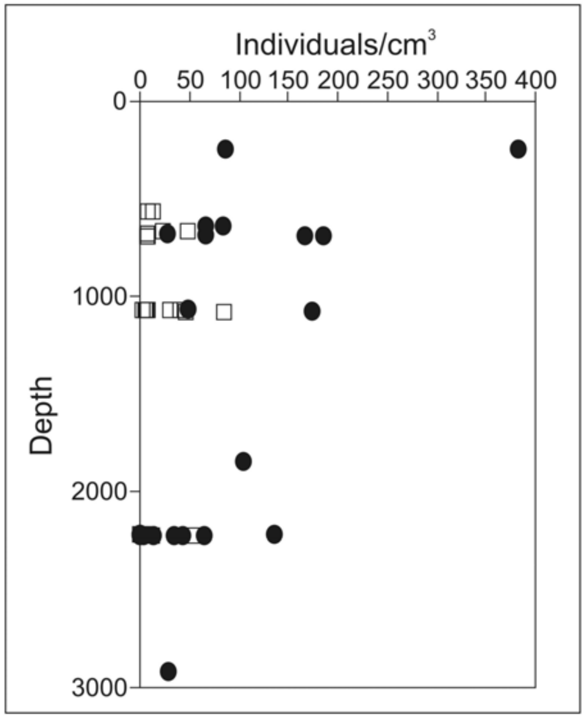

Figure 3.2. Assemblage density (individuals/cm^3) in surface and near-surface samples plotted against water depths. Open squares, samples from bacterial mat substrates; closed circles, others.

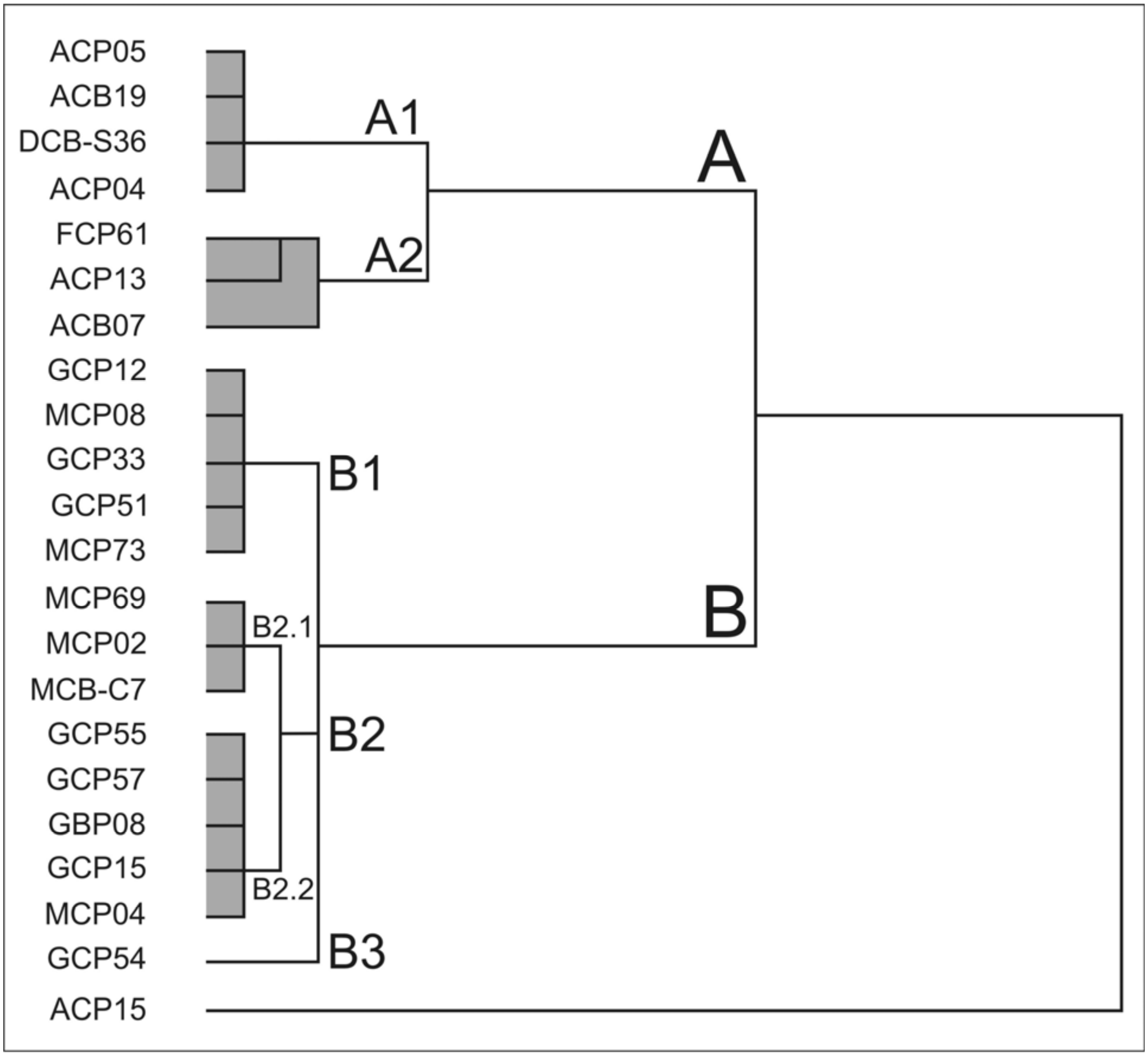

Figure 3.3. Q-mode clusters, surface samples.

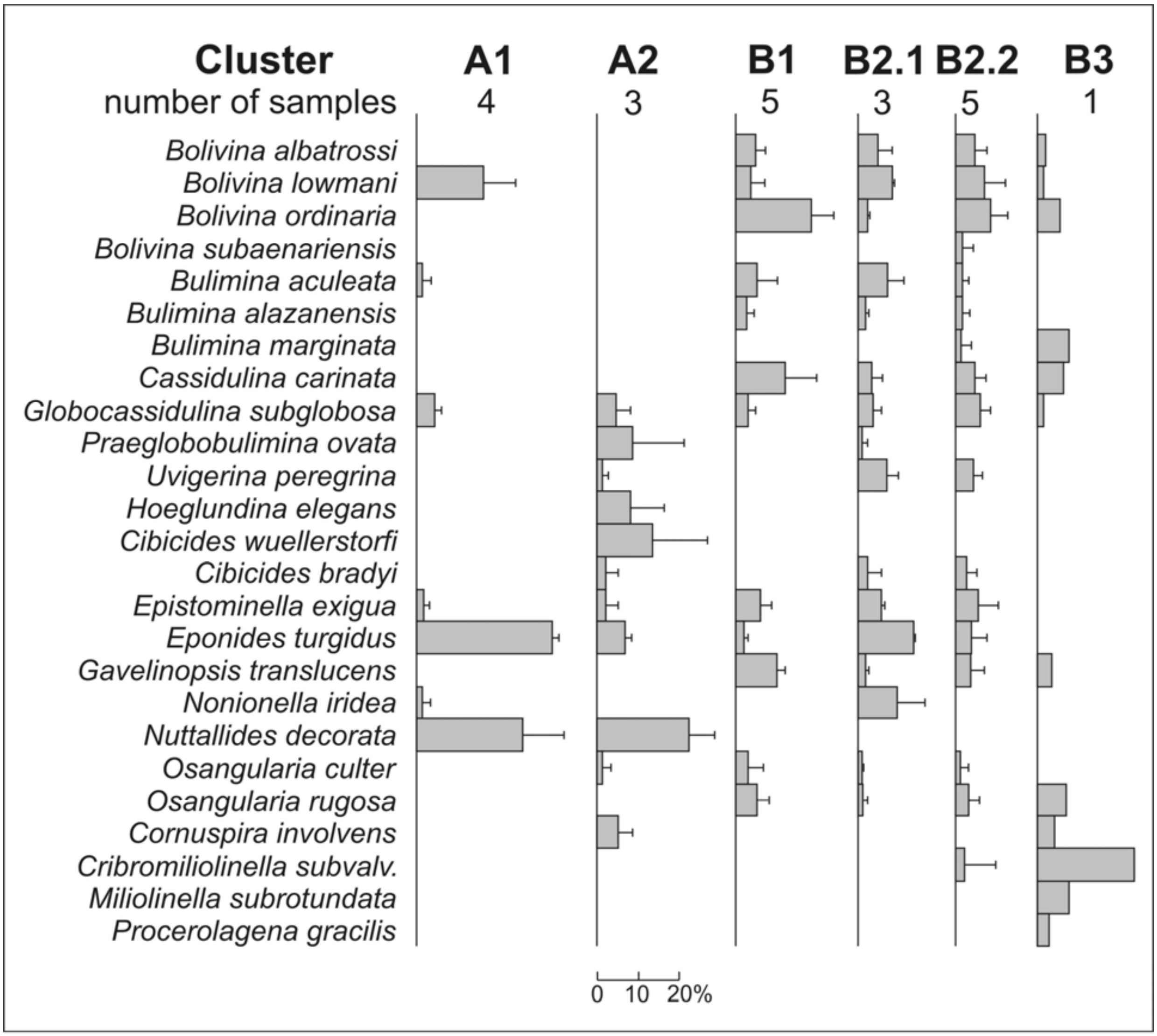

Figure 3.4. Relative abundances of the more important species in minor clusters, surface samples.

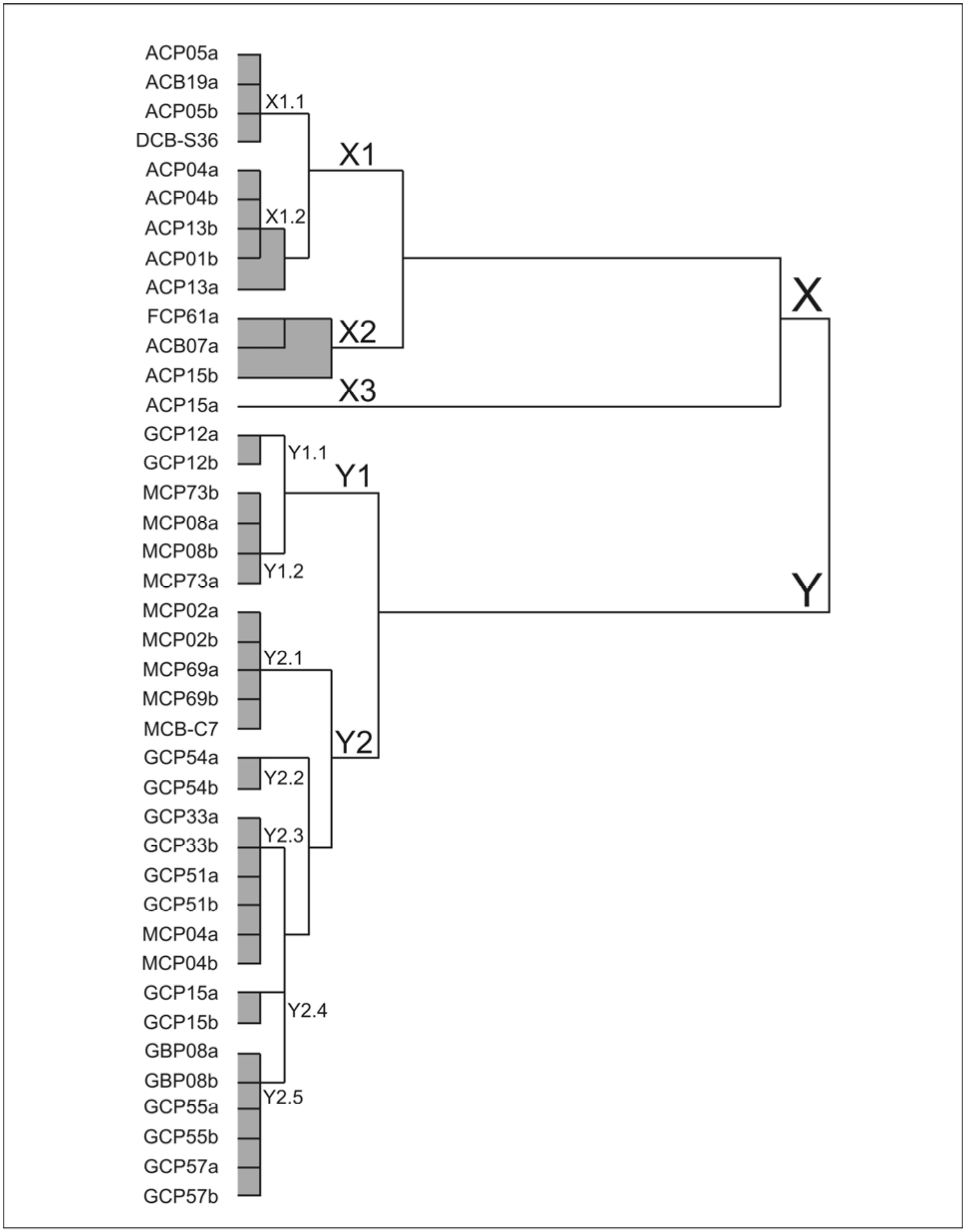

Figure 3.5. Q-mode clusters, surface (0-1 cm) and near-surface (1-2 cm) samples. Surface samples are indicated by suffix a, near-surface samples by b.

Table 3-4

Q-Mode Minor Clusters for Surface-Sample Data:
Constituent Samples, Water Depths, Substrates,
and Important Foraminiferal Species (Mean Abundance >5% in Minor Cluster)

MINOR CLUSTER	SAMPLES	DEPTH (m)	SUBSTRATE	IMPORTANT SPECIES	%
A1	ACP04a ACP05a ACB19a DCB-S36	2227 2225 2219 1848	White mud mound Mud Non-seep gray mud Non-seep	*Eponides turgidus* *Nuttallides decorata* *Bolivina lowmani*	33 26 16
A2	ACB07a ACP13a FCP61a	2227 2221 2918	Gray bacterial mat White bacterial mat Tubeworm clump	*Nuttallides decorata* *Cibicides wuellerstorfi* *Praeglobobulimina ovata* *Hoeglundina elegans* *Eponides turgidus* *Cornuspira involvens*	22 14 9 8 7 5
B1	MCP08a MCP73a GCP12a GCP33a GCP51a	1071 1070 569 664 696	Gray bacterial mat Bacterial mat White bacterial mat White bacterial mat Bacterial mat on mound with clams	*Bolivina ordinaria* *Cassidulina carinata* *Gavelinopsis translucens* *Epistominella exigua* *Bolivina albatrossi*	19 12 10 6 5
B2.1	MCP02a MCP69a MCB-C7	1067 1081 1076	Mud from ridge top Bacterial mat Non-seep	*Eponides turgidus* *Nonionella iridea* *Bolivina lowmani* *Bulimina aculeata* *Uvigerina peregrina* *Epistominella exigua* *Bolivina albatrossi*	14 10 9 7 7 6 5
B2.2	MCP04a GBP08a GCP15a GCP55a GCP57a	1072 640 245 689 675	Gray bacterial mat Non-seep gray mud Non-seep gray mud Non-seep mud Sand	*Bolivina ordinaria* *Bolivina lowmani* *Globocassidulina subglobosa* *Epistominella exigua* *Bolivina albatrossi* *Cassidulina carinata* *Uvigerina peregrina*	9 7 6 6 5 5 4
B3	GCP54a	675	White bacterial mat	*Cribromiliolinella subvalvularis* *Miliolinella subrotunda* *Bulimina marginata* *Osangularia rugosa* *Cassidulina carinata* *Bolivina ordinaria* *Cornuspira involvens*	24 8 8 7 6 6 4
C (outlier)	ACP15a	2221	Orange bacterial mat	*Cornuspira involvens*	100

Table 3-5

Q-Mode Minor Clusters for Combined Surface- and Near-Surface-Sample Data: Constituent Samples, Water Depths, Substrates, and Important Foraminiferal Species (Mean Abundance >5% in Minor Cluster)

MINOR CLUSTER	SAMPLES	DEPTH (m)	SUBSTRATE	IMPORTANT SPECIES	%
X1.1	ACP05a	2225	Mud	*Eponides turgidus*	31
	ACP05b	2225	Mud	*Nuttallides decorata*	23
	ACB19a	2219	Non-seep gray mud	*Bolivina lowmani*	21
	DCB-S36	1848	Non-seep		
X1.2	ACP01b	2226	White mud mound	*Nuttallides decorata*	33
	ACP04a	2227	White mud mound	*Eponides turgidus*	24
	ACP04b	2227	White mud mound	*Hoeglundina elegans*	5
	ACP13a	2221	White bacterial mat	*Globocassidulina subglobosa*	5
	ACP13b	2221	White bacterial mat		
X2	ACB07a	2227	Gray bacterial mat	*Nuttallides decorata*	16
	ACP15b	2221	Orange bacterial mat	*Cornuspira involvens*	16
	FCP61a	2918	Tubeworm clump	*Cibicides wuellerstorfi*	14
				Bolivina lowmani	11
				Praeglobobulimina ovata	8
X3	ACP15a	2221	Orange bacterial mat	*Cornuspira involvens*	100
Y1.1	GCP12a	569	White bacterial mat	*Bolivina ordinaria*	23
	GCP12b	569	White bacterial mat	*Gavelinopsis translucens*	19
				Cassidulina carinata	10
Y1.2	MCP08a	1071	Gray bacterial mat	*Bolivina ordinaria*	21
	MCP08b	1071	Gray bacterial mat	*Cassidulina carinata*	20
	MCP73a	1070	Bacterial mat	*Epistominella exigua*	9
	MCP73b	1070	Bacterial mat	*Gavelinopsis translucens*	8
				Bolivina albatrossi	7
				Osangularia culter	7
				Bulimina alazanensis	6
				Osangularia rugosa	6
Y2.1	MCP02a	1067	Mud from ridge top	*Eponides turgidus*	13
	MCP02b	1067	Mud from ridge top	*Uvigerina peregrina*	9
	MCP69a	1081	Bacterial mat	*Nonionella iridea*	8
	MCP69b	1081	Bacterial mat	*Bolivina lowmani*	8
	MCB-C7	1076	Non-seep	*Bulimina aculeata*	8
				Epistominella exigua	6
				Bolivina albatrossi	5
Y2.2	GCP54a	675	White bacterial mat	*Cribromiliolinella subvalvularis*	22
	GCP54b	675	White bacterial mat	*Bolivina ordinaria*	9
				Cornuspira involvens	6
				Procerolagena gracilis	5
				Bolivina lowmani	5
Y2.3	MCP04a	1072	Gray bacterial mat	*Bolivina ordinaria*	15
	MCP04b	1072	Gray bacterial mat	*Bulimina aculeata*	8
	GCP33a	664	White bacterial mat	*Bolivina lowmani*	6
	GCP33b	664	White bacterial mat	*Epistominella exigua*	6
	GCP51a	696	Bacterial mat on mound	*Cassidulina carinata*	5
	GCP51b	696	with clams	*Gavelinopsis translucens*	5
				Cribromiliolinella subvalvularis	5

Table 3-5. Q-Mode Minor Clusters for Combined Surface- and Near-Surface-Sample Data: Constituent Samples, Water Depths, Substrates, and Important Foraminiferal Species (Mean Abundance >5% in Minor Cluster) (continued).

MINOR CLUSTER	SAMPLES	DEPTH (m)	SUBSTRATE	IMPORTANT SPECIES	%
Y2.4	GCP15a	245	Non-seep gray mud	*Globocassidulina subglobosa*	8
	GCP15b	245	Non-seep gray mud	*Bolivina subaenariensis*	6
				Bulimina marginata	6
				Bolivina ordinaria	6
Y2.5	GBP08a	640	Non-seep gray mud	*Globocassidulina subglobosa*	8
	GBP08b	640	Non-seep gray mud	*Bolivina ordinaria*	8
	GCP55a	689	Non-seep mud	*Epistominella exigua*	7
	GCP55b	689	Non-seep mud	*Eponides turgidus*	6
	GCP57a	675	Sand	*Bolivina lowmani*	6
	GCP57b	675	Sand	*Gavelinopsis translucens*	6
				Bolivina albatrossi	6
				Cassidulina carinata	5
				Cibicidoides bradyi	5
				Uvigerina peregrina	5

However, several surface samples that clustered together in the CA of the first dataset, do not cluster together in this second CA (Tables 3.4 and 3.5).

Table 3-6 lists the 15 most important calcareous species affecting cluster formation, the minor clusters in both dendrograms (Figs. 3.3 and 3.5) to which they contribute greater than 5%, and their previously recorded depth ranges in the Gulf of Mexico. *Nuttallides decorata* is a defining species in clusters A and X, but is absent from shallower-bathyal samples of clusters B and Y (Figs. 3.4 and 3.6). *Eponides turgidus* and *Bolivina lowmani* also are important species in clusters A and X, although they are not restricted to deepest bathyal samples. *Bolivina ordinaria*, *Cassidulina carinata*, *Gavelinopsis translucens*, *Osangularia rugosa*, and *Bolivina albatrossi* are important in the minor clusters within B and Y, and are absent or negligible in the deepest bathyal samples (Figs. 3.4 and 3.6). These species have all been previously recorded from comparable depths within the Gulf of Mexico (Sen Gupta et al., in press). *Cribromiliolinella subvalvularis*, the dominant species in minor clusters B3 (Table 3-4, Figs. 3.4) and Y2.2 (Table 3-5, Fig. 3.6), has not been previously identified from the Gulf of Mexico.

3.6. Agglutinated Foraminifera

We identified 60 species of agglutinated Foraminifera, belonging to four orders, at the sampling sites. The dominant species belong to the genus *Hyperammina*. Other important agglutinated taxa include *Saccorhiza ramosa*, *Portatrochammina antarctica*, *Prolixoplecta parvula*, *Trochamminoides coronatus*, *Ammodiscus tenuis*, and *Lagenammina tubulata*.

Agglutinated Foraminifera are an important component of the assemblage in many samples, but estimations of their number, particularly those for tubular species such as *Hyperammina* and *Saccorhiza* (which are frequently broken into segments), can be hindered by taphonomic problems. Estimates of agglutinated Foraminifera as a percentage of the total assemblage are provided in Table 3-7, but these are possibly overestimates, because a significant proportion of the assemblage may be composed of tubular species. In 28 samples, agglutinated species constitute more than 15% of the foraminiferal assemblage; each of these samples contain >50 agglutinated individuals. The species that make up >5% of the agglutinated assemblage are listed in Table 3-7.

One sample, ACP11b, is barren of Foraminifera. Five samples contain only calcareous species, whereas two samples contain only agglutinated species; all but two of these seven samples (ACP01b, 2.7 individuals/cm^3; ACP13b, 4.7 individuals/cm^3) contain less than 1 individual/cm^3 (Table 3-3). The assemblage in 12 samples is 85-100% calcareous, with <50 agglutinated individuals in each sample; two samples from Alaminos Canyon contain <25 agglutinated individuals. No dominant agglutinated species is listed for these agglutinant-poor samples in Table 3-7.

Twelve samples have >49% agglutinated Foraminifera; three have >90%. (Nine of the 12 samples are from bacterial mat substrates.) *Hyperammina* is the dominant genus in 7 samples—three from Alaminos Canyon (ACB07a, ACB08a, ACB09a), two from Mississippi Canyon (MCP04b, MCP08a), and two from Green Canyon (GCP33a, GCP33b); *Hyperammina* sp. is the dominant species in all these samples but MCP04b, in which *Hyperammina laevigata* is dominant. Other species that contribute >5% to these agglutinated assemblages include

Table 3-6

List of the 15 Most Important Calcareous Species in Cluster Analysis

These species have >5% mean abundance in the minor clusters noted.
The previous records are taken from Sen Gupta et al. (in press).

SPECIES	OCCURRENCE (CURRENT STUDY)	PREVIOUS RECORD IN GULF (m)	MINOR CLUSTERS
Nuttallides decorata	DC, AC, FC	155-3850	A1, A2 X1.1, X1.2, X2
Eponides turgidus	GCs, GCd, GB, SMC, MC, DC, AC, FC	1-3850	A1, A2, B2.1 X1.1, X1.2, Y2.1
Bolivina lowmani	GCs, GCd, GB, SMC, MC, DC, AC, FC	0-3632	A1, B2.1, B2.2 Y2.1, Y2.2, Y2.3, Y2.5
Cibicides wuellerstorfi	DC, AC, FC	457-3850	A2 X2
Praeglobobulimina ovata	GCs, GCd, MC, AC, FC	10-2432	A2 X2
Cornuspira involvens	GCd, SMC, AC	1-1426	A2, C X2, X3, Y2.2
Hoeglundina elegans	GCs, GCd, SMC, DC, AC, FC	36-3632	A2 X1.2
Bolivina ordinaria	GCs, GCd, GB, SMC, MC, DC	18-3164	B1, B2.2, B3 Y1.1, Y1.2, Y2.2, Y2.3, Y2.4, Y2.5
Cassidulina carinata	GCs, GCd, GB, SMC, MC, AC, FC	21-3237	B1, B2.2, B3 Y1.1, Y1.2, Y2.3, Y2.5
Gavelinopsis translucens	GCs, GCd, GB, SMC, MC	0-3246	B1 Y1.1, Y1.2, Y2.3, Y2.5
Osangularia rugosa	GCs, GCd, GB, SMC, MC, DC, AC, FC	256-3850	B3 Y1.2
Bolivina albatrossi	GCs, GCd, GB, SMC, MC, DC, AC, FC	8-3237	B1, B2.1, B2.2 Y1.2, Y2.1, Y2.5
Cribromiliolinella subvalvularis	GCd, MC, AC	None	B3 Y2.2, Y2.3
Nonionella iridea	GCd, GB, SMC, MC, DC	None	B2.1 Y2.1
Globocassidulina subglobosa	GCs, GCd, GB, SMC, MC, DC, AC, FC	2-3850	B2.2 X1.2, Y2.4, Y2.5

GCs = Green Canyon shallow (245 m); GCd = Green Canyon deep (569-696 m); GB = Garden Banks (640 m); SMC = South of Mississippi Canyon (1076 m); MC = Mississippi Canyon (1067-1081 m); DC = De Soto Canyon (1848 m); AC = Alaminos Canyon (2219-2227 m); FC = Farnella Canyon (2918 m).

Table 3-7

Counts (N) and Cumulative Percentages (Agg. %) of Agglutinated Individuals in Samples, With Listing of Dominant Species (>5% of Agglutinated Assemblage)

SAMPLE NUMBER	WATER DEPTH (m)	SUBSTRATE	AGG. %	DOMINANT AGGLUTINANT	N
ACP01a	2226	White mud mound	0		0
ACP01b	2226	White mud mound	0		0
ACP04a	2227	White mud mound	3		6
ACP04b	2227	White mud mound	2		5
ACP05a	2225	Mud next to tubeworm clump	49	*Saccorhiza ramosa*	30
ACP05b	2225	Mud next to tubeworm clump	57	*Saccorhiza ramosa, Hyperammina* sp., *Portatrochammina antarctica*	41
ACP10a	2219	Orange bacterial mat with tubeworm roots	93		4
ACP10b	2219	Orange bacterial mat with tubeworm roots	0		0
ACP11a	2219	Mud next to mussel bed	38		2
ACP11b	2219	Mud next to mussel bed	0		0
ACP12a	2219	Mud next to mussel bed	100		1
ACP12b	2219	Mud next to mussel bed	100		3
ACP13a	2221	White, fluffy bacterial mat	3		1
ACP13b	2221	White, fluffy bacterial mat	0		0
ACP15a	2221	Orange bacterial mat	29	*Portatrochammina antarctica, Ammodiscus tenuis*	9
ACP15b	2221	Orange bacterial mat	25	*Portatrochammina antarctica*	4
ACB07a	2227	Gray bacterial mat with tubeworm roots	94	*Hyperammina* sp., *Ammodiscus tenuis, Portatrochammina antarctica*	8
ACB08a	2227	Gray bacterial mat	99	*Hyperammina* sp., *Ammodiscus tenuis, Portatrochammina antarctica*	13
ACB09a	2227	Fluffy bacterial mat	99	*Hyperammina* sp., *Portatrochammina antarctica*	7
ACB19a	2219	Non-seep gray mud	43	*Saccorhiza ramosa, Hyperammina* sp.	32
MCP02a	1067	Mud from ridge top, near mussel bed	27	*Prolixoplecta parvula, Trochamminoides coronatus, Portatrochammina antarctica, Hyperammina laevigata*	18
MCP02b	1067	Mud from ridge top, near mussel bed	11	*Prolixoplecta parvula, Trochamminoides coronatus*	16
MCP04a	1072	Gray bacterial mat	32	*Prolixoplecta parvula, Portatrochammina antarctica*	5
MCP04b	1072	Gray bacterial mat	66	*Hyperammina laevigata, Textularia* sp. *Portatrochammina antarctica*	9
MCP08a	1071	Gray bacterial mat	58	*Hyperammina* sp.	2
MCP08b	1071	Gray bacterial mat	1		1

Table 3-7. Counts (N) and Cumulative Percentages (Agg. %) of Agglutinated Individuals in Samples, With Listing of Dominant Species (>5% of Agglutinated Assemblage) (continued).

SAMPLE NUMBER	WATER DEPTH (m)	SUBSTRATE	AGG. %	DOMINANT AGGLUTINANT	N
MCP69a	1081	Bacterial mat	37	*Prolixoplecta parvula, Trochamminoides coronatus, Lagenammina difflugiformis, Portatrochammina antarctica, Hyperammina* sp.	21
MCP69b	1081	Bacterial mat	33	*Prolixoplecta parvula, Trochamminoides coronatus, Portatrochammina antarctica, Hyperammina* sp.	30
MCP73a	1070	Bacterial mat	7		6
MCP73b	1070	Bacterial mat	6		4
GCP33a	664	White bacterial mat	60	*Hyperammina* sp., *Prolixoplecta parvula, Portatrochammina antarctica, Hyperammina laevigata,* unidentified trochamminids	17
GCP33b	664	White bacterial mat	54	*Hyperammina* sp., *Hyperammina laevigata, Prolixoplecta parvula, Portatrochammina antarctica,* unidentified trochamminids	14
GCP51a	696	Bacterial mat on mound with clams	18	*Portatrochammina antarctica, Prolixoplecta parvula, Psammosphaera fusca, Discammina compressa*, unidentified trochamminids	11
GCP51b	696	Bacterial mat on mound with clams	8		9
GCP54a	675	White bacterial mat	49	*Prolixoplecta parvula, Hyperammina* sp., *Portatrochammina antarctica,* unidentified trochamminids	15
GCP54b	675	White bacterial mat	62	*Prolixoplecta parvula, Hyperammina* sp., *Portatrochammina antarctica,* unidentified trochamminids	19
GCP55a	689	Non-seep mud	29	*Hyperammina* sp., *Lagenammina tubulata, Haplophragmoides* sp. cf. *H. kirki, Saccorhiza ramosa,* unidentified trochamminids	30
GCP55b	689	Non-seep mud	21	*Lagenammina tubulata, Gaudryina minuta, Hyperammina* sp., *Hyperammina friabilis, Reophax guttifera*, unidentified trochamminids	30
GCP57a	675	Non-seep sand	20	*Lagenammina tubulata, Psammosphaera fusca, Rhizammina algaeformis, Hyperammina friabilis, Saccorhiza ramosa,* unidentified trochamminids	34

Table 3-7. Counts (N) and Cumulative Percentages (Agg. %) of Agglutinated Individuals in Samples, With Listing of Dominant Species (>5% of Agglutinated Assemblage) (continued).

SAMPLE NUMBER	WATER DEPTH (m)	SUBSTRATE	AGG. %	DOMINANT AGGLUTINANT	N
GCP57b	675	Non-seep sand	21	*Hyperammina friabilis*, *Gaudryina minuta*, *Lagenammina tubulata*, *Psammosphaera fusca*, *Hyperammina* sp., *Portatrochammina antarctica*, unidentified trochamminids	38
GCP12a	569	White bacterial mat	1		4
GCP12b	569	White bacterial mat	1		5
GBP08a	640	Non-seep gray mud	12	*Prolixoplecta parvula*	21
GBP08b	640	Non-seep gray mud	11	*Haplophragmoides* sp. cf. *H. kirki*	18
GCP15a	245	Non-seep gray mud	41	unidentified trochamminids *Lagenammina difflugiformis*, *Pseudogaudryina atlantica*, *Pseudoclavulina serventyi*, *Tetrataxiella* sp.	49
GCP15b	245	Non-seep gray mud	30	*Lagenammina difflugiformis*, *Tetrataxiella* sp., unidentified trochamminids	40
MCB-C7	1076	Non-seep	54	*Rhizammina indivisa*, *Lagenammina difflugiformis*, *Hyperammina friabilis*, *Lagenammina tubulata*, *Portatrochammina antarctica*, *Trochamminoides coronatus*	33
DCB-S36	1848	Non-seep	36	*Saccorhiza ramosa*, *Lagenammina tubulata*, *Trochamminoides coronatus*, *Usbekistania charoides*, *Reophax scorpiurus*, *Hyperammina friabilis*	50
FCP61	2918	Tubeworm clump	21	*Saccorhiza ramosa*, *Hyperammina* sp., *Martinottiella communis*	21

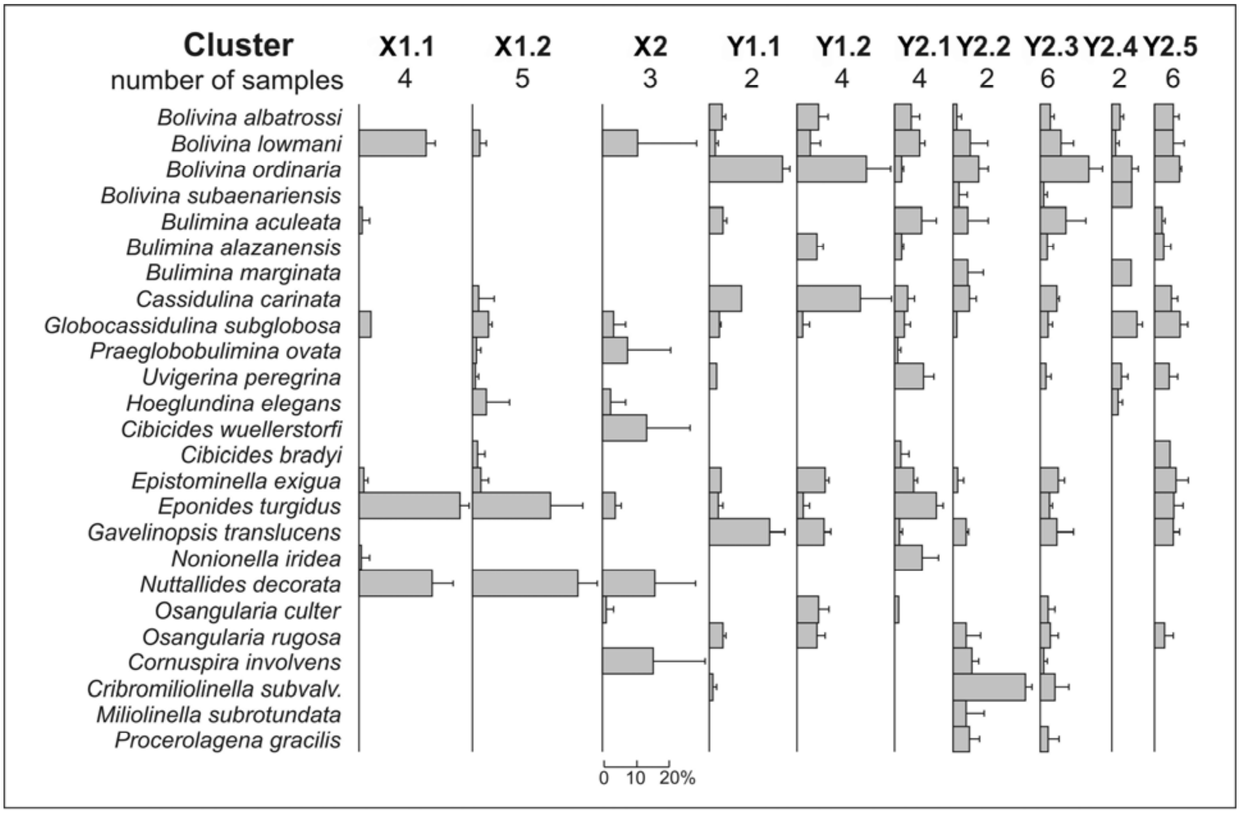

Figure 3.6. Relative abundances of the more important species in minor clusters, surface and near-surface samples.

Portatrochammina antarctica (all areas), *Ammodiscus tenuis* (Alaminos Canyon), and *Prolixoplecta parvula* (Green Canyon). As regards the other five samples of this group (>49% agglutinated), GCP54a and GCP54b are bacterial mat samples from Green Canyon in which *Prolixoplecta parvula* is dominant. *Saccorhiza ramosa* is dominant in non-seep samples (ACP05a, ACP05b) from Alaminos Canyon, and *Rhizammina indivisa* is dominant in a non-seep sample (MCB-C7) from south of Mississippi Canyon.

Saccorhiza ramosa is the dominant agglutinated species in non-seep, deepest-bathyal samples and *Portatrochammina antarctica* is dominant in deepest-bathyal bacterial mats. *Prolixoplecta parvula* is dominant in both bacterial mat and non-seep sites from bathyal Mississippi Canyon. *Portatrochammina antarctica* is important in most of these samples. Diverse agglutinated species, including several unidentified trochamminids, constitute a significant part of the assemblage in both shallow and deep Green Canyon samples. Other important species include *Portatrochammina antarctica*, *Lagenammina tubulata*, and *Hyperammina friabilis*.

Samples from bacterial mat substrates have a smaller number of agglutinated species than non-seep samples at comparable depths (Table 3-7). In Alaminos and De Soto Canyons, non-seep samples contain 30-50 agglutinated species, compared to 4-13 species in bacterial mats. Non-seep samples from Mississippi Canyon and south of Mississippi Canyon have 18-33 species, compared to 2-9 species in mats. Bacterial mat samples MCP69a (21 species) and MCP69b (30 species) will be discussed later. Non-seep Green Canyon samples have 30-49 agglutinated species, compared to 4-19 species in bacterial mat samples.

3.7. Diagenesis

Samples MCP73a, MCP73b, and MCP08b contain numerous shells of *Hyperammina* sp. that show overgrowths of barite or are infilled with barite rosettes (Appendix, Plate 84). Also, barite chimneys are known to be associated with hydrocarbon venting in Mississippi Canyon at 500 m water depth (Fu et al., 1994). Besides barite, the constituents of these chimneys include minor amounts of pyrite, iron oxide, Mg calcite, and detrital silicates. Our finding of barite rosettes cemented by iron oxide in shells of *Hyperammina* at an 1100 m deep site extends the water depth of barite formation in Mississippi Canyon by about 600 m.

Pyrite-filled shells of calcareous and agglutinated Foraminifera have been recovered from Alaminos Canyon cores. Figure 6, Plate 110 (Appendix) shows pyrite framboids infilling a calcareous *Nuttallides decorata* shell. The presence of pyrite is an indicator of anoxia in sediments, and pyritized foraminiferal shells have been found in diverse oxygen-deficient environments. Of particular relevance to our study, however, is the reported occurrence of pyrite framboids within shells of *Uvigerina peregrina* in cold-seep sediments of Monterey Bay, California (Stakes et al., 1999), attesting to anoxia and bacterial reduction of sulfate there, as is the case at Alaminos Canyon seep sites.

3.8. Stratigraphic Record

In order to investigate recent temporal variation in seepage intensity—as indicated by the foraminiferal assemblage—we examined species frequencies in death assemblages in multiple downcore samples from two Alaminos Canyon cores and one Mississipi Canyon core. For numerical analyses, we considered just the calcareous species that constitute at least 1% of the assemblage in one or more samples (Tables 3.8, 3.9, 3.10). The Alaminos Canyon cores, ACP05 and ACP15, were from adjacent locations and similar water depths (about 2220 m); the Mississippi Canyon core, MCP73, was from a depth of 1070 m (see Table 1.1 for coordinates). Twenty-two species or congeneric species groups (identified at generic level) provided the data for ACP05 and ACP15, whereas the MCP73 data came from 13 such taxa.

Alaminos Canyon core ACP05. This core was taken through the sediment next to a tubeworm bush. The top five samples (each 1-cm thick) were examined. Taken separately, the stratigraphic trends in the relative abundances (percentages) of most species seem erratic, but two major species, *Bolivina lowmani* and *Nuttallides decorata*, show a definite unidirectional change. *B. lowmani*, an endobenthic species, putatively more tolerant to sulfide emission and seepage-related dysoxia, shows a marked upcore increase between 5 and 2 cm. In contrast, *N. decorata*, an epibenthic species that dominates samples of non-seep clusters, and is possibly less tolerant of seepage effects, shows a sharp upcore decrease between 5 and 3 cm (Fig. 3.7). A Q-mode cluster analysis of the assemblage data (Table 3-8) corroborates this change. Two major clusters are present; one with the three uppermost samples, the other with the two samples farther down (Fig. 3.8). We surmise that a higher level of seep gases is reflected in the assemblage composition in the top 3 cm of the core.

Alaminos Canyon core ACP15. This core was taken through a bacterial mat at the sediment-water interface. All 1-cm samples were examined from the core top down to 13 cm. The variations in abundances of three species, in all but the surface (0-1 cm) sample, are shown in Fig. 3.9. The surface sample is anomalous, because it contains just one calcareous species, *Cornuspira involvens*, which disappears below the 3-cm level in the core. The abundance of the endobenbenthic species *Bolivina lowmani* stays between 4 and 11% from 13 to 7 cm, and then rises steeply and linearly to 39% at 3 cm, undergoing a small decrease in the next 2 cm. The abundance of *Epistominella exigua* (also endobenthic) attains a high of 14% in the 4-5 cm sample, but is <6% in all other samples. The trend of the epibenthic *Nuttallides decorata* is clearly opposed to that of *B. lowmani*; it shows a decline from 13 cm (30%) to 7 cm (7%). The cluster diagram (Fig. 3.10) shows two main clusters, each with very similar samples (at small Euclidean distances). One cluster consists of the 1-2 and 2-3 cm samples; the other includes the rest, except an outlier (the 0-1 cm sample). We infer an increase of seepage in the time interval represented by the 3-7 cm segment of the core.

Mississippi Canyon core MCP73. The surface sediment at the coring site was black, with an orange bacterial mat on top. Seven selected samples—a continuous series from 0 to 5 cm, and the 6-7 and 14-15 cm samples—were examined for Foraminifera. Percentage plots for *Cassidulina carinata* (endobenthic) and *Osangularia culter* (epibenthic) are shown in Fig. 3.11. The distributions do not show any conspicuous trends, possibly because of sampling gaps. However, the lowest abundance of *C. carinata* (5%) and the greatest abundance of *O. culter* (20%) are in the oldest sample (14-15 cm); younger sediments may have been deposited under conditions of increased seepage. The cluster diagram (Fig. 3.12) does not show clusters of contiguous samples; the 14-15 cm sample is an outlier.

Table 3-8

Core ACP05, Alaminos Canyon (*Alvin* Dive 3624):
Percentages of Calcareous Species That Constitute at Least 1% of the Assemblage in One or More Samples.

	SAMPLE				
	0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm
SPLIT EXAMINED	1	1	1/4	1/4	1/4
TOTAL CALCAREOUS SPECIMENS	261	1056	226	218	328
SPECIES	PERCENTAGES				
Bolivina lowmani	22.6	23.5	21.7	18.8	12.5
Eponides turgidus	31.0	27.6	25.7	20.2	25.6
Globocassidulina subglobosa	3.5	3.8	4.9	2.8	1.8
Gyroidina orbicularis	1.5	0.8	2.2	4.1	1.2
Nuttallides decorata	26.8	24.9	25.2	30.3	36.6
Quinqueloculina spp.	1.5	1.6	2.7	0.9	0.3

Table 3-9

Core ACP15, Alaminos Canyon (*Alvin* Dive 3625): Percentages of Calcareous Species That Constitute at Least 1% of the Assemblage in One or More Samples.

	SAMPLE												
	0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	5-6 cm	6-7 cm	7-8 cm	8-9 cm	9-10 cm	10-11 cm	11-12 cm	12-13 cm
SPLIT EXAMINED	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL CALCAREOUS SPECIMENS	183	44	32	18	7	28	74	133	140	231	227	268	220
SPECIES	PERCENTAGES												
Cornuspira involvens	100	31.8	18.8	0	0	0	0	0	0	0	0	0	0
Epistominella exigua	0	0	0	5.6	14.3	0	5.4	3.8	2.9	3	1.3	2.6	0
Epistominella sp.	0	0	12.5	0	0	0	0	0	0	0	0	0	0
Eponides sp. cf. *E. regularis*	0	0	0	0	0	0	0	0.8	0	0.4	0.9	0.8	2.3
Eponides turgidus	0	2.3	3.1	5.6	0	28.6	32.4	11.3	29.3	32	30.4	28	16.8
Fissurina spp.	0	0	0	0	0	3.6	1.4	2.3	1.4	2.2	2.2	1.1	0.9
Gyroidina orbicularis	0	0	0	0	0	0	1.4	3.8	0.7	2.6	1.3	0.4	1.4
Hoeglundina elegans	0	0	0	0	14.3	17.9	9.5	12	8.6	4.8	9.3	7.1	9.1
Lagena hispidula	0	0	0	0	0	0	4.1	0	0	0	0	0.4	0
?*Lagena* spp.	0	0	0	0	0	3.6	1.4	1.5	0.7	0.9	0.9	0.4	1.8
Neoconorbina terquemi	0	0	3.1	0	0	0	0	0	0	0	0.4	0	0
Nonion sp.	0	22.7	21.9	16.7	28.6	0	0	0	0	0.4	0	0	0
Nonionellina sp.	0	0	3.1	0	0	0	1.4	0	0	0	0	0.4	0.5
Nuttallides decorata	0	9.1	3.1	0	0	10.7	6.8	21.8	17.9	21.2	18.9	25.4	30
Oridosalis umbonatus	0	0	0	5.6	14.3	3.6	0	3	0	1.3	0.9	0.8	1.4
Osangularia culter	0	0	0	0	0	3.6	2.7	1.5	4.3	0.9	5.3	2.2	2.7
Parafissurina kerguelenensis	0	0	0	0	0	3.6	0	1.5	0.7	0.4	0	0	0
Pullenia quinqueloba	0	0	0	5.6	0	3.6	10.8	4.5	2.9	6.5	4.4	2.2	4.1
Quinqueloculina spp.	0	0	0	0	0	0	1.4	3	1.4	1.7	0.4	0.8	0.5
Siphonodosaria calomorpha	0	0	0	0	0	3.6	0	0	0.7	0.9	0	0.4	0

Table 3-10

Core MCP73, Mississippi Canyon (*Alvin* Dive 3631): Percentages of Calcareous Species That Constitute at Least 1% of the Assemblage in One or More Samples.

	SAMPLE						
	0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	6-7 cm	14-15 cm
SPLIT EXAMINED	1/8	1/16	1/16	1/16	1/8	1/4	3/16
TOTAL CALCAREOUS SPECIMENS	133	90	80	86	103	75	121
SPECIES	PERCENTAGES						
Bolivina albatrossi	3.76	4.44	2.5	6.98	0.97	2.67	7.44
Bolivina lowmani	8.27	4.44	8.75	5.81	8.74	10.67	7.44
Bolivina ordinaria	13.53	25.56	30	20.93	31.07	17.33	22.31
Bulimina alazanensis	5.26	7.78	2.5	10.47	0.97	1.33	5.79
Bulimina mexicana	0.75	0	0	0	0	2.67	0
Cassidulina carinata	24.06	13.33	21.25	20.93	19.42	22.67	4.96
Globocassidulina subglobosa	4.511	2.22	2.5	1.16	3.88	1.33	2.48
Epistominella exigua	7.52	8.89	10	4.65	7.77	12	13.22
Eponides turgidus	0.75	4.44	0	1.163	0.97	0	0.83
Gavelinopsis translucens	9.023	8.89	7.5	4.65	4.85	1.33	4.96
Osangularia culter	9.77	8.89	3.75	5.814	5.83	14.67	19.83
Osangularia rugosa	7.52	4.44	2.5	5.81	4.85	4	2.48
Quinqueloculina spp.	0	2.22	2.5	0	0	0	0

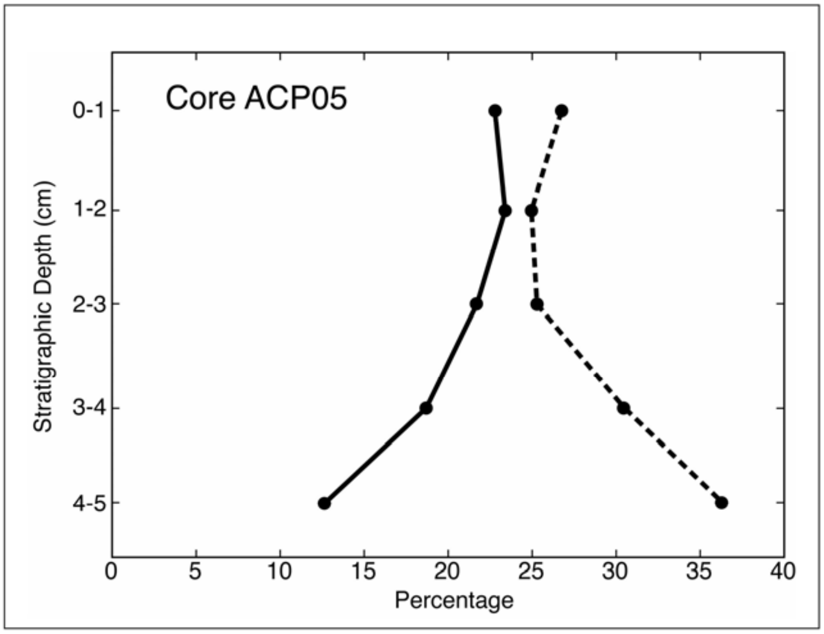

Figure 3.7. Abundance variations of *Bolivina lowmani* (solid line) and *Nuttallides decorata* (dashed line) in Alaminos Canyon core ACP05.

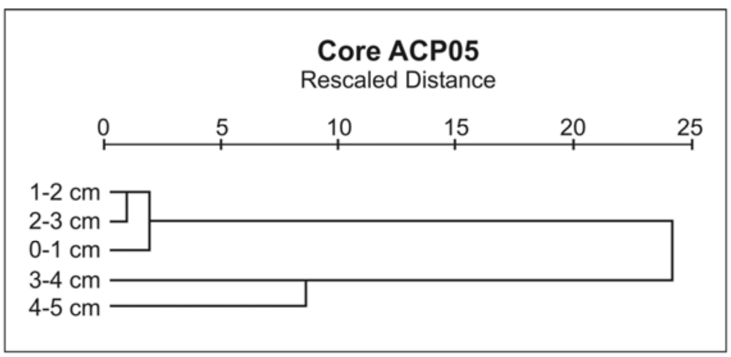

Figure 3.8. Q-mode cluster diagram (Ward's method) for stratigraphic data, Alaminos Canyon core ACP05.

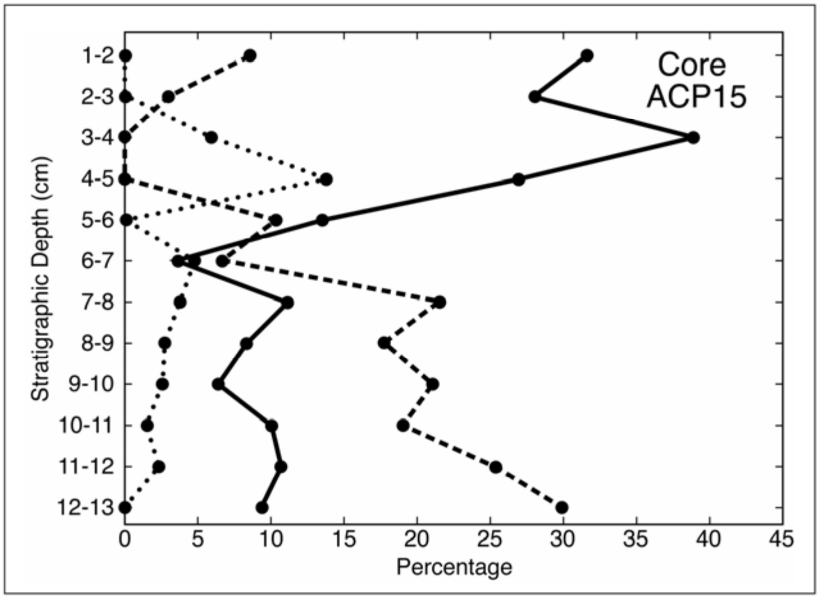

Figure 3.9. Abundance variations of *Bolivina lowmani* (solid line), *Epistominella exigua* (dotted line) and *Nuttallides decorata* (dashed line) in Alaminos Canyon core ACP15.

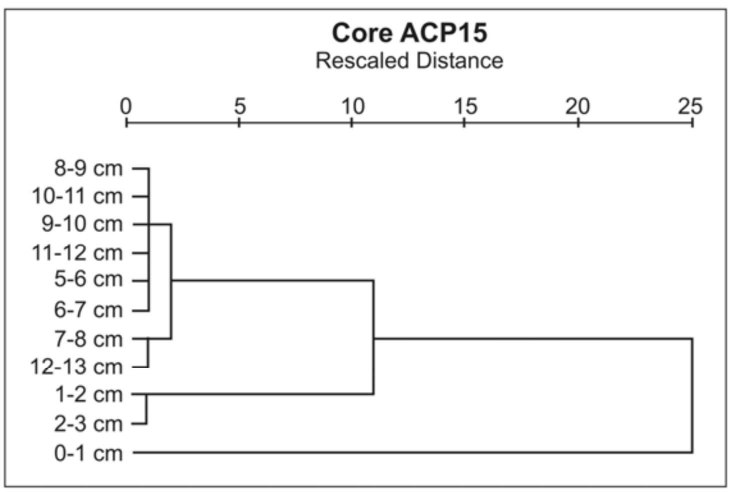

Figure 3.10. Q-mode cluster diagram (Ward's method) for stratigraphic data, Alaminos Canyon core ACP15.

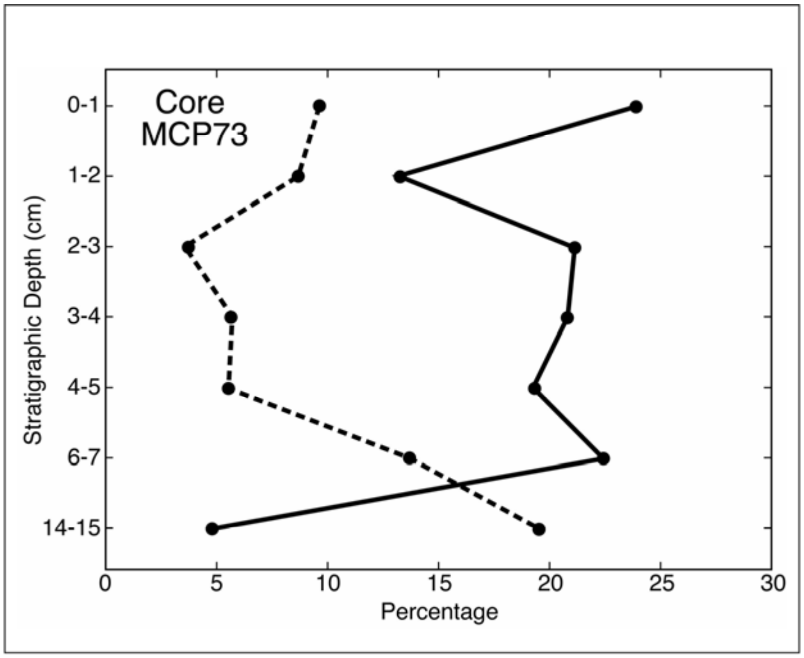

Figure 3.11. Abundance variations of *Cassidulina carinata* (solid line) and *Osangularia culter* (dashed line) in Mississippi Canyon core MCP73.

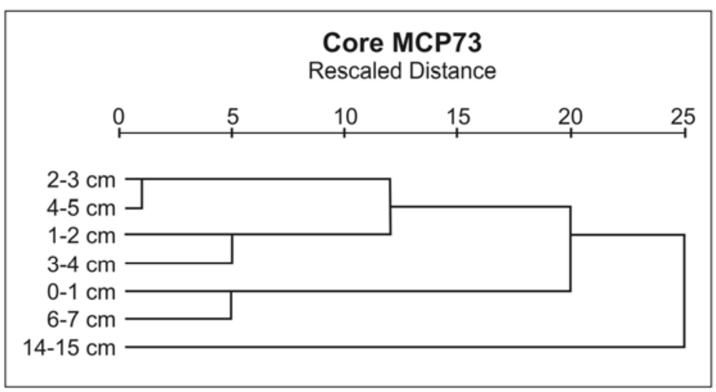

Figure 3.12. Q-mode cluster diagram (Ward's method) for stratigraphic data, Mississippi Canyon core MCP73.

4. FORAMINIFERA IN TUBEWORM SAMPLES

[Note: Much of this chapter has been published as an article (Sen Gupta et al., 2007) in *Marine Micropaleontology*, an Elsevier journal (copyright 2006). Excerpts are included here and in Chapter 5, and species illustrations in the Atlas (Appendix), with permission from Elsevier.]

4.1. Introduction

Overall, many endobenthic species, in the Gulf of Mexico and elsewhere, are known to be adapted to the typical environmental constraints of cold-seep seafloor (Akimoto et al., 1994; Sen Gupta and Aharon, 1994; Sen Gupta et al., 1997; Rathburn et al., 2000, 2003; Bernhard et al., 2001; Hill et al., 2003; Robinson et al., 2004; Heinz et al., 2005; Panieri, 2005), but the presence of certain epibenthic species (e.g., *Cibicides* spp.) has remained perplexing, because these species are generally known to be restricted to oxic waters (e.g., Kaiho, 1994). To test the hypothesis that such species may actually live in oxic microhabitats very close to points of seepage, we examined surfaces of vestimentiferan tubeworms (*Escarpia laminata* and *Lamellibrachia luymesi*). These tubeworms were retrieved from three seepage areas during dives of the submersible *Alvin* in Alaminos Canyon (depth 2225 m) in 2000 (labeled LS in Table 4-1, collected by Lorene Smith) and those of the submersible *Johnson Sea-Link* in Mississippi Canyon (620 m) and Green Canyon (562 m) in 2002 (labeled EC and MC in Table 4-1, collected by Erik Cordes, Pennsylvania State University).

4.2. Tubeworm Foraminifera

The identified foraminiferal species are named in Table 4-1; all three major groups of Foraminifera (hyaline, porcelaneous, and agglutinated) are represented by these 15 species. They are illustrated, mostly in life positions, in the plates of the Atlas (Appendix); the plate references are given in Table 4-1. Judging by the edges of the shells as seen in electron micrographs, the species are attached by protoplasm or by organic adhesive, and not by mineral cement or special shell extensions (see Poag, 1982). Although the tubeworms are endemic to cold seeps, none of the identified Foraminifera are endemic to either the seeps or the Gulf of Mexico.

These foraminiferal species attached to seep tubeworms generally conform to their known water-depth limits in non-seep areas of the Gulf of Mexico (Sen Gupta et al., in press). The thin-walled *Calcituba polymorpha* (Appendix, Plate 32) is a striking exception. It has been previously reported only from a depth of about 1 m in the gulf, but we find it on a tubeworm at 562 m. We ascribe this discrepancy to the poor record of the species in sediments due to the "extreme fragility" of its shell (Arnold, 1967), and to a dearth of observations on attached Foraminifera beyond shelf depths.

Microhabitat considerations. The escape of methane and sulfide in Gulf of Mexico cold seeps is localized and episodic (Roberts and Carney, 1997). Although vestimentiferan tubeworms such as *Lamellibrachia* and *Escarpia* need sulfide for sustenance, their presence or growth does not imply escape of H_2S from the seafloor. At the first stage of colony formation, the settlement and aggregation of vestimentiferans depend on sulfide emission at the sediment-water interface, but at later stages, as H_2S in seafloor water is reduced, the colony growth is maintained by the tapping of H_2S from sediment pore water by downward-extending vestimentiferan roots (Julian et al., 1999; Freytag et al., 2001; Bergquist et al., 2003). For much of the time during which tubeworms grow, the water above the base is oxic and almost sulfide-free, thus providing an environment in which many epibenthic foraminifers can settle on tubeworm surfaces. One of these taxa, *Cornuspira involvens* (Appendix, Plate 48), is known to exist as an endobenthic species in a non-seep muddy substrate from 0 to 2 cm, but 2-3 cm above the redox boundary (Murray, 2003). Apparently, it is opportunistically sessile on vestimentiferan tubes.

Our surface-sediment samples from the base of Gulf of Mexico tubeworm bushes contain shells of some species reported here. One of these samples (FCP61), from a locality in Farnella Canyon, contains an unusual assemblage of calcareous Foraminifera. Among the 53 species of this group, *Praeglobobulimina ovata*, an endobenthic species known to live in H_2S-containing seep sediments (Robinson et al., 2004), is dominant (23%), but *Cibicides wuellerstorfi* (14%) ranks second. This admixture shows that a confusing environmental signal can be introduced in the foraminiferal thanatocoenose of cold-seep sediments simply by post-mortem dislodgment of attached species from elevated microhabitats (which were not affected by seep gases), even without sediment movement by bottom currents.

Table 4-1

Foraminifera Attached to Vestimentiferan Tubeworms

FORAMINIFERAL SPECIES (with atlas plate numbers)	SITE		
	Alaminos Canyon	Mississippi Canyon	Green Canyon
	VESTIMENTIFERAN SPECIES (with specimen numbers and heights of tubes)		
	Escarpia laminata (8 tubes, LS1-8, 19-37 cm)	*Lamellibrachia luymesi* (6 tubes; EC1, 26 cm; MC1-5, 18-32 cm)	*L. luymesi* (4 tubes, EC2-5, 14-24 cm)
(1) CALCAREOUS PERFORATE (HYALINE) GROUP			
Anomalinoides globulosus (Chapman & Parr), Plate 10			T
Cibicides wuellerstorfi (Schwager), Plate 41	x		
Cibicidoides pachyderma (Rzehak), Plate 43	x	x	x
Discanomalina semipunctata (Bailey), Plates 55, 56		T	
Laminononion tumidum (Cushman & Edwards), Plate 95		x	x
Patellina corrugata Williamson, Plate 125		x	x
Planulina ariminensis d'Orbigny, Plates 128, 129		x	x
Spirillina vivipara Ehrenberg, Plates 168, 169		T	
(2) CALCAREOUS IMPERFORATE (PORCELANEOUS) GROUP			
Calcituba polymorpha von Roboz, Plate 32			T
Cornuspira foliacea (Philippi), Plate 46	TM		
Cornuspira involvens (Reuss), Plate 48	x		x
Miliolinella sp., Plate 106		x	x
(3) AGGLUTINATED GROUP			
Ammoscalaria tenuimargo (Brady), Plate 7	T		
Deuterammina rotaliformis (Heron-Allen & Earland), Plate 53		T	T
Veleroninoides jeffreysii (Williamson), Plate 192		T	

T = only attached to tubeworms, not present in examined seep sediments; M = attached to mussels.

5. DISCUSSION AND CONCLUSIONS

5.1. Dominant Calcareous Species

One hundred seventeen species of calcareous Foraminifera were present in surface or near-surface sediment samples from seep and non-seep (control) sites. Of these, 54 species constituted 2% or more of the assemblage in one or more samples. The distributions of several dominant or common species provide clues to their tolerance to environmental stresses of seep microhabitats.

Bolivina ordinaria, *Cassidulina carinata*, *Gavelinopsis translucens*, *Osangularia rugosa*, and *Bolivina albatrossi* are important in the shallower-bathyal clusters of B and Y. All of these species have been reported as living under *Beggiatoa* mats in Green Canyon and have been considered to be tolerant of anoxia and sulfide toxicity (Sen Gupta et al., 1997). In the present study, Rose-Bengal-stained individuals of these five species were not common and were not restricted to bacterial mat samples. Stained specimens of *Bolivina ordinaria* were found in bacterial mat samples from Mississippi Canyon (MCP04b) and Green Canyon (GCP54a), and stained specimens of *Osangularia rugosa* were found in bacterial mat samples from Mississippi Canyon (MCP08a and MCP08b). Stained individuals of *Bolivina albatrossi* were found in non-seep samples from Mississippi Canyon (MCP02b) and Green Canyon (GCP55a and GCP57a). (It is possible that some sites recorded as "non-seep" during seafloor observations were close to points of seepage and the substrate actually contained seep fluids.) Stained individuals of *Gavelinopsis translucens* and *Cassidulina carinata* were found in both bacterial mat and non-seep samples from Mississippi and Green Canyons. *Bolivina ordinaria* is the most abundant of the five species. It is present in all minor clusters and is the dominant species in many. The other four species are important in many of the minor clusters but are never dominant. *Cassidulina carinata* is present in every minor cluster of B and Y and is important in many. *Gavelinopsis translucens* and *Bolivina albatrossi* are important in most minor clusters.

Bolivina ordinaria is the dominant species in minor clusters B1, B2.2, Y1.1, Y1.2, and Y2.3. Besides the four associates of *B. ordinaria* mentioned above, *Globocassidulina subglobosa*, *Epistominella exigua*, *Bolivina lowmani*, and *Uvigerina peregrina* are important in these clusters. All of these species, except *Bolivina lowmani*, have been previously identified as living under *Beggiatoa* mats (Sen Gupta et al., 1997). *Globocassidulina subglobosa* has also been recorded as abundant in seep samples from the Gulf of Mexico (Sen Gupta and Aharon, 1994; Sen Gupta et al., 1997; Robinson et al., 2004) and the Rockall Trough (Panieri, 2005). It is generally known to be abundant in organic-rich, oxygen-depleted sediments (Sen Gupta and Machain-Castillo, 1993). In our study, however, Rose-Bengal-stained specimens of *Globocassidulina subglobosa* were found only in processed non-seep samples from Alaminos and Green Canyons (ACB19a, GCP55a, and GCP57a). *Uvigerina peregrina*, a worldwide deep-sea species, has also been recorded as living in severely oxygen-depleted environments (Bernhard and Sen Gupta, 1999), such as the Pacific margin of El Salvador (Smith, 1964), Sagami Bay, Japan (Ohga and Kitazato, 1997), northern Arabian Sea (Jannink et al., 1998), and California margin (Bernhard, 1992; Rathburn et al., 2000; Rathburn et al., 2003).

Bolivina ordinaria is important, but not dominant, in minor clusters B3, Y2.2, Y2.4, and Y2.5; Y2.4 also contains *Bolivina subaenariensis* and *Bulimina marginata*. *Bolivina subaenariensis* has been previously recorded as abundant under bacterial mats of Green Canyon (Sen Gupta and Aharon, 1994) and also in an oxygen-deprived upwelling region on the Florida Atlantic slope (Sen Gupta et al., 1981). *Bulimina marginata* was observed in shallow-water oxygen-depleted samples from Drammensfjord, Norway (Alve, 1990; 1995a; Bernhard and Alve, 1996). In our study seven Rose-Bengal-stained specimens of *Bulimina marginata* were identified from the bacterial mat sample GCP54a.

5.2. Agglutinated Species

Of the 14 samples that contained >49% agglutinated Foraminifera, 10 were from seep sites. *Hyperammina* is dominant in all but two of these. *Ammodiscus tenuis* is an important species, behind *Hyperammina* sp., in bacterial mat samples from Alaminos Canyon. In non-seep samples, *Hyperammina* and *Saccorhiza* dominate. These large tubular Foraminifera are generally considered to be fast growing and opportunistic, and are probably able to tolerate some degree of oxygen depletion (Gooday et al., 1997). However, Rose-Bengal-stained specimens of *Hyperammina* sp. are found in both seep and non-seep samples, while stained specimens of *Saccorhiza ramosa* are limited to non-seep samples. Apparently, *Hyperammina* sp. is more tolerant of anoxia than *Saccorhiza ramosa*. In Misissippi Canyon, shells of *Hyperammina* sp. may be encrusted or infilled with barite; formation of authigenic barite here indicates hydrocarbon venting (Fu et al., 1994).

Portatrochammina antarctica is the dominant agglutinated species in samples ACP15a and ACP15b; 65% of the specimens in ACP15a caught the Rose Bengal stain. *Portatrochammina antarctica* is likely to be epifaunal, because this mode of life is characteristic of many trochospiral agglutinated Foraminifera (Gooday, 1990; Mackensen and Douglas, 1989; Jones and Charnock, 1985).

Two seep samples, GCP54a and GCP54b, contain >49% agglutinated Foraminifera, but the dominant species is *Prolixoplecta parvula*, not *Hyperammina* sp. This species is also dominant in several Mississippi Canyon samples (including MCP04a, a seep sample) that contain 15-49% agglutinated individuals. Non-seep samples from Green Canyon have diverse assemblages, and include species of the genera *Hyperammina*, *Lagenammina*, *Saccorhiza*, and *Reophax*.

5.3. Species Diversity

Mississippi Canyon samples in non-seep minor cluster Y2.1 have more calcareous species (38-57) than seep samples from this area (16-37). Green Canyon non-seep samples also have higher numbers of calcareous species (46, 60-112), compared to bacterial mat samples (27-53). This distinction is not as clear with the deepest-bathyal samples. Calcareous species richness is highly variable in samples from Alaminos, Farnella, and De Soto Canyons. Sample ACP05a in non-seep minor cluster X1.1 has 30 calcareous species, whereas the other samples in this cluster have 55-73 species. Samples ACP04a and ACP04b, in minor cluster X1.2 (probably non-seep), have 72 and 47 calcareous species, respectively, but other samples in X1.2 have 16-32 species. In seep minor cluster X2, sample FCP61a contains 53 calcareous species, whereas the other two samples have 6-9 species. ACP15a, the only sample in X3, has just one calcareous species. Except for

ACPO4a and ACP05a, the number of calcareous species (55-73) in minor cluster X1.1 is higher than in X1.2, X2, and X3 (1-53).

The agglutinated species richness may be a more reliable indicator of seepage. Alaminos Canyon samples in non-seep minor cluster X1.1 have 30-41 species of agglutinated Foraminifera, whereas those in seep cluster X2 have 4-8; the outlier seep sample ACP15a has 9. Non-seep samples from Mississippi Canyon minor cluster Y2.1 have 16-33 agglutinated species, compared to 1-9 species in seep clusters Y1.2 and Y2.3. Green Canyon samples in seep clusters Y1.1, Y2.2, and Y2.3 have 4-19 agglutinated species, whereas those in non-seep Y2.4 and Y2.5 have 30-49 species.

There is evidence that species richness in some samples may be elevated by post-mortem mixing of species from different microhabitats. This problem will be discussed later in this chapter.

5.4. Absence of Endemics

Data from the present study and all previous reports (Sen Gupta and Aharon, 1994; Sen Gupta et al., 1997; Robinson et al., 2004) demonstrate that foraminiferal species from various microhabitats of Gulf of Mexico hydrocarbon seeps are not exotic taxa, but recruits from the seep-free surrounding area. A similar conclusion is reached when species lists from other cold seeps are examined (Akimoto et al., 1994; Rathburn et al., 2000, 2003; Bernhard et al., 2001; Torres et al., 2003; Hill et al., 2003; Panieri, 2003, 2005, 2006; Levin, 2005). Thus, unlike the macrofauna (annelids, molluscs), no identified foraminiferal taxa are endemic to cold seeps. In our present data set, no species identified from the non-seep De Soto Canyon sample (DCB-S36) is restricted to that control sample. Twenty-one species found in seep-associated microhabitats in this study were previously unknown from the Gulf of Mexico, but they have been reported from non-seep areas in other marine basins.

5.5. Substrate Effect

A major aspect of macrofaunal distribution at Gulf of Mexico seeps (mussel beds versus tubeworm clusters) is related to geochemical differences in the environment, because of the physiological dependence of seep mussels (*Bathymodiolus* sp.) on methane (e.g., Childress et al., 1986) and that of tubeworms (*Lamellibrachia* sp., *Escarpia* sp.) on hydrogen sulfide (e.g., Brooks et al., 1987). These relationships are reflected in the areal separations of these two types of macrofauna in the Bush Hill area (Green Canyon, MMS Block 184/185). MacDonald et al. (1989) found a significant correlation ($p<0.05$) here between (a) the ranked abundance of mussels and the concentration of methane in water samples and (b) the ranked abundance of tubeworms and the concentration of extractable organic material (related to sulfide level) in sediment samples. A comparable pattern has been reported for three foraminiferal species, *Rutherfordoides cornuta*, *Nonionella auris*, and *Bulimina striata*, living at Pacific seeps (but not at Gulf of Mexico seeps). Apparently, the distributions of the first two species are related to high CH_4 in the sediment, and that of the third species to high H_2S content (Akimoto et al., 1994; Wefer et al., 1994). Our seep samples are mainly from under bacterial mats, but the set also includes a few samples from muddy sediment adjacent to mussel beds or tubeworm bushes.

However, we found no evidence of any significant difference between the foraminiferal communities of these substrates.

5.6. Trophic Resources

For foraminiferal species that are able to survive the geochemical constraints of seep environments, the available food is abundant. Besides particulate food matter in the water and sediment, the bacterial productivity is generally orders of magnitude greater around hydrocarbon seeps than in non-seep marine environments (Ducklow and Carlson, 1992). Known values of bacterial biomass from Green Canyon seeps fit this pattern. Daily production can be as high as 18 g C m^{-3} (Hyun, 1994), and microbial doubling time in the seep water column can be as fast as about an hour, thus creating a major effect on the carbon resource of the entire benthic community (LaRock et al., 1994). In addition, the formation of large bacterial aggregates from individual cells possibly makes it easier for the seep community of the Louisiana slope to utilize the bacterial food (Hyun et al., 1997).

5.7. Effect of Oil in the Environment

One potential source of stress for the Foraminifera in hydrocarbon seeps is the liquid petroleum present in bottom water and sediments. In our previous studies (essentially on bacterial mats), we could not detect any effect of these natural pollutants on the structure of the foraminiferal community (Sen Gupta et al., 1997). Samples with an extraordinary amount of oil were not barren of Foraminifera, and did not contain deformed individuals, as reported for a gigantic oil spill from a tanker (Vénec Péyre, 1981), or for environments polluted with heavy metals (e.g., Alve, 1995b; Yanko et al., 1999). The present study led to the same conclusion. Also, the influence of petroleum pollution on foraminiferal communities is reported to be minor or undetectable in habitats near Louisiana offshore drilling platforms (Lockin and Maddocks, 1982) and in the North Sea (Murray, 1985). As regards non-foraminiferal meiofauna, a community survives in a shallow-marine petroleum seep off California, because the "stressful effects....are more than offset by dynamic trophic processes associated with the fringes of spots of active seepage" (Montagna and Spies, 1985). Furthermore, laboratory experiments on metazoan meiofauna indicate an adaptation to increased levels of petroleum hydrocarbons, if the natural environment of the community is one of chronic contamination by such chemicals (Carman et al., 1995).

5.8. Bathymetric Imprint

Like other marine benthos, seafloor foraminiferal communities show conspicuous patterns of depth segregation in virtually all marine basins. As demonstrated by numerous studies, the Gulf of Mexico is no exception (see, e.g., Phleger, 1960). This bathymetric imprint, caused by a not-fully-understood combination of many factors, is also observed in the assemblages described in this report. Regardless of whether the constituent samples are from seep or non-seep substrates, the two major clusters produced by either cluster analysis are partitioned by bathymetry. Both clusters A (just surface samples) and X (surface and near-surface) include all samples from 1848 to 2918 m, whereas clusters B (surface) and Y (surface and near-surface) include all samples from 245 to 1081 m. The separation between seep and non-seep samples is seen only in minor clusters.

Overall, the depth distributions of sediment-dwelling species in our samples do not show any marked departure from the known depths of their occurrence in the Gulf of Mexico (Sen Gupta et al., in press), although our findings have extended these known depth ranges in some cases. Epibenthic Foraminifera of seep tubeworms also conform to their known water-depth limits in non-seep areas, but the thin-walled porcelaneous species *Calcituba polymorpha* (Appendix, Plate 32) provides a striking exception. It has been previously reported only from a depth of about 1 m in the gulf, but we find it on a tubeworm at 562 m. We ascribe this discrepancy to the poor record of the species in sediments due to the "extreme fragility" of its shell (Arnold, 1967), and to a dearth of observations on attached Foraminifera beyond shelf depths (Sen Gupta, et al., 2007).

5.9. Tolerance of Anoxia and Sulfide

Environment of bacterial (*Beggiatoa*) mats. *Beggiatoa* is a large, chemolithotrophic, sulfide-oxidizing bacterium. Many samples of the sediment under mats of *Beggiatoa* were examined in this and earlier investigations of Gulf of Mexico seep Foraminifera. A critical oxic-anoxic boundary zone is present within the mats, with H_2S present in the underlying sediment (because of sulfate-reducing bacteria), but O_2 in overlying water (e.g., Jørgensen, 1977; Spies and Davis, 1979; Larkin and Strohl, 1983). In laboratory experiments, the disappearance of O_2 and appearance of H_2S have been detected within *Beggiatoa* mats that were a fraction of a millimeter in thickness (e.g., Jørgensen, 1977, 1982; Jørgensen and Revsbech, 1983; Nelson et al., 1986). In the Gulf of Mexico, the larger *Beggiatoa* mats may be several meters wide (Sassen et al., 1993), but even the easily recognizable (i.e., apparently well established) mats are no more than a few mm thick, and frequently less than one mm thick. The exceptions are the network-like *Beggiatoa* mats that follow fissures in hard ground, and are 1 mm to 3 cm thick (Larkin et al., 1994). None of our samples, however, were from this type of mat; they were all obtained from round patches of mats (1-2 m across) overlying a mud substrate. We surmise that in our studied cores, an oxic-anoxic boundary zone was present within about 1 mm from the core top, and Foraminifera living below this sediment depth are microaerophiles or facultative anaerobes. In a previous study (Sen Gupta et al., 1997), a few living individuals were found at a substrate depth of about 3 cm, where the sediment was black and the pore fluid sulfidic. Preliminary carbon isotope data, however, have not resolved the question whether species of Foraminifera invading the anoxic layers under *Beggiatoa* mats can construct tests in these microhabitats (Sen Gupta and Aharon, 1994; Sen Gupta et al., 1997).

From the vertical distribution of living (Rose-Bengal-stained) individuals of foraminiferal species in sediment under Green Canyon *Beggiatoa* mats, Sen Gupta et al. (1997) concluded that several species, including *Bolivina albatrossi, B. ordinaria, Cassidulina carinata,* and *Gavelinopsis translucens,* are facultative anaerobes. Several minor sample clusters recognized in the present study (B1, B2.2, Y1.1, Y1.2, and Y2.3) are dominated by these species, especially by *Bolivina ordinaria*; these are regarded as seep clusters. Overall, species of *Bolivina* are common in areas with dysoxic/anoxic conditions and high food supply (Bernhard et al., 1997; Bernhard and Reimers, 1991; Panieri, 2006), and this adaptation is reflected in their distribution at and around seeps.

In contrast, *Nuttalides decorata* and *Eponides turgidus*, common in waters deeper than 1200 m in the Gulf of Mexico (Phleger and Parker, 1951), are generally rare or absent at seep locations. All Rose-Bengal-stained specimens of these species are from non-seep samples, except for one specimen of *E. turgidus* in the bacterial mat sample GCP51a and one of *N. decorata* in the bacterial mat sample ACB08a. Together, these two species constitute >50% of the assemblage in minor clusters A1 and X1 which we interpret as non-seep clusters (although two samples in X1.2 were collected from white bacterial mats). The control sample from De Soto Canyon, DCB-S36, is a component of both clusters. Because of post-mortem mixing of foraminiferal shells, however, a relatively high abundance of these species in a sediment sample does not necessarily indicate absence of seepage. Minor clusters B2.1 and Y2.1, containing both seep and non-seep samples, have dominant *Eponides turgidus* (14% in B2.1 and 13% in Y2.1). The species *Nonionella iridea* is also important in these minor clusters (10% in B2.1 and 8% in Y2.1). Other important species in these minor clusters include the anoxia/dysoxia tolerant *Uvigerina peregrina*, *Bulimina aculeata*, *Epistominella exigua*, and *Bolivina albatrossi*. *Nonionella iridea* has not been previously recorded from the Gulf of Mexico, but other species of *Nonionella* have been listed as common in oxygen-depleted environments (Bernhard and Sen Gupta, 1999), including *N. stella*, which was abundant in samples from the Santa Barbara Basin, California (Bernhard et al., 1997) and the northern California margin (Rathburn et al., 2000).

Protistan ecologists generally accept that no "real anaerobic species" are known among the Foraminifera (Fenchel and Finlay, 1995). However, in benthic marine habitats, foraminifers generally withstand hypoxia better than other meiofauna (Josefson and Widbom, 1988), and species that are tolerant to extremely low levels of oxygen have been reported from diverse water depths (e.g., Sen Gupta and Machain-Castillo, 1993; Bernhard and Sen Gupta, 1999). In the central Santa Barbara Basin, living Foraminifera (determined by ATP assay) with intact organelles (determined by electron microscopy) have been found in anoxic pore waters 3 cm below *Beggiatoa* mats, but even these species do not tolerate anoxia indefinitely (Bernhard and Reimers, 1991). Such evidence would suggest that the survival of most Foraminifera under *Beggiatoa* mats at Gulf of Mexico hydrocarbon seeps is a short-term phenomenon, but this hypothesis has not been tested. Compared to the isobathyal but much larger *Beggiatoa* mats of the silled Santa Barbara Basin, those of the Green Canyon hydrocarbon seeps (data from Sen Gupta et al., 1997) support much smaller foraminiferal populations. This discrepancy can be explained by (a) the size difference of the mats in the two areas, and (b) the inherently ephemeral nature of the Green Canyon mats, whose occurrence is controlled by the shifting point sources of sea-floor hydrocarbon emission. Such shifts are connected with the complex interplay of various geological and geochemical factors, such as locations of hydrocarbon (methane and petroleum) reservoirs, faulting, erosion, and sedimentation (Roberts and Aharon, 1994).

Porcelaneous species. Very few porcelaneous (miliolid) species have been reported from dysoxic to anoxic environments (Bernhard and Sen Gupta, 1999). However, using the Rose Bengal stain, living populations of *Triloculina trigonula* have been recorded in Green Canyon from under *Beggiatoa* mats, and those of *Quinqueloculina* spp. from under *Thioploca* mats (Sen Gupta et al., 1997; Robinson et al., 2004). Also, living *Pyrgo* sp. has been reported from seep habitats in Blake Ridge (Robinson et al., 2004). In this context, we draw attention to *Cribromiliolinella subvalvularis*, previously identified from the Gulf of Mexico. This miliolid dominates the surface and near-surface samples (24% and 21%, respectively) in Green Canyon core GCP54, taken through a white bacterial mat; 30% of its individuals in the 0-1 cm sample (GCP54a) and 43% in the 1-2 cm sample (GCP54b) caught the Rose Bengal stain. Thus, we recognize *C. subvalvularis* to be a facultative anaerobe. Another porcelaneous species in our samples that may belong to this category is *Cornuspira involvens*; the unusually variable substrate preference of this species will be discussed in the next paragraph.

Elevated epibenthos. As indicated above, benthic Foraminifera that actually live in sediments of Gulf of Mexico cold seeps need to be tolerant of severe oxygen deprivation and the presence of methane and hydrogen sulfide. Judging by the growth environments of sulfide-oxidizing bacteria (e.g., Jørgensen, 1982) and foraminiferal abundances in non-seep but sulfide-enriched, bacterial mat environments elsewhere (Bernhard and Buck, 2004), cold-seep species living under bacterial mats (Sen Gupta et al., 1997) must be particularly tolerant of H_2S. This constraint, however, does not apply to species that do not live in or on the sediment, but grow attached to vestimentiferan tubeworms—centimeters to decimeters above the seafloor—thus avoiding the oxygen depletion and H_2S toxicity at the sediment-water interface. In this study, we have found 8 species that live exclusively on tubeworms. Two of them, *Cibicides wuellerstorfi* and *Planulina ariminensis,* have been found affixed to elevated microhabitats (rock fragments, hydroids, etc.) in several non-seep areas outside the Gulf of Mexico, and it has been argued that this adaptation gives such suspension-feeding species a special advantage in a slow bottom current (Lutze and Thiel, 1989; Linke and Lutze, 1993). At seep sites, where bacterial and particulate food is plentiful (Levin, 2005), the attachment to tubeworm surfaces above the seafloor also offers freedom from hypoxia and sulfide toxicity (Freytag et al., 2001; Cordes et al., 2003). There is ample documentation that the cosmopolitan species *Cibicides wuellerstorfi,* widely reported (under 5 generic names, see Sen Gupta, 1989) from deep-bathyal and abyssal waters (especially from the North Atlantic Deep Water), is restricted to oxic environments (e.g., Douglas and Woodruff, 1981; Kaiho, 1994). Besides our findings in the Gulf of Mexico, *C. wuellerstorfi* is also known to be attached to tubeworms "above the sediment-water interface" at an abyssal seep site on the Aleutian margin (Adamic et al., 2005). From these observations, we infer that (1) many sessile Foraminifera, of diverse taxonomic affinities and bathymetric preferences, colonize surfaces of vestimentiferan tubeworms (and possibly other elevated microhabitats) at hydrocarbon seeps, and (2) in many seepage areas, these attachment points are sufficiently above locations of gas escape in the seafloor to provide the species with an oxic microhabitat with little or no H_2S (Sen Gupta et al., 2007).

One species living attached to Alaminos Canyon tubeworms surfaces is a facultative epibenthos. This species, *Cornuspira involvens*, together with *Cibicides wuellerstorfi*, is abundant in sample ACB07a taken from a gray bacterial mat with tubeworm roots. Arguably, for both species, this abundance reflects post-mortem dislodgment from tubeworm stalks. *C. involvens* is also the sole calcareous species in sample ACP15a (also from Alaminos Canyon) collected from an orange bacterial mat with tubeworm roots. The individuals, however, were all living (as judged by Rose Bengal) and encysted when collected; they did not seem dislodged from tubeworms. Foraminifera may become dormant in adverse conditions (Bernhard and Sen Gupta, 1999) and encystment may reflect dormancy; cysts of the well-known shelf species *Elphidium incertum* have been reported from anoxic environments (Linke and Lutze, 1993). Abundant Rose-Bengal-stained individuals of *C. involvens* are also present in ACP15b, 1-2 cm below the sediment-water interface. Furthermore, it is known to exist as a shallow endobenthic species in a non-seep muddy substrate from 0 to 2 cm, although 2-3 cm above the redox boundary (Murray, 2003). Our results indicate that *C. involvens* is opportunistically sessile on vestimentiferan tubes but may also survive as a facultative anaerobe in seep sediments.

5.10. Post-Mortem Assemblage Mixing

Some unusual features of our sample assemblages can be explained by post-mortem mixing of foraminiferal shells. A notable example comes from the Farnella Canyon surface sample (FCP61a), the deepest-water sample (2918 m) in our set. The calcareous species richness (53) is one of the highest for samples in the deepest-bathyal major cluster. *Praeglobobulimina ovata* is dominant (23%), but *Cibicides wuellerstorfi* (14%) ranks second. This combination is enigmatic, because the endobenthic *P. ovata* is known to live at the sedimentary oxic-anoxic boundary (Corliss, 1985; Corliss and Emerson, 1990) and even in H_2S-containing seep sediments (Robinson et al., 2004), whereas *C. wuellerstorfi*, an elevated-epibenthic species, is restricted to oxic waters (Kaiho, 1994; Douglas and Woodruff, 1981; Murray, 1995). Because (a) *C. wuellerstorfi*, a deepest-bathyal to abyssal species, is sessile on vestimentiferan tubeworms, and (b) FCP61a was taken from sediment at the base of a tubeworm bush, we conclude that the presence of the species there is due to post-mortem dislodgment from tubeworms. Such post-mortem mixing of foraminiferal species from entirely different microhabitats could significantly raise the number of species (live and dead) present in a sediment. Thus, an abundance of the shells of aerophilic, epibenthic Foraminifera in a sediment sample does not necessarily mean absence of gas seepage at the seafloor. The data on epibenthic (especially, sessile) species need to be treated with caution when particular species or assemblages of fossil Foraminifera are used as clues to ancient cold-seep environments (e.g., Barbieri and Panieri, 2004).

5.11. Conclusions

(1) There are no seep endemics among the 185 identified species of benthic Foraminifera, even among the 21 that were previously unknown in the Gulf of Mexico.

(2) The imprint of water depth on foraminiferal assemblages is clearly detectable because the species are recruited from the surrounding non-seep habitats. The two major surface-sample groups (clusters) recognized by numerical data analysis are separated by bathymetry. The shallower-water group contains all samples (seep and non-seep) from Green Canyon, Garden Banks, and Mississippi Canyon (245-1081 m); the deeper-water (deepest-bathyal) group contains all samples from Alaminos, Farnella, and De Soto Canyons (1848-2918 m).

(3) Foraminiferal species of wide-ranging morphologic and taxonomic affinities are able to maintain sizeable populations at sites of hydrocarbon seepage. The most conspicuous dominants at seep-influenced substrates (bacterial mats) in the shallower cluster are endobenthic species, especially *Bolivina* spp.; these are possibly facultative anaerobes. The pattern is not as clear in the deepest-bathyal group, because some epibenthic species (e.g., *Nuttallides decorata*) are included among the dominants.

(4) The high bacterial productivity at northern Gulf of Mexico hydrocarbon seeps is a major factor in sustaining the foraminiferal populations.

(5) The presence of oil in surface and subsurface sediments has no conspicuous effect on the dominant foraminiferal species of hydrocarbon seeps.

(6) The abundance of *Cibicides wuellerstorfi* in seep sediments is an evidence of post-mortem assemblage mixing; *C. wuellerstorfi* is an elevated-epibenthic species of deep bathyal to abyssal depths, and is intolerant of anoxia or dysoxia.

(7) In the shallower sampling areas, the diversity (species richness) of both calcareous and agglutinated Foraminifera is higher in non-seep than in seep substrates. This distinction is not clear in the deepest-bathyal areas. The diversity at some sites may have been elevated by post-mortem mixing of species from different microhabitats.

(8) Fifteen epibenthic species were found attached to vestimentiferan tubeworms, centimeters to decimeters above the seafloor. Such species are not affected by the oxygen depletion and H_2S toxicity at the sediment-water interface. Eight of these species were found exclusively on tubeworms and not in sediments.

6. LITERATURE CITED

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APPENDIX: ATLAS OF FORAMINIFERA

Explanatory Notes

One hundred eighty species are illustrated in this atlas in 193 plates. The plates are arranged *alphabetically* by species names. Each plate contains one or more illustrations of a single species; most are scanning electron micrographs, but some digital photomicrographs (mainly of species attached to tubeworms) are also included.

All relevant information on these species, including taxonomy and brief descriptions, is given in Chapter 2 (Systematics). Sample references for illustrated specimens are also given. The digital photomicrographs are identified under species names in Chapter 2; all others are scanning electron micrographs.

Five rare species are not shown on the atlas plates, because of a lack of specimens suitable for illustration. These species are: *Heronallenia* sp., *Miliolinella subrotunda* (Seguenza), *Neoconorbina terquemi* (Rzehak), *Procerolagena gracillima* (Seguenza), and *Trochamminoides coronatus* (Brady).

Abditodentrix pseudothalmanni (Boltovskoy and Giussani de Kahn)

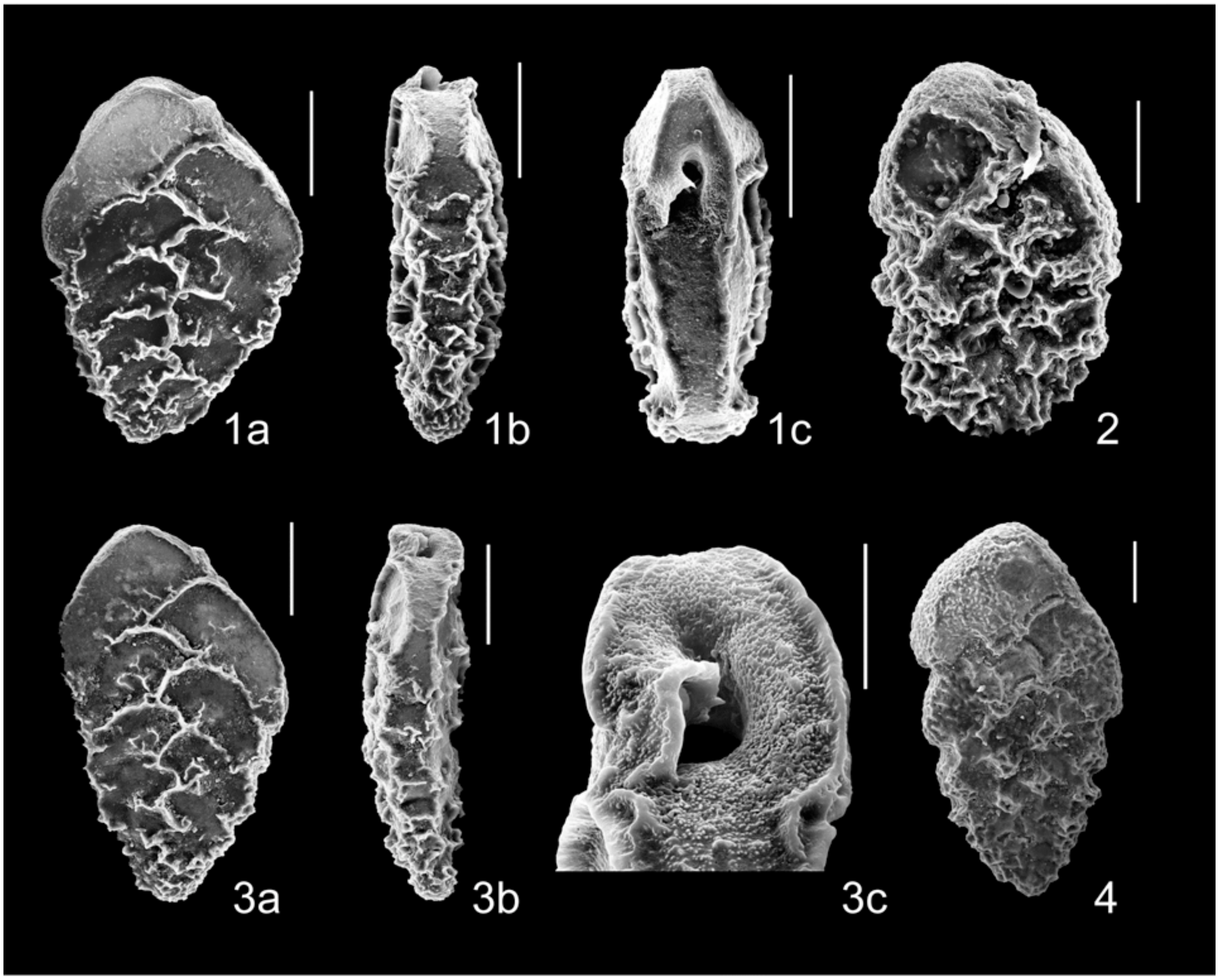

Plate 1

Scale bars = 50 μm
except in 3c (20 μm)

Adercotryma glomeratum (Brady)

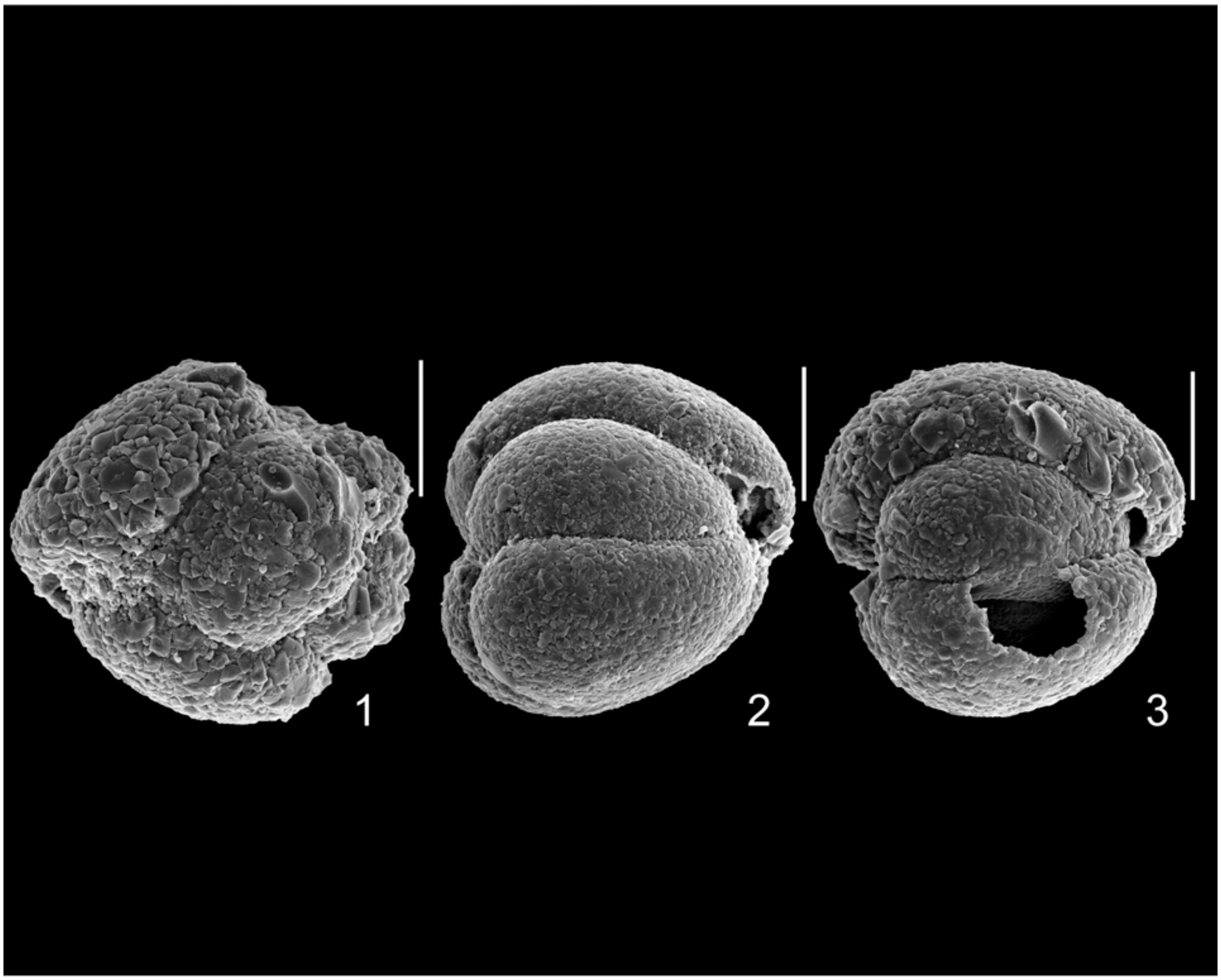

Plate 2 Scale bars = 50 µm

Ammobaculites catenulatus Cushman and McCulloch

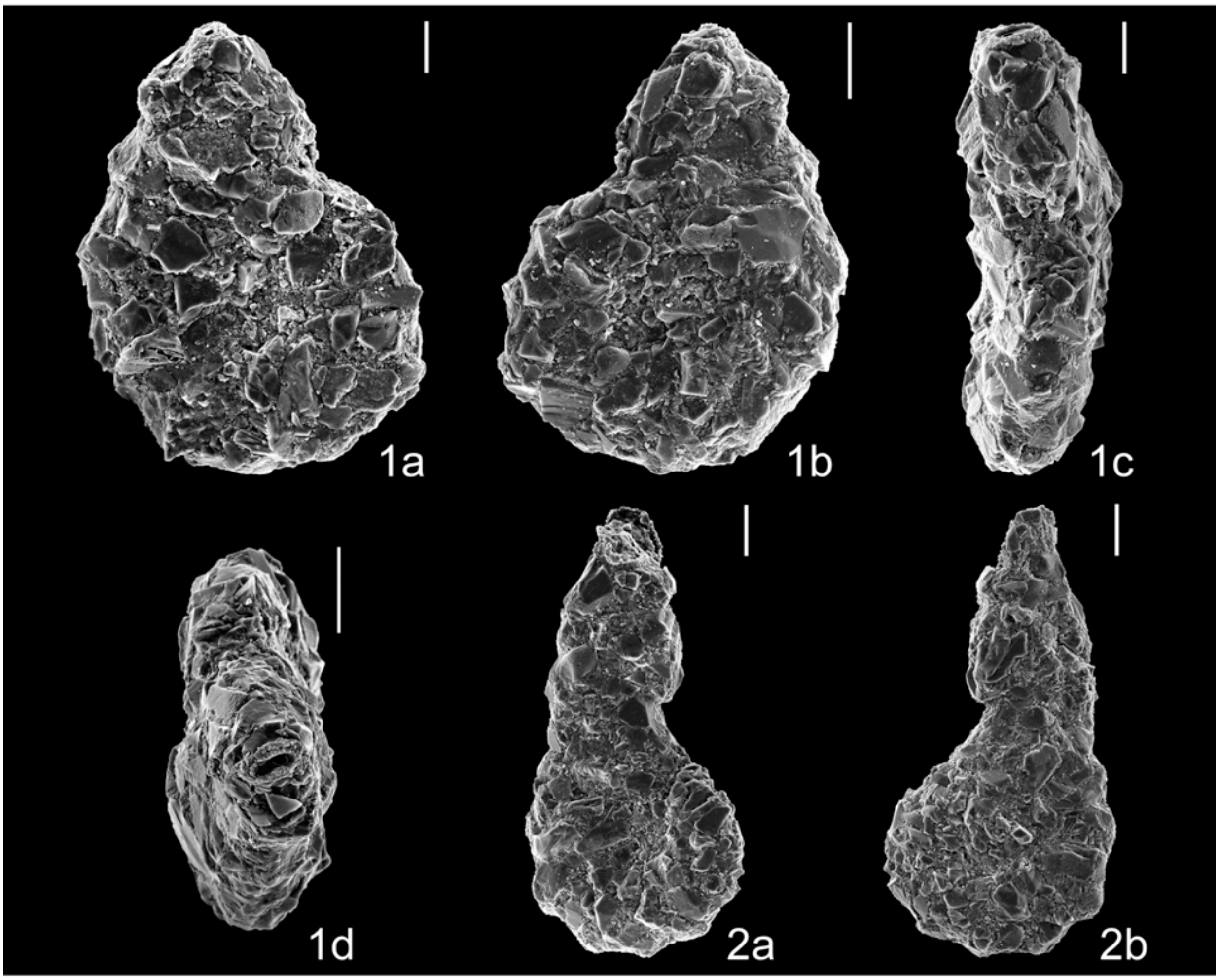

Plate 3 Scale bars = 50 μm

Ammobaculites filiformis Earland

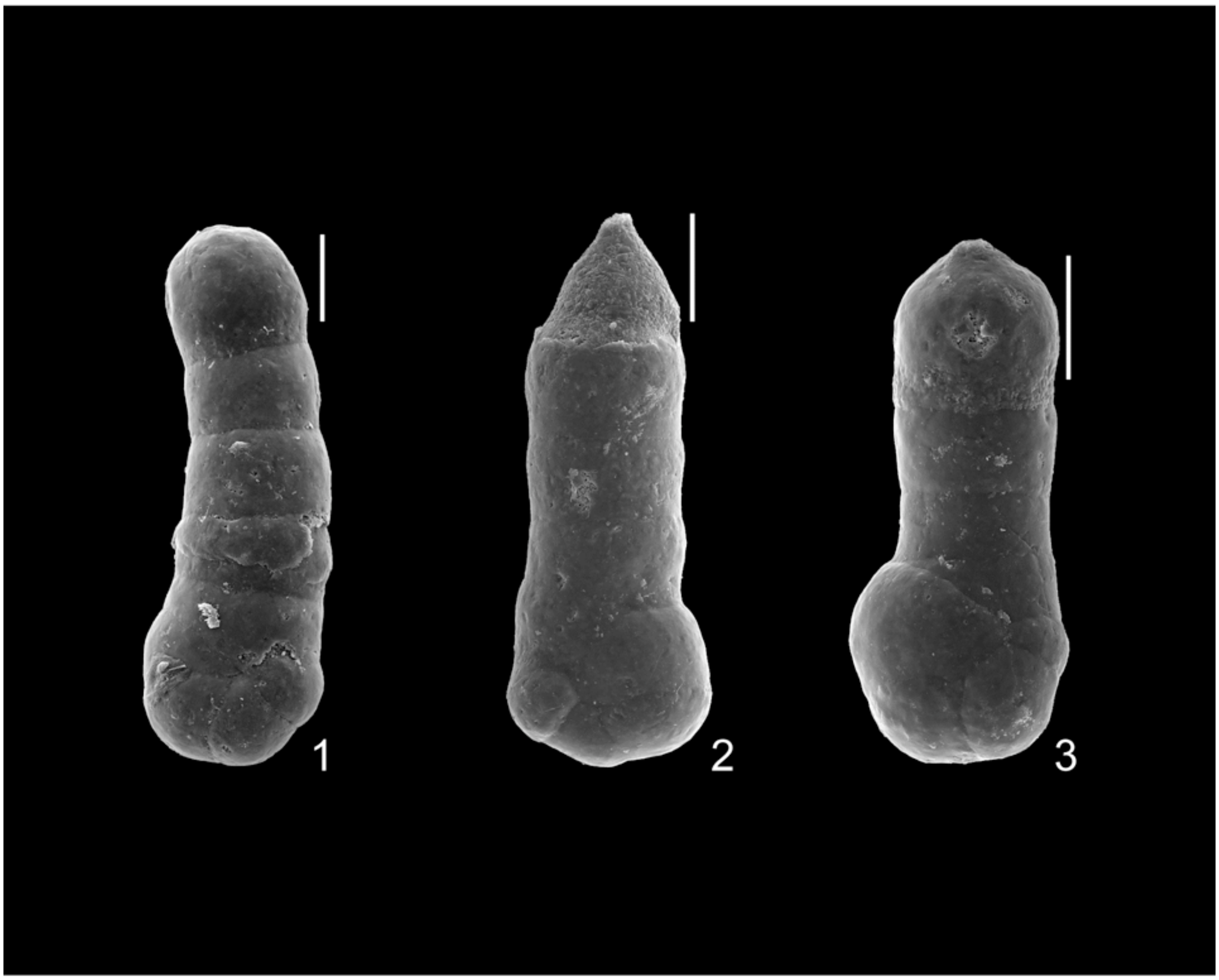

Plate 4

Scale bars = 50 μm

Ammodiscus tenuis (Brady)

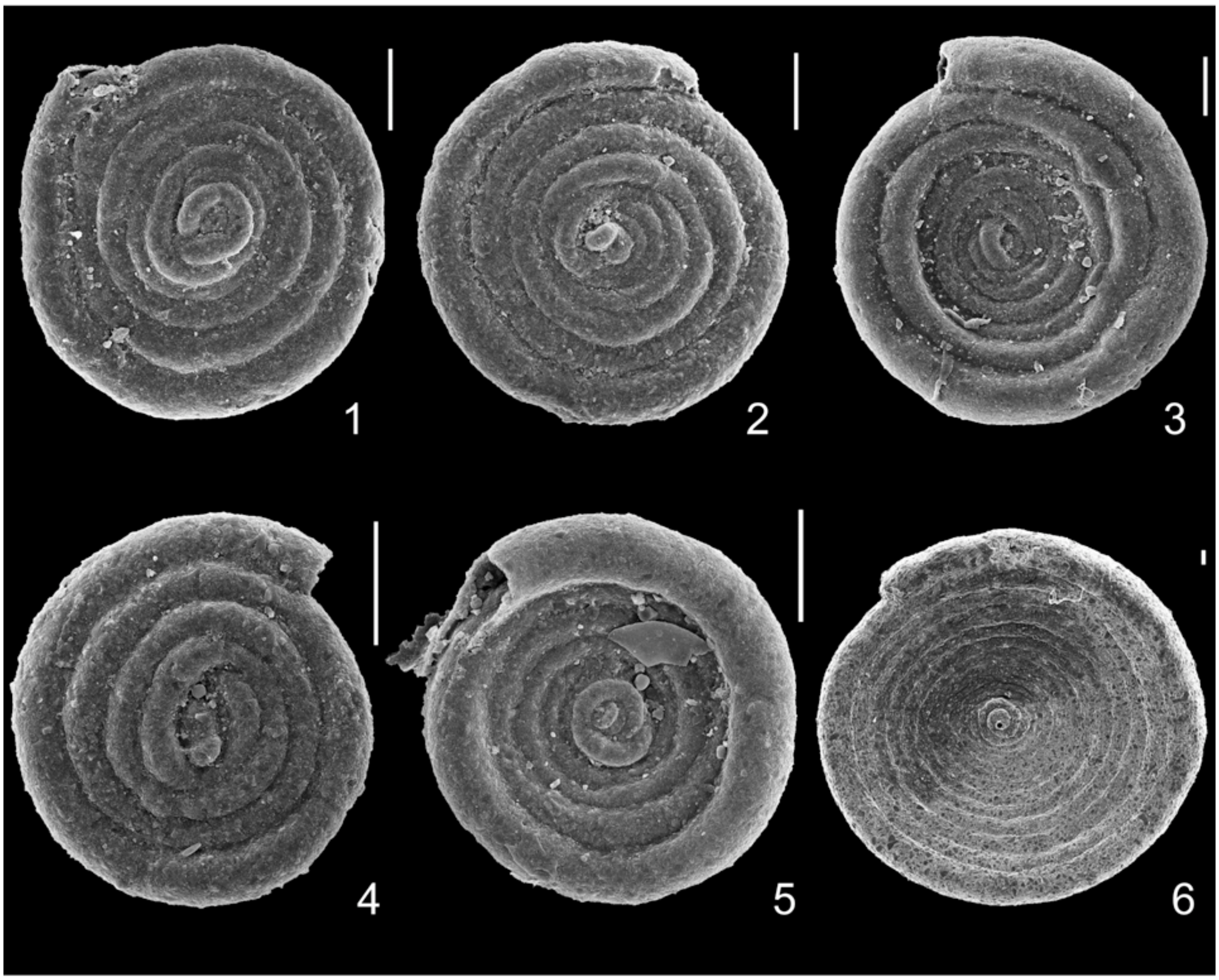

Plate 5 Scale bars = 50 μm

Ammolagena clavata (Jones and Parker)

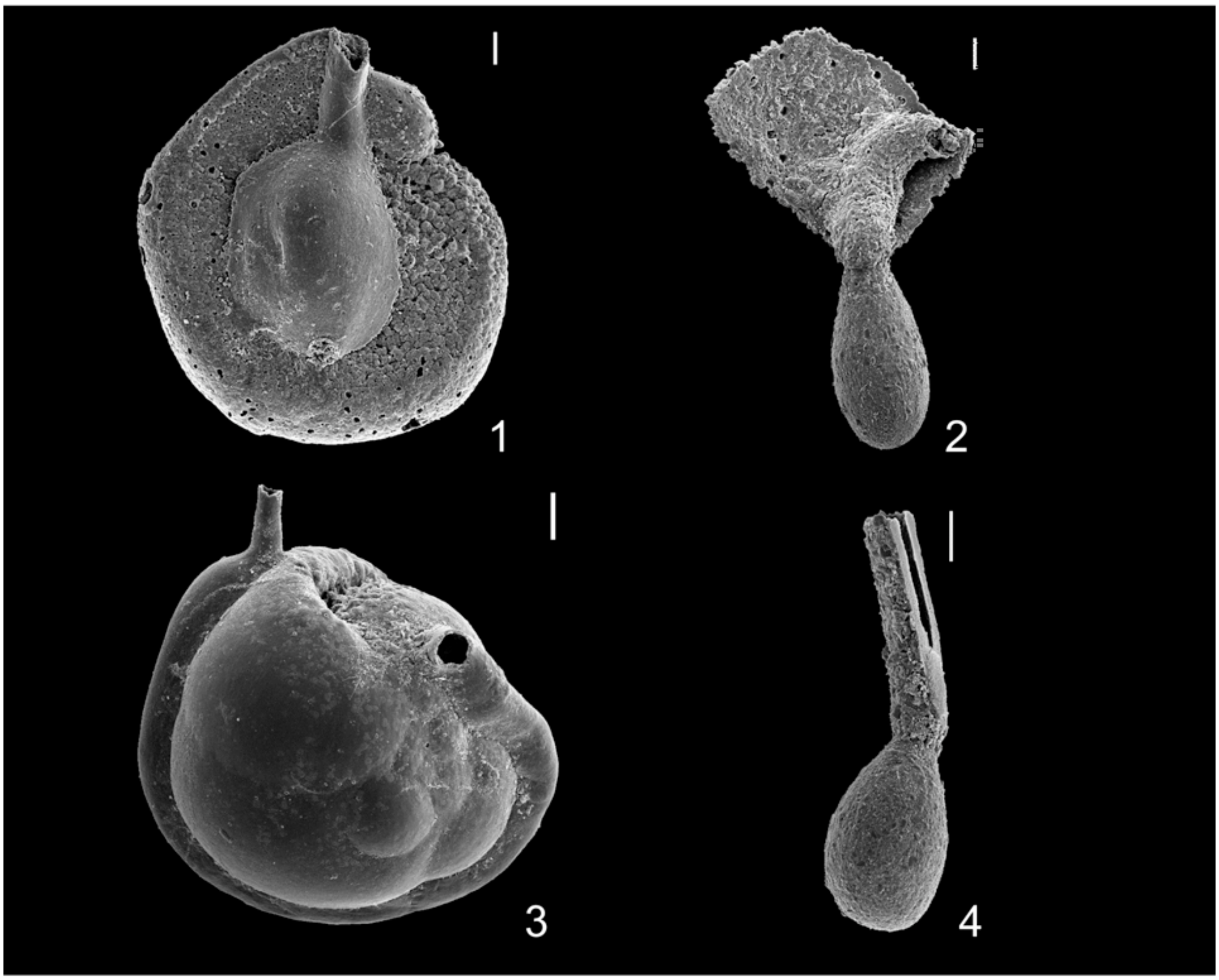

Plate 6

Scale bars = 50 µm

Ammoscalaria tenuimargo (Brady)

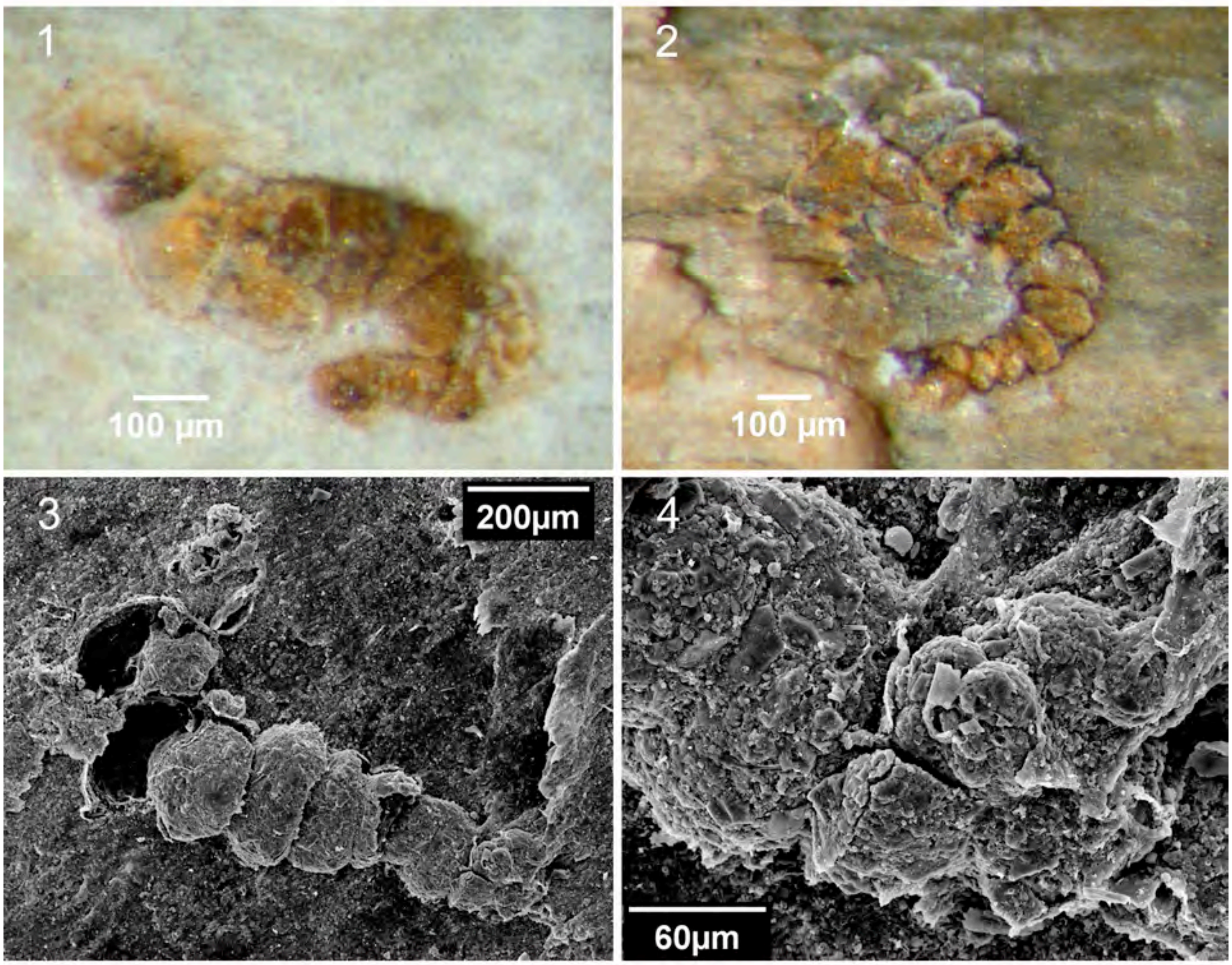

Plate 7

Amphicoryna hirsuta (d'Orbigny)

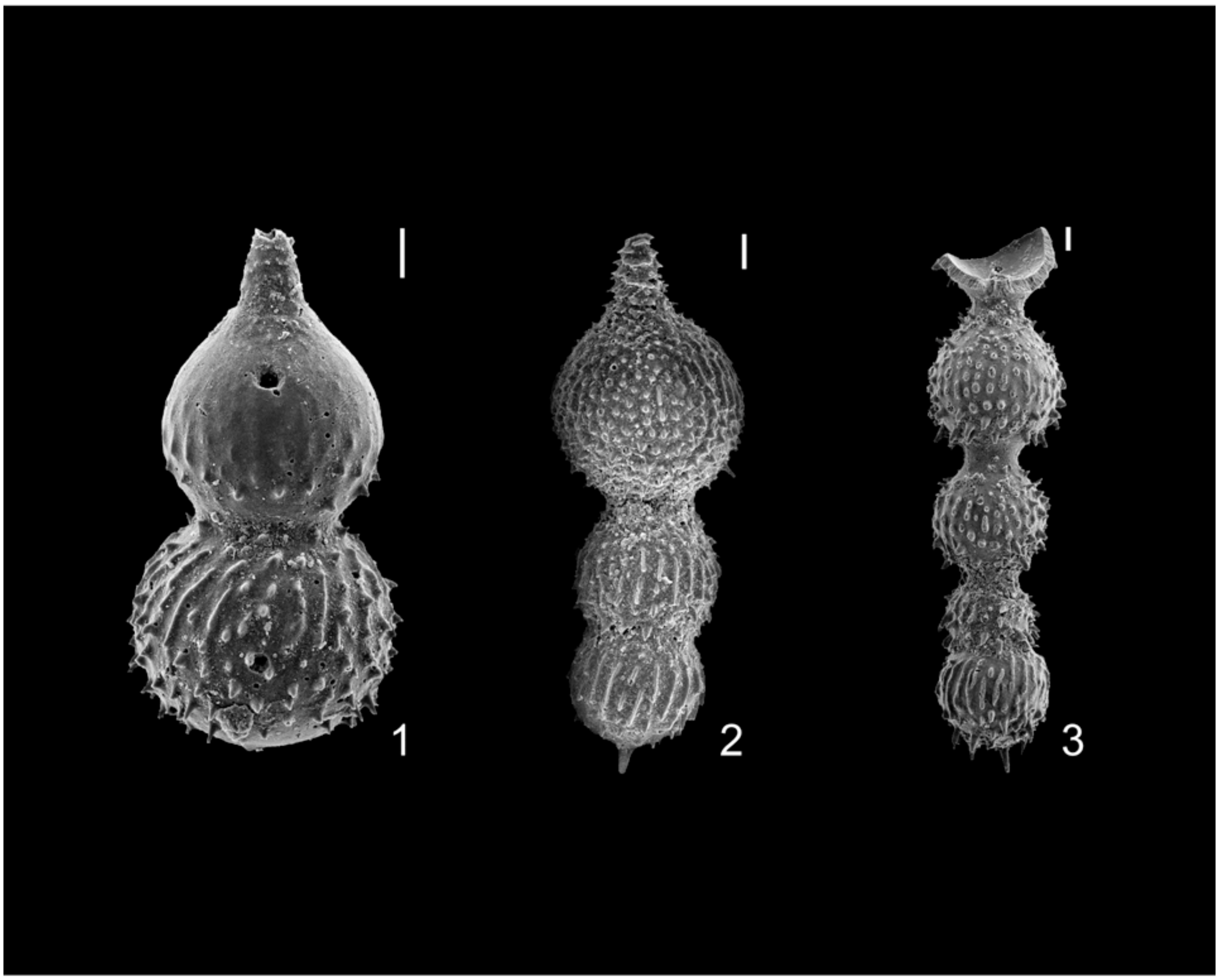

Plate 8

Scale bars = 50 μm

Anomalinoides globulosus (Chapman and Parr)

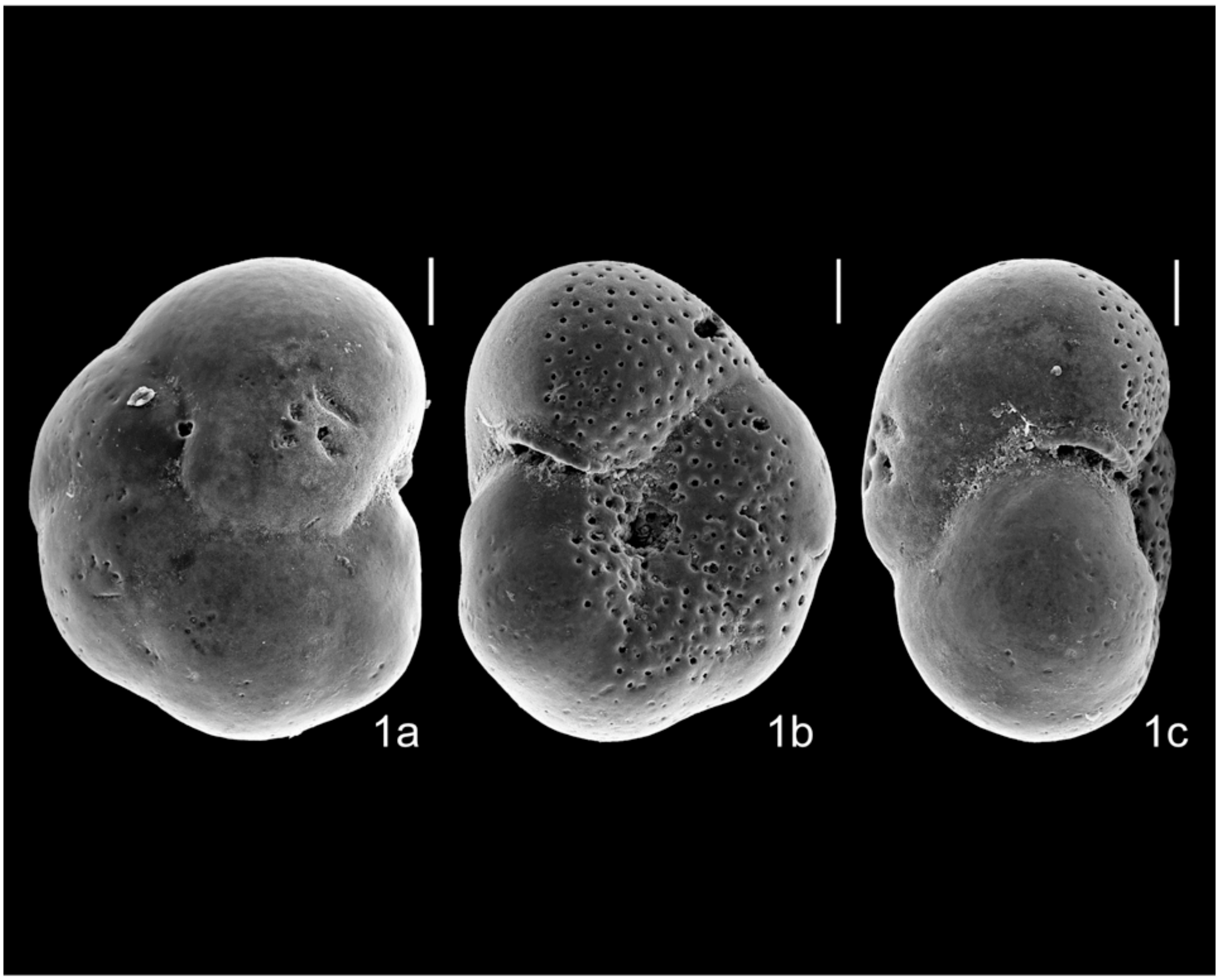

Plate 9

Scale bars = 50 μm

Anomalinoides globulosus (Chapman and Parr)

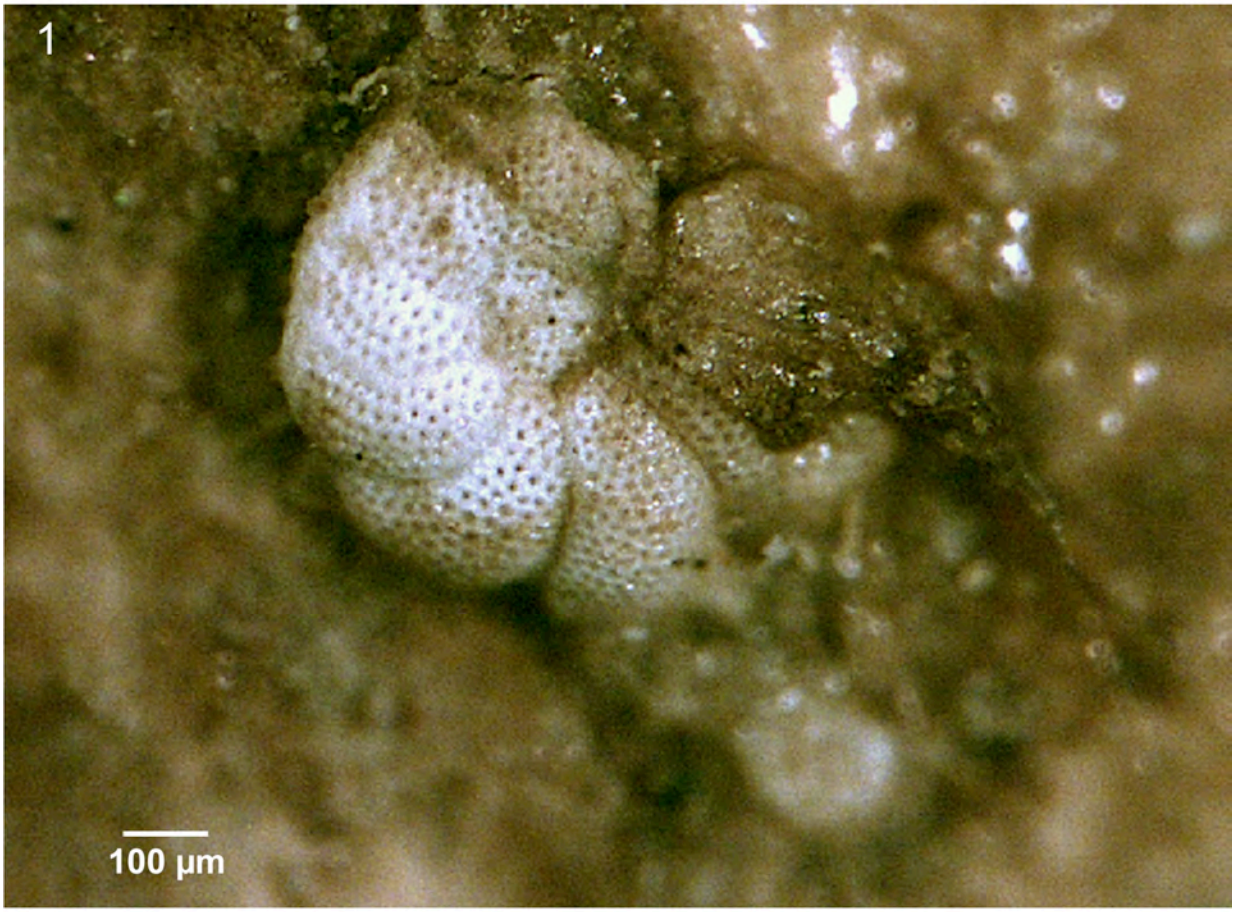

Plate 10

Anomalinoides mexicanus Parker

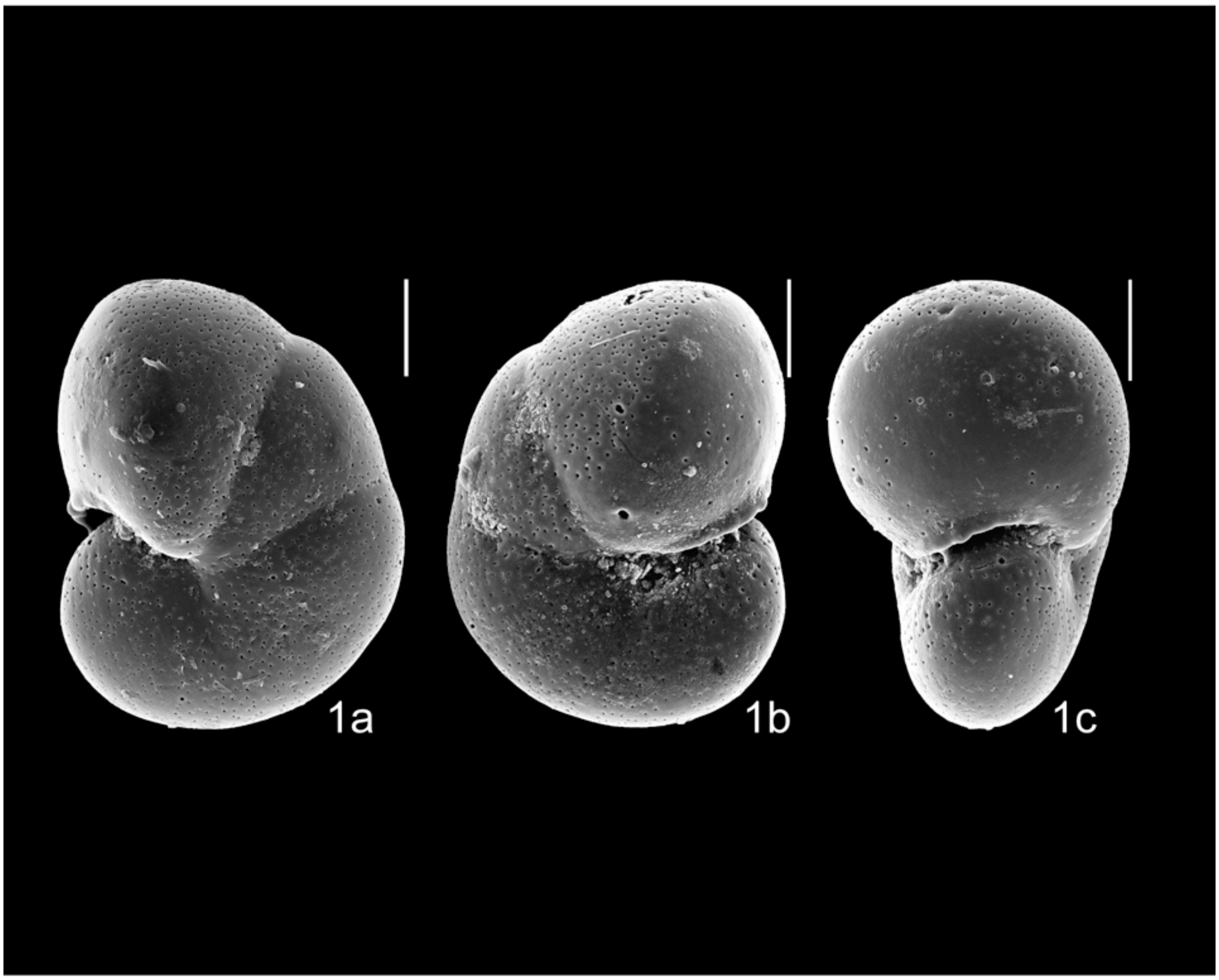

Plate 11

Scale bars = 50 µm

Archimerismus subnodosus (Brady)

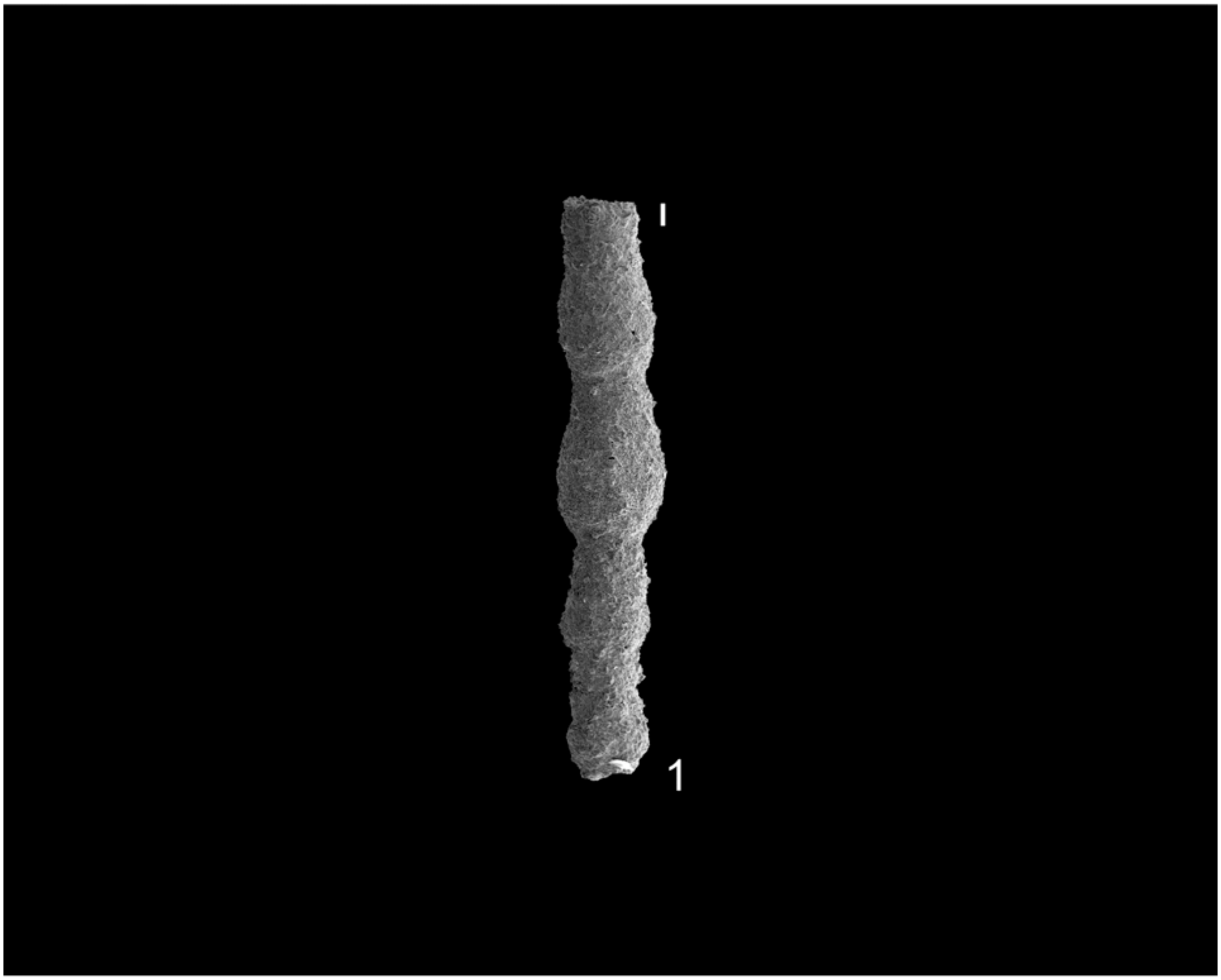

Plate 12

Scale bar = 50 μm

Barbourinella atlantica (Bermúdez)

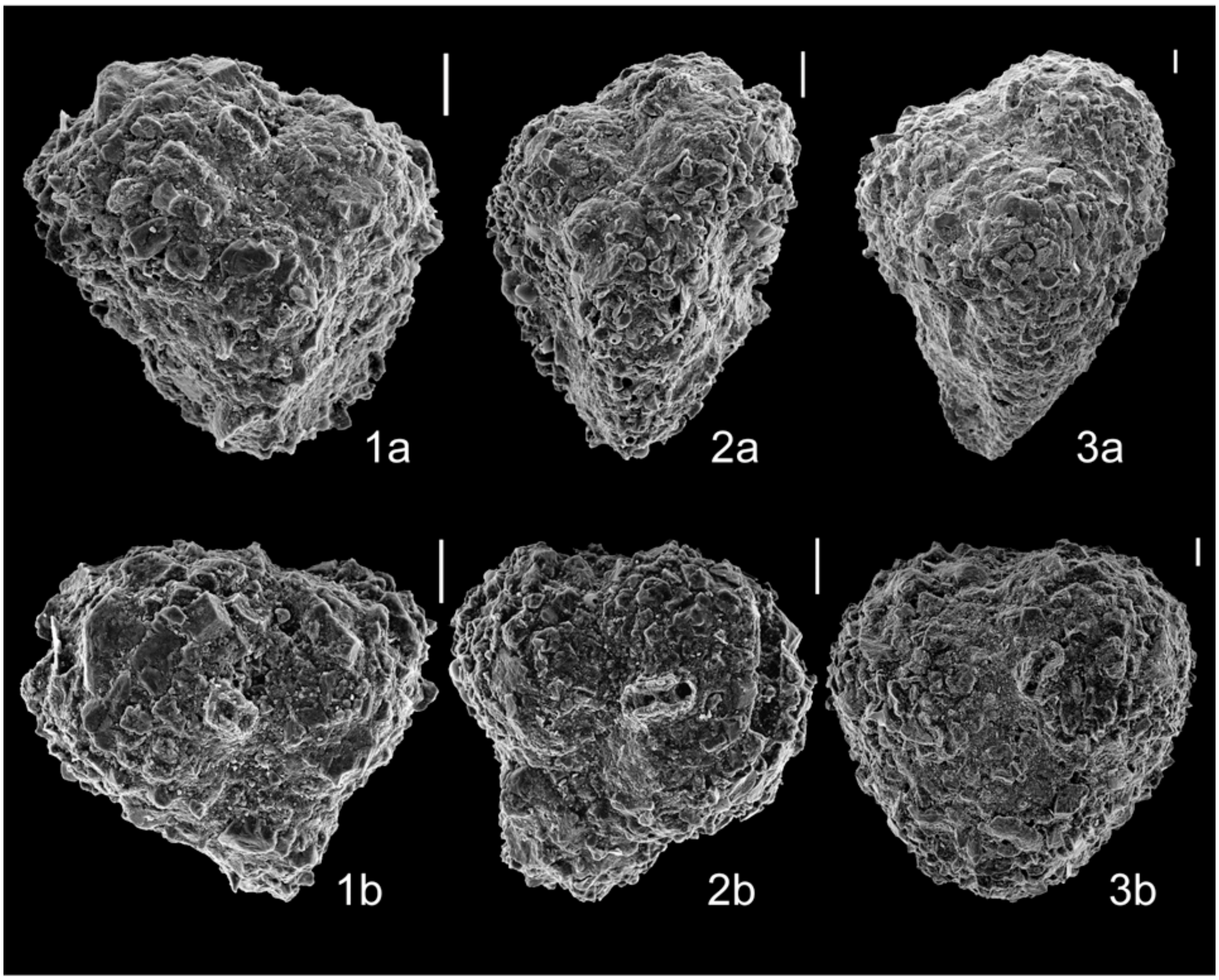

Plate 13

Scale bars = 50 μm

Bolivina alata (Seguenza)

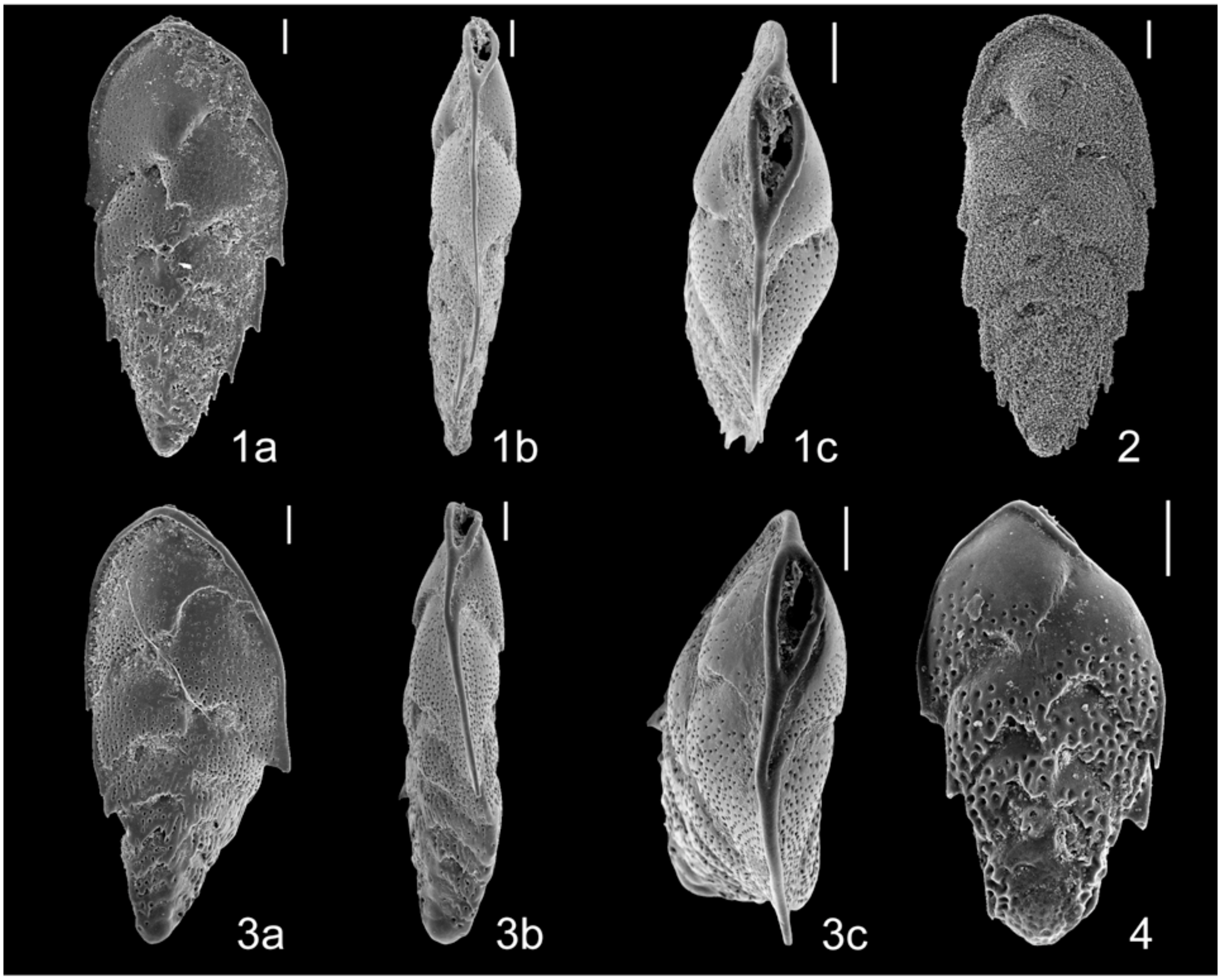

Plate 14 Scale bars = 50 μm

Bolivina albatrossi Cushman

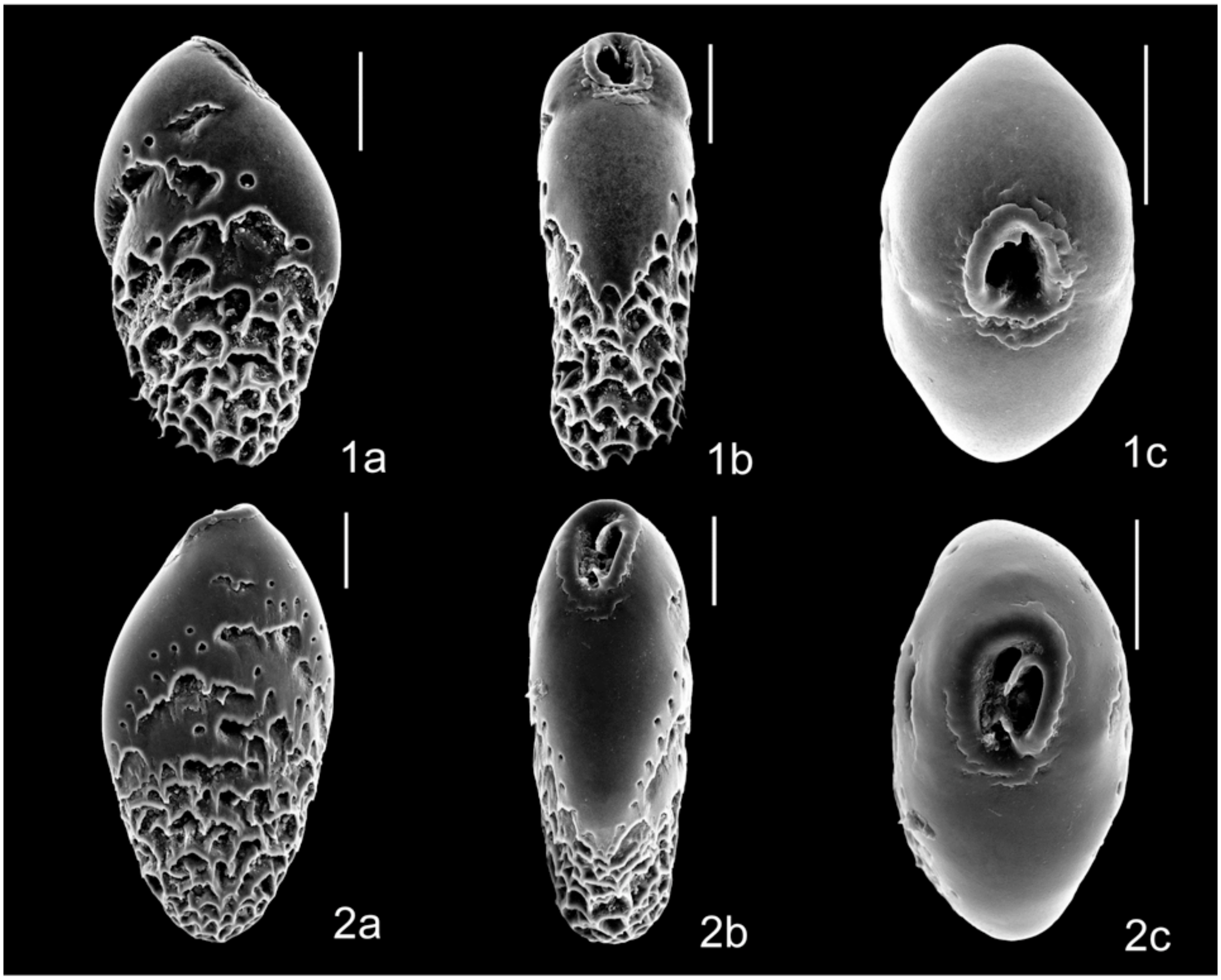

Plate 15

Scale bars = 50 µm

Bolivina barbata Phleger and Parker

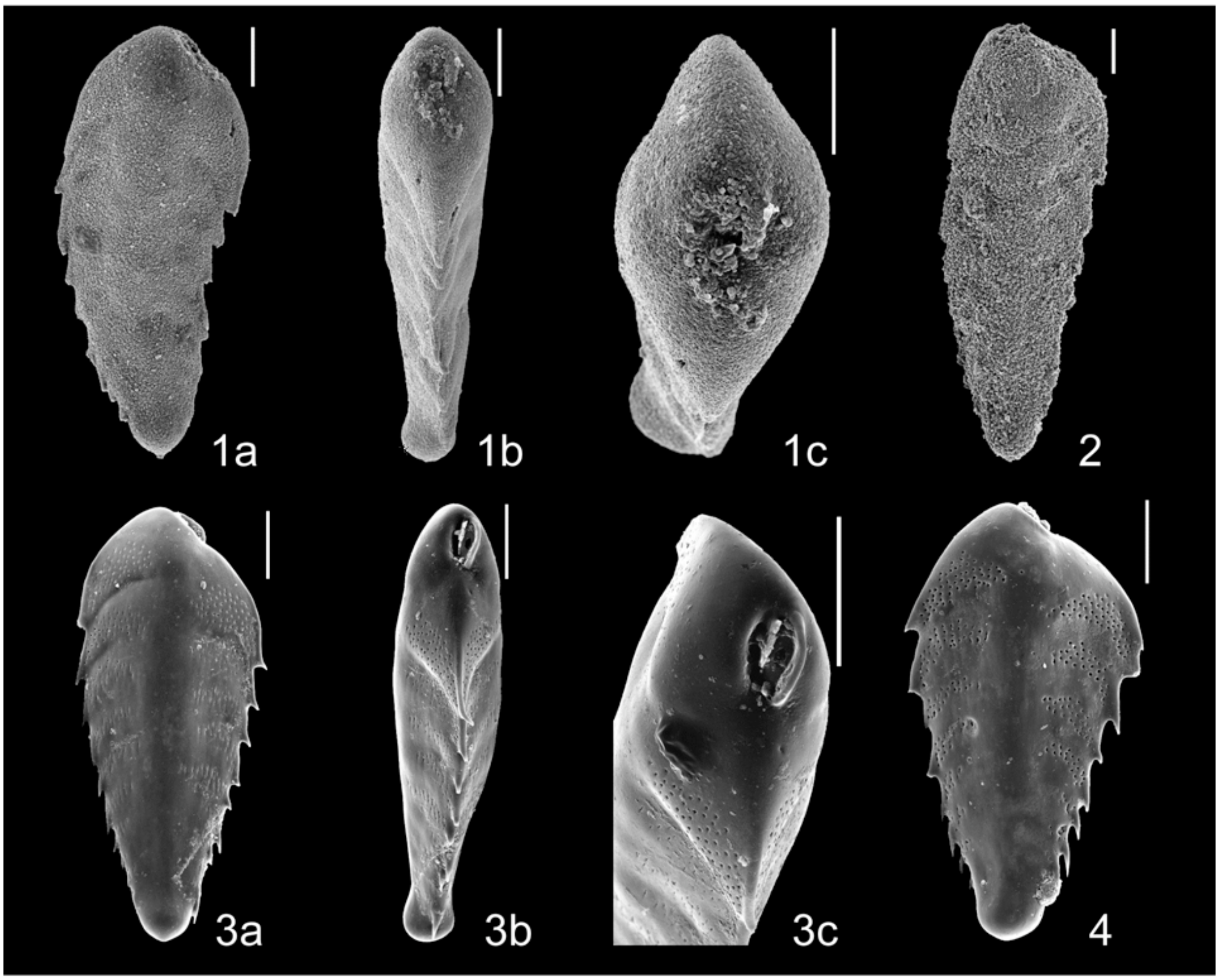

Plate 16 Scale bars = 50 μm

Bolivina daggarius Parker

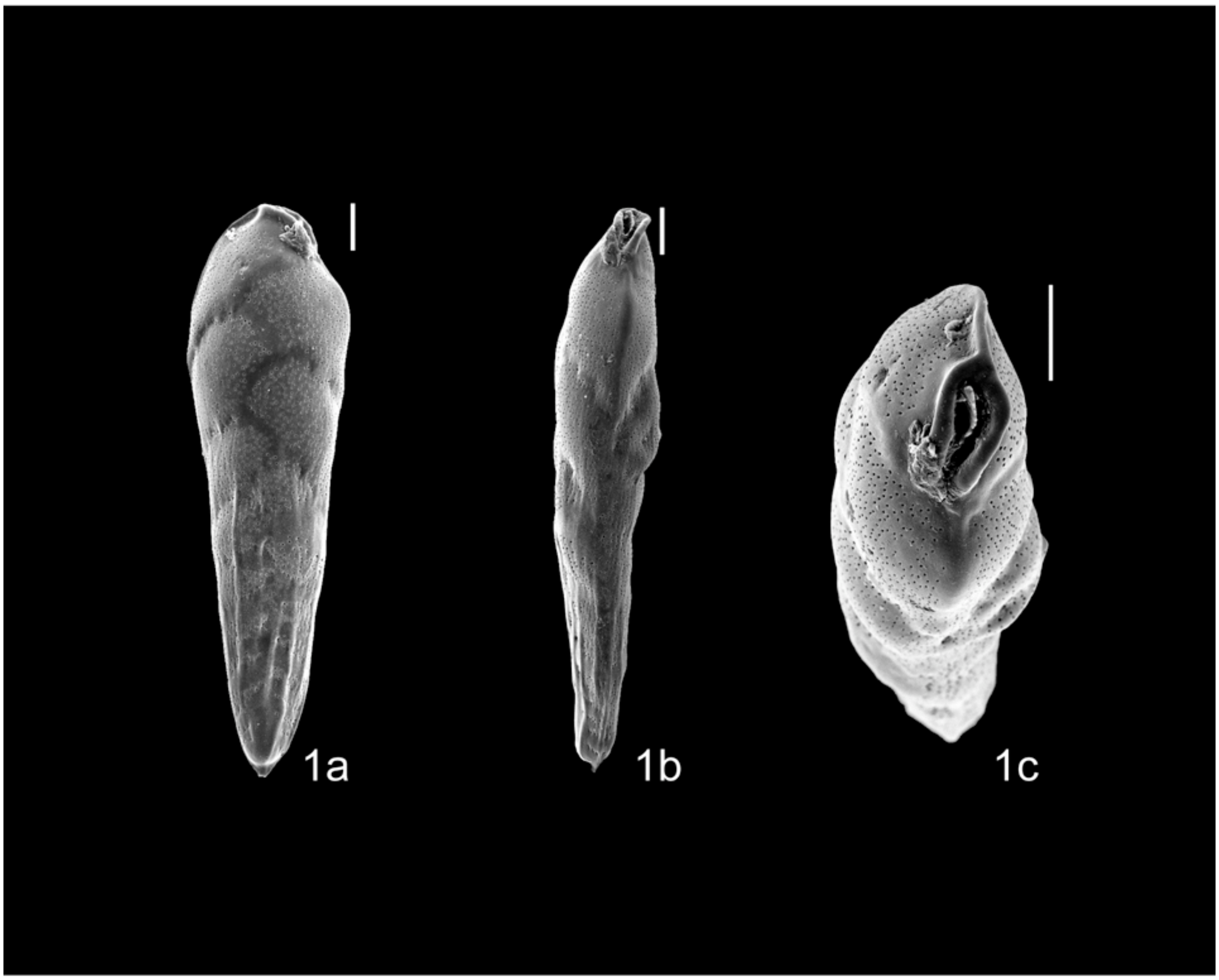

Plate 17

Scale bars = 50 µm

Bolivina goesii Cushman

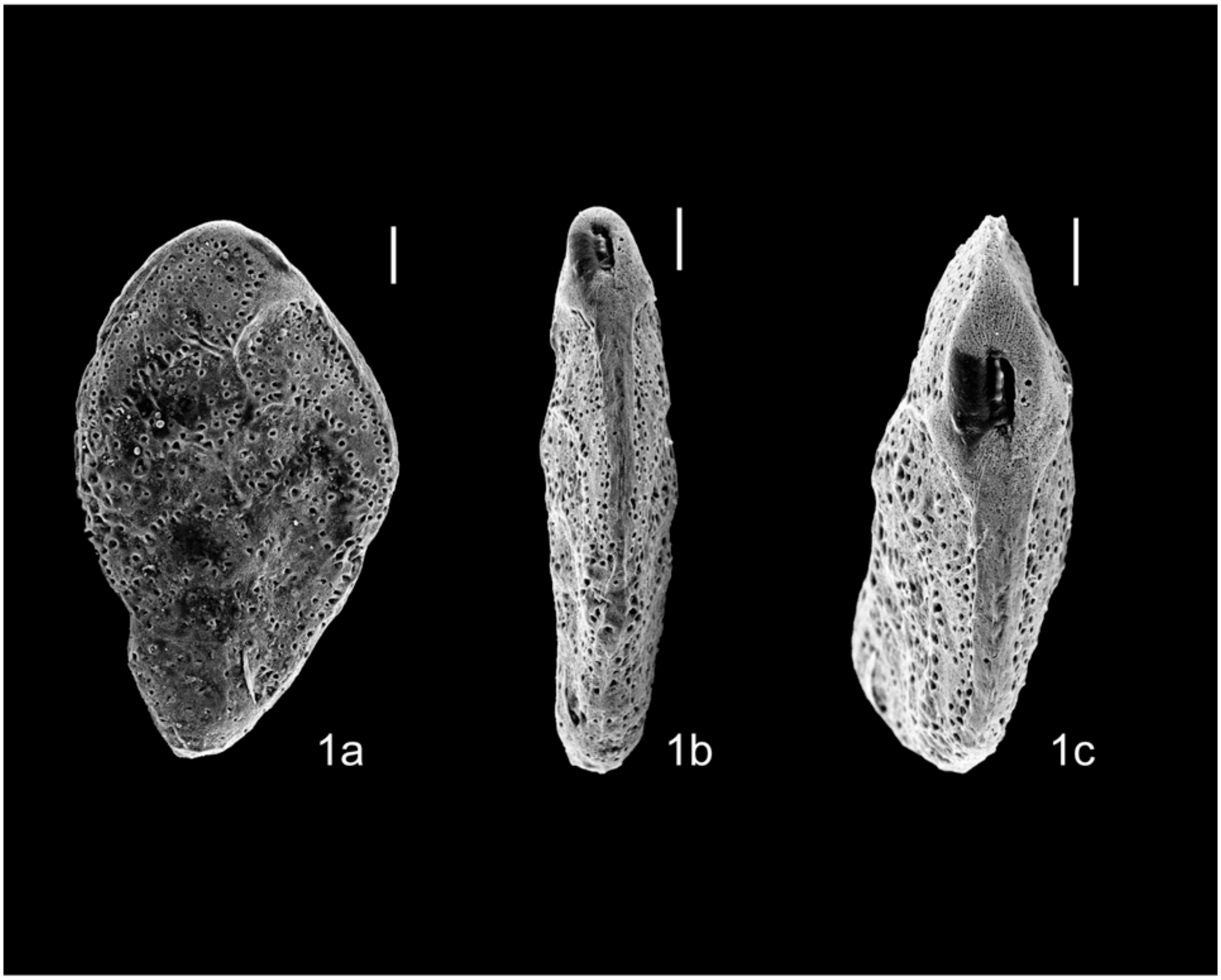

Plate 18

Scale bars = 50 μm

Bolivina sp. cf. *B. hastata* Phleger and Parker

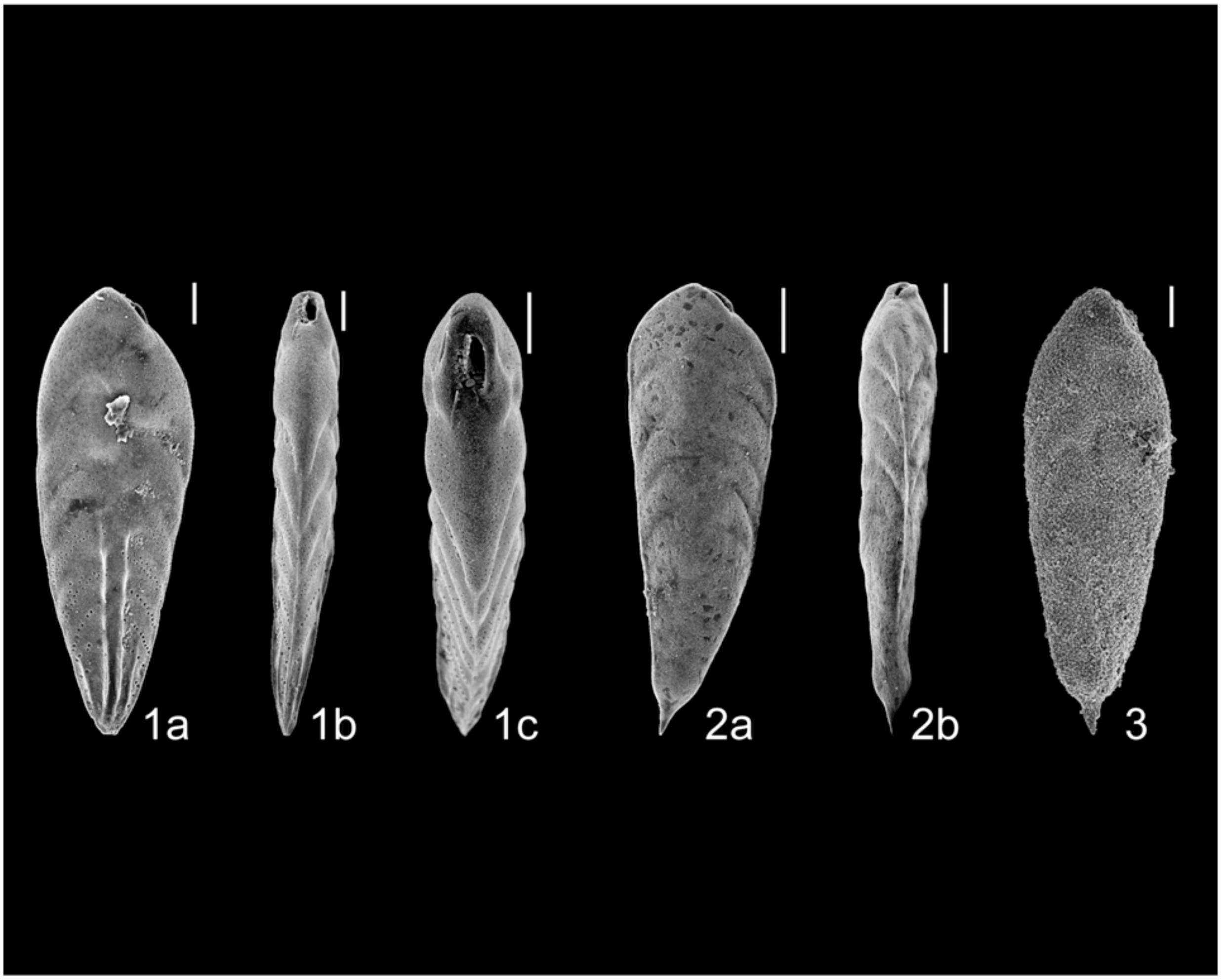

Plate 19 Scale bars = 50 μm

Bolivina lowmani Phleger and Parker

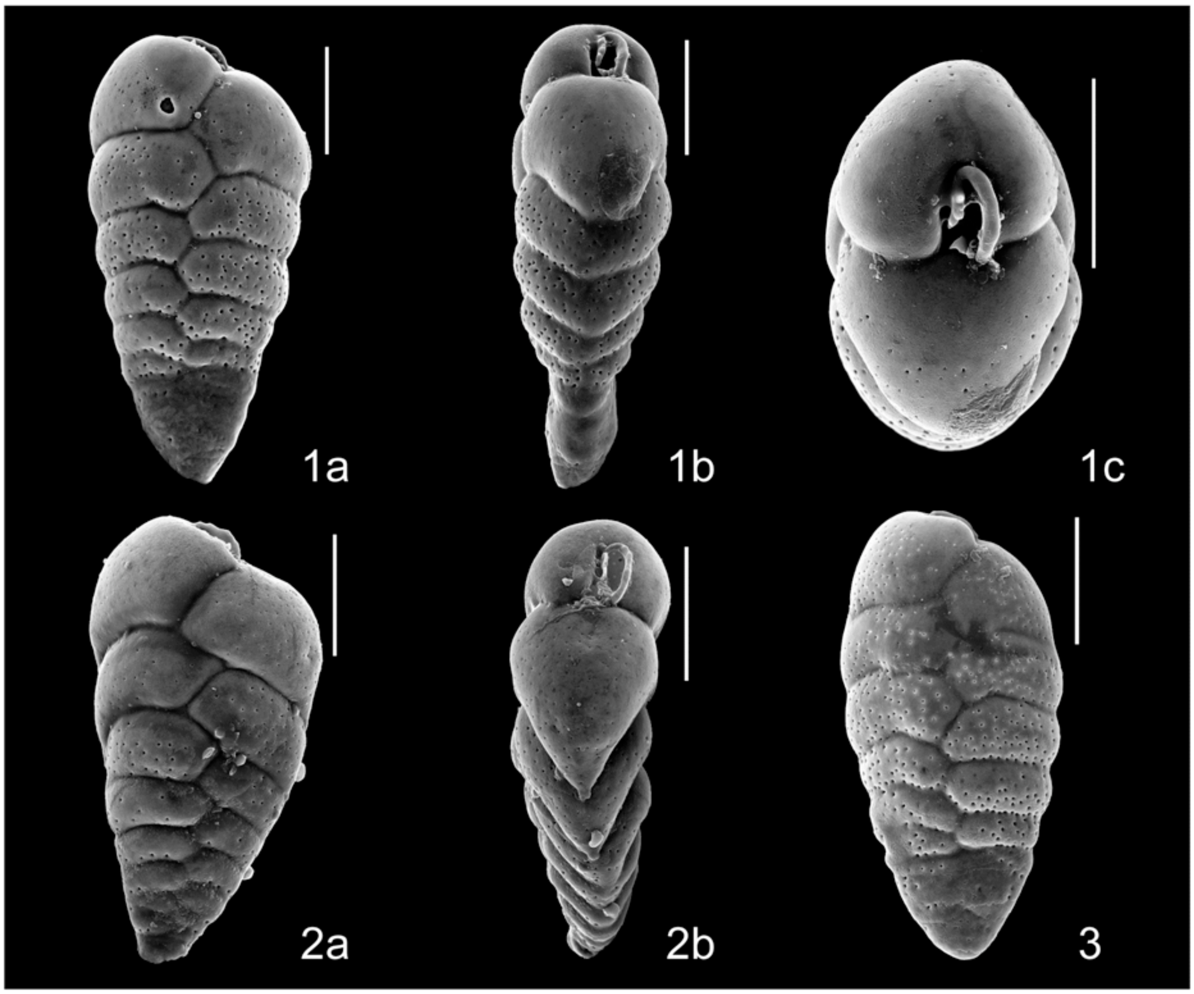

Plate 20

Scale bars = 50 μm

Bolivina minima Phleger and Parker

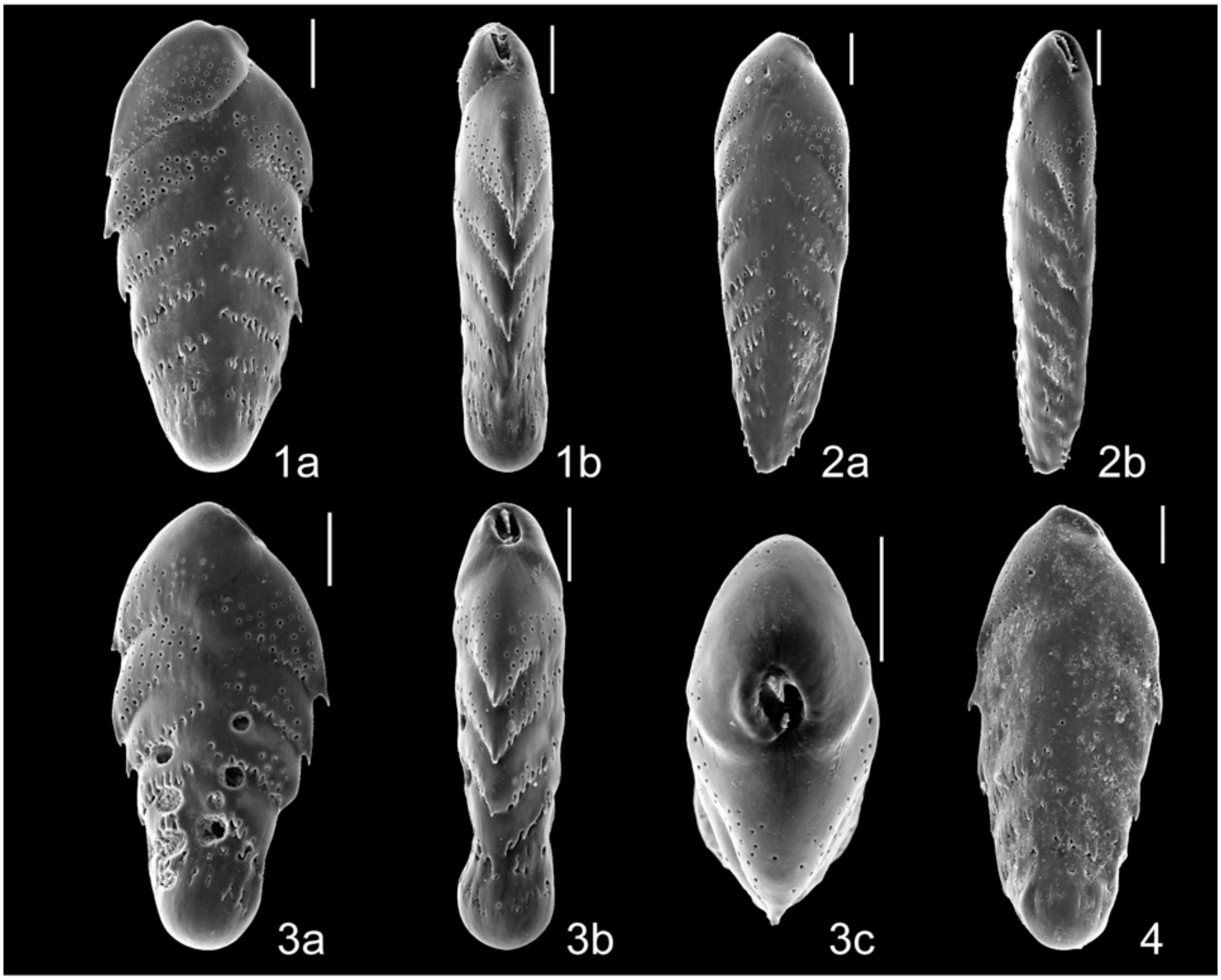

Plate 21

Scale bars = 50 μm

Bolivina ordinaria Phleger and Parker

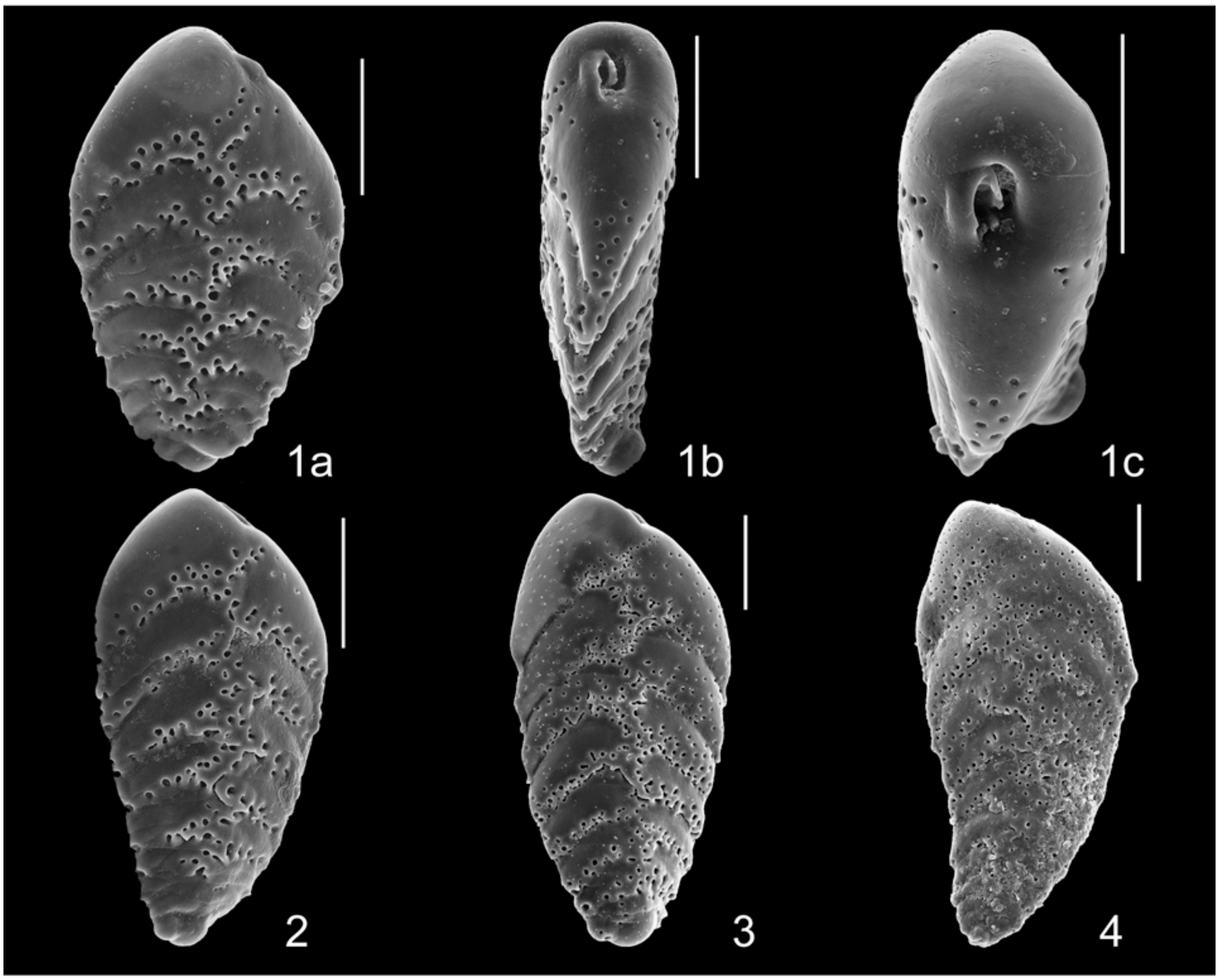

Plate 22

Scale bars = 50 μm

Bolivina sp. cf. *B. pusilla* Schwager

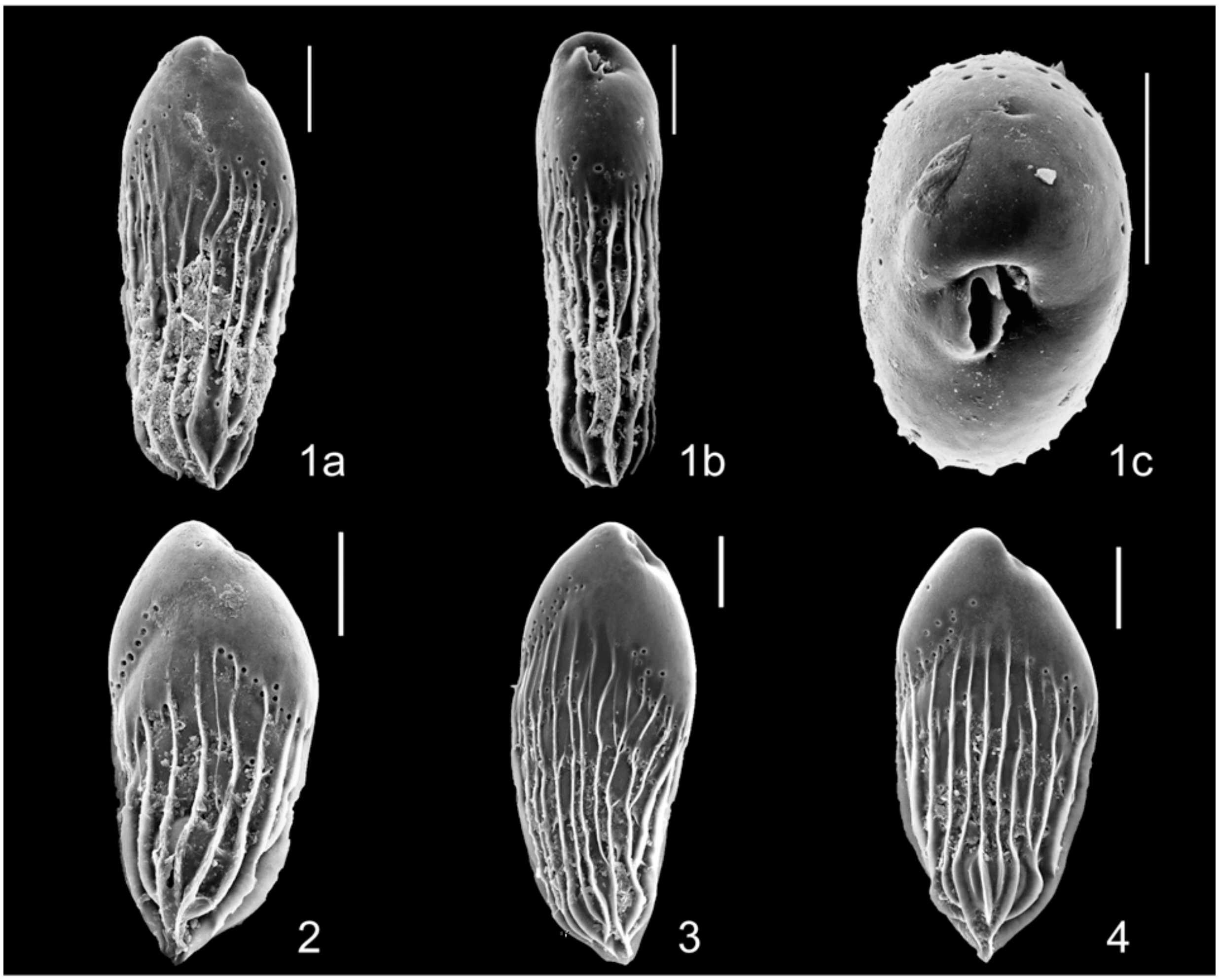

Plate 23 Scale bars = 50 μm

Bolivina subaenariensis Cushman

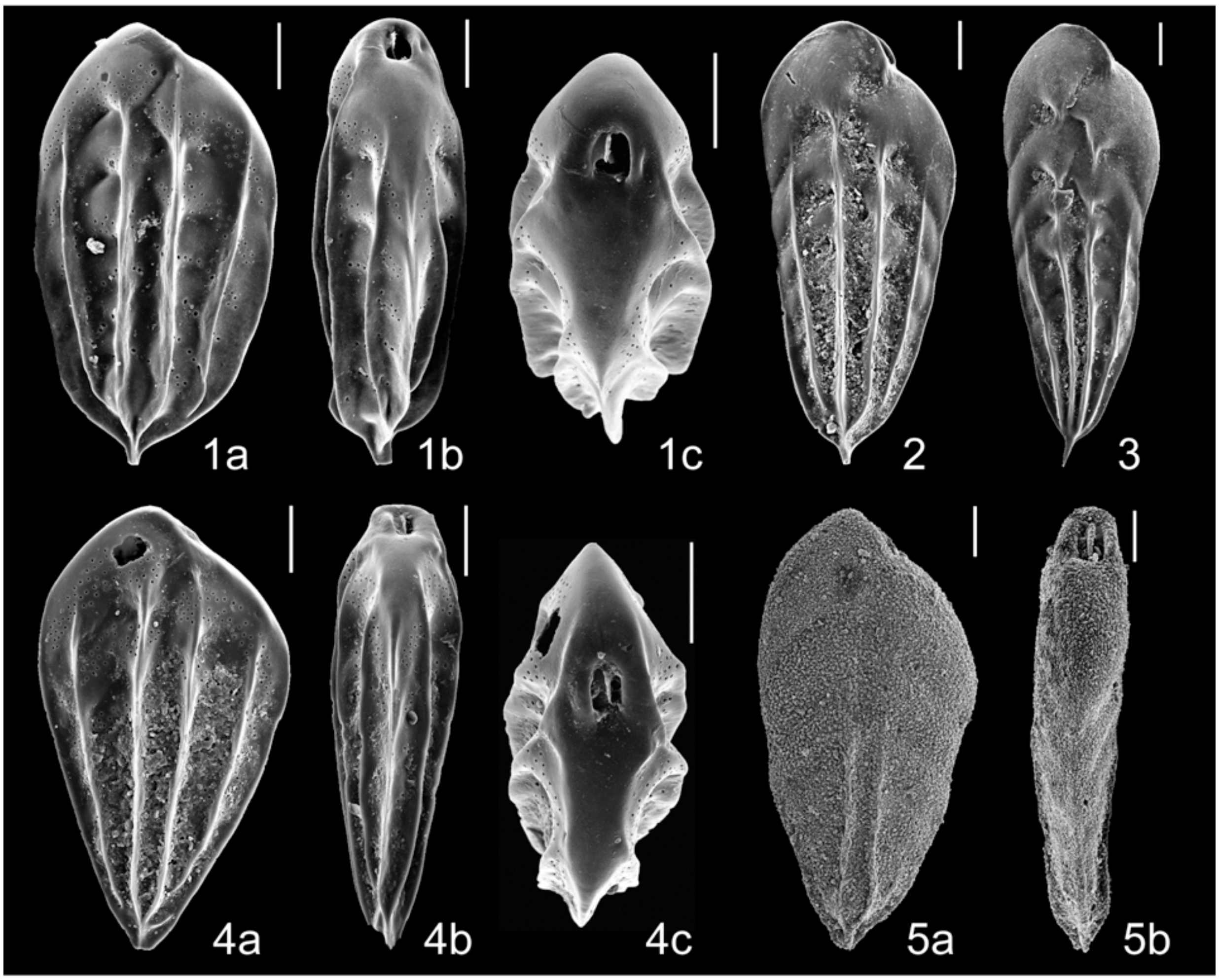

Plate 24

Scale bars = 50 μm

Bolivina translucens Phleger and Parker

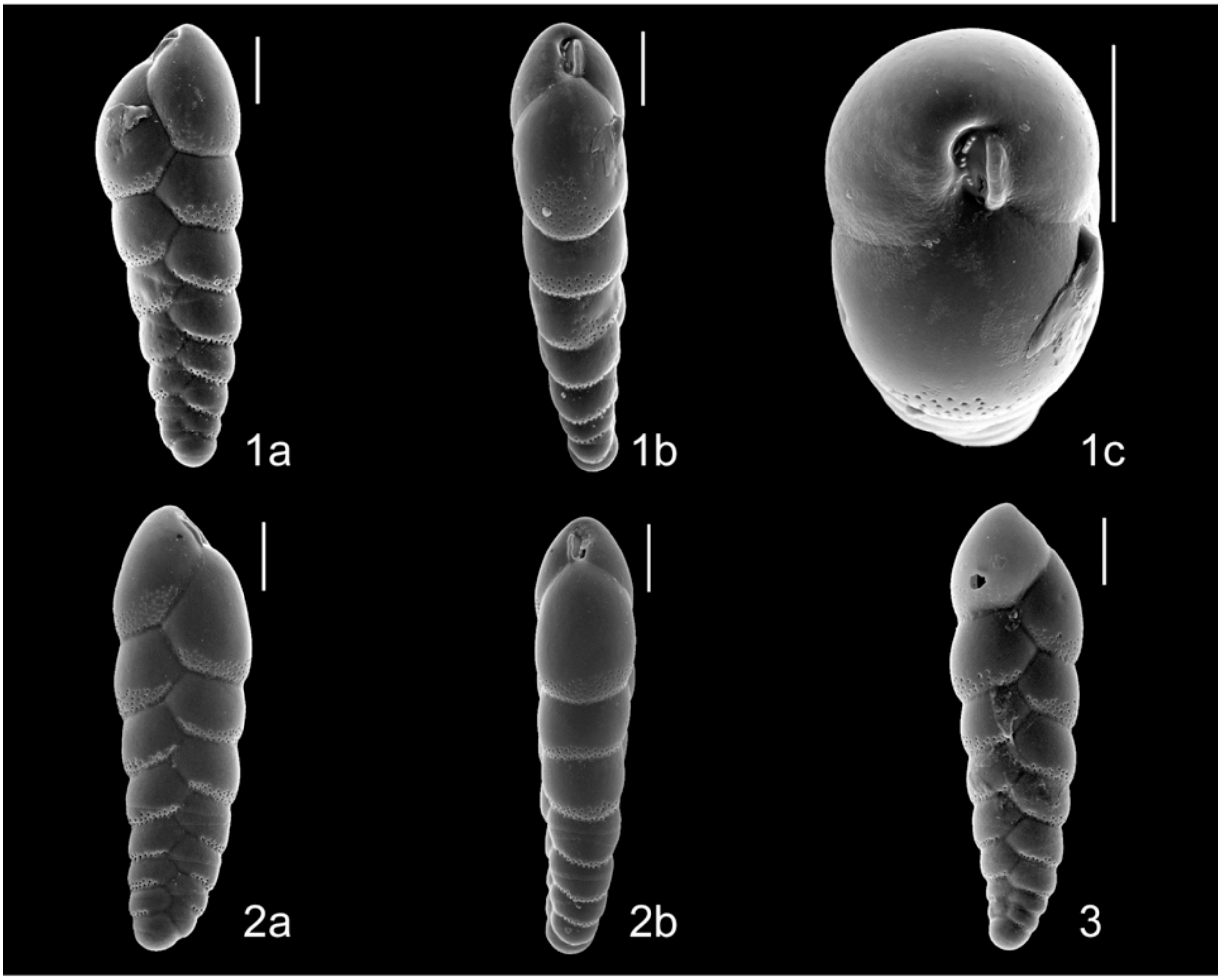

Plate 25

Scale bars = 50 μm

Bolivinita quadrilatera (Schwager)

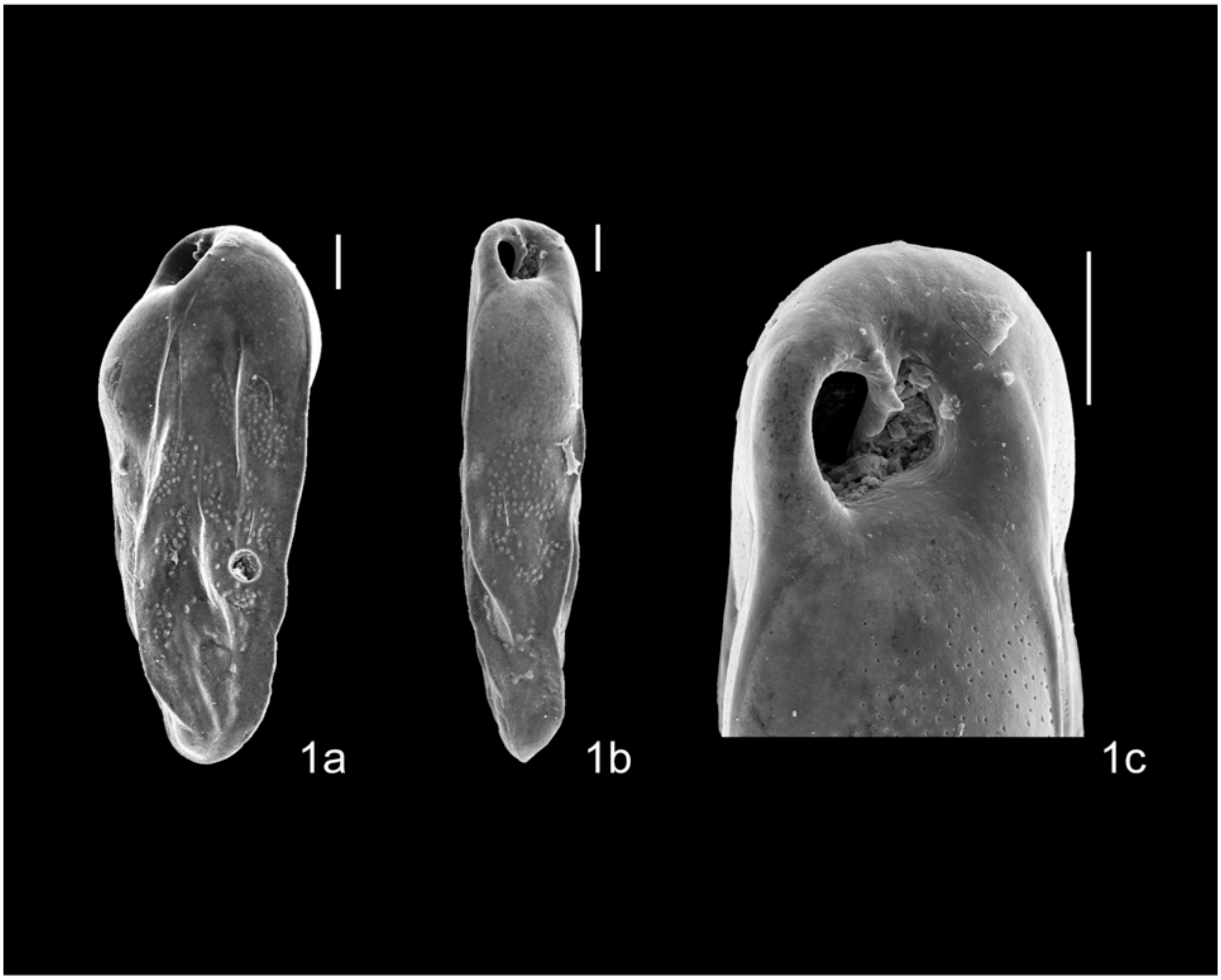

Plate 26 Scale bars = 50 μm

Bulimina aculeata d'Orbigny

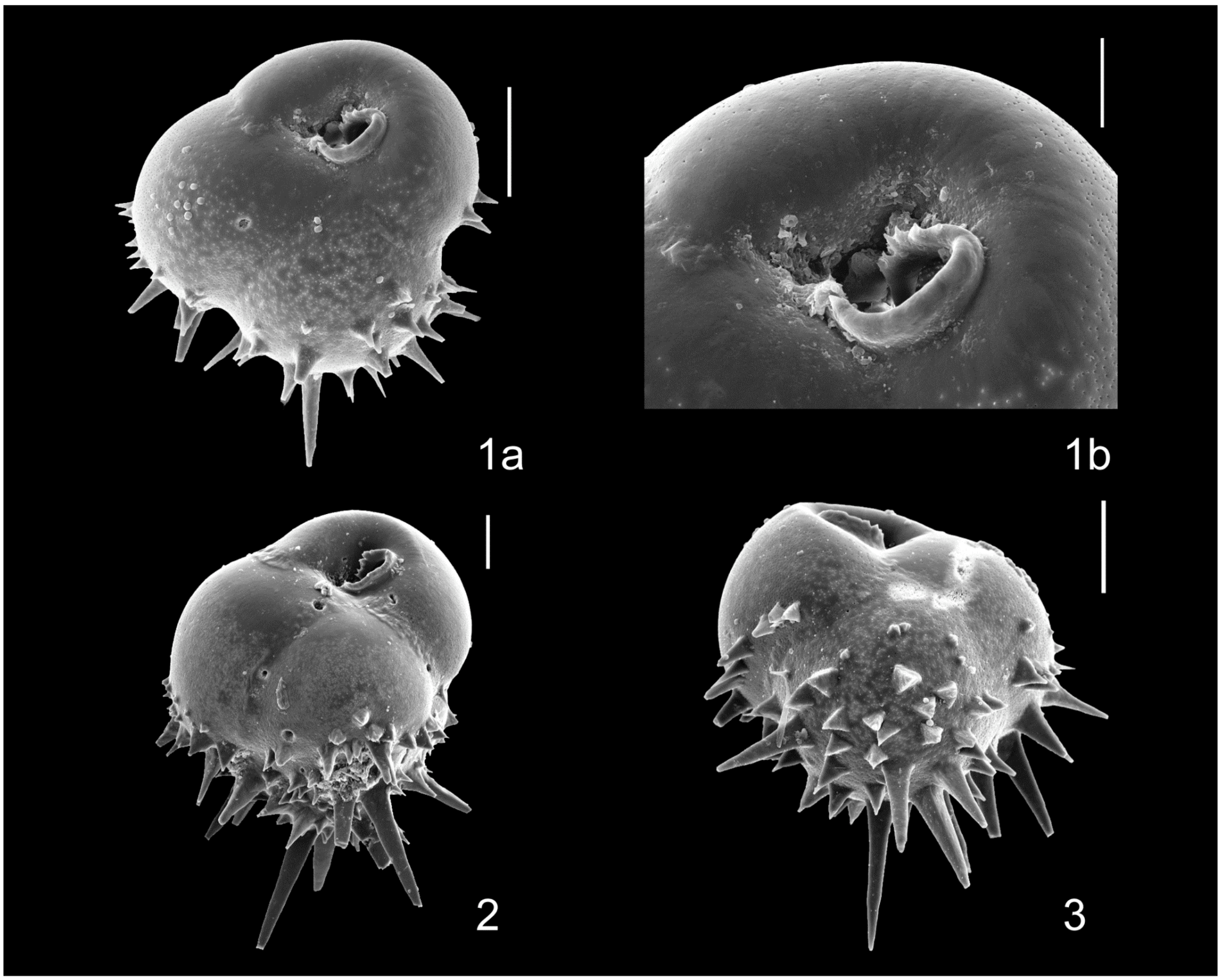

Plate 27

Scale bars = 50 μm
except in 1b (20 μm)

Bulimina alazanensis Cushman

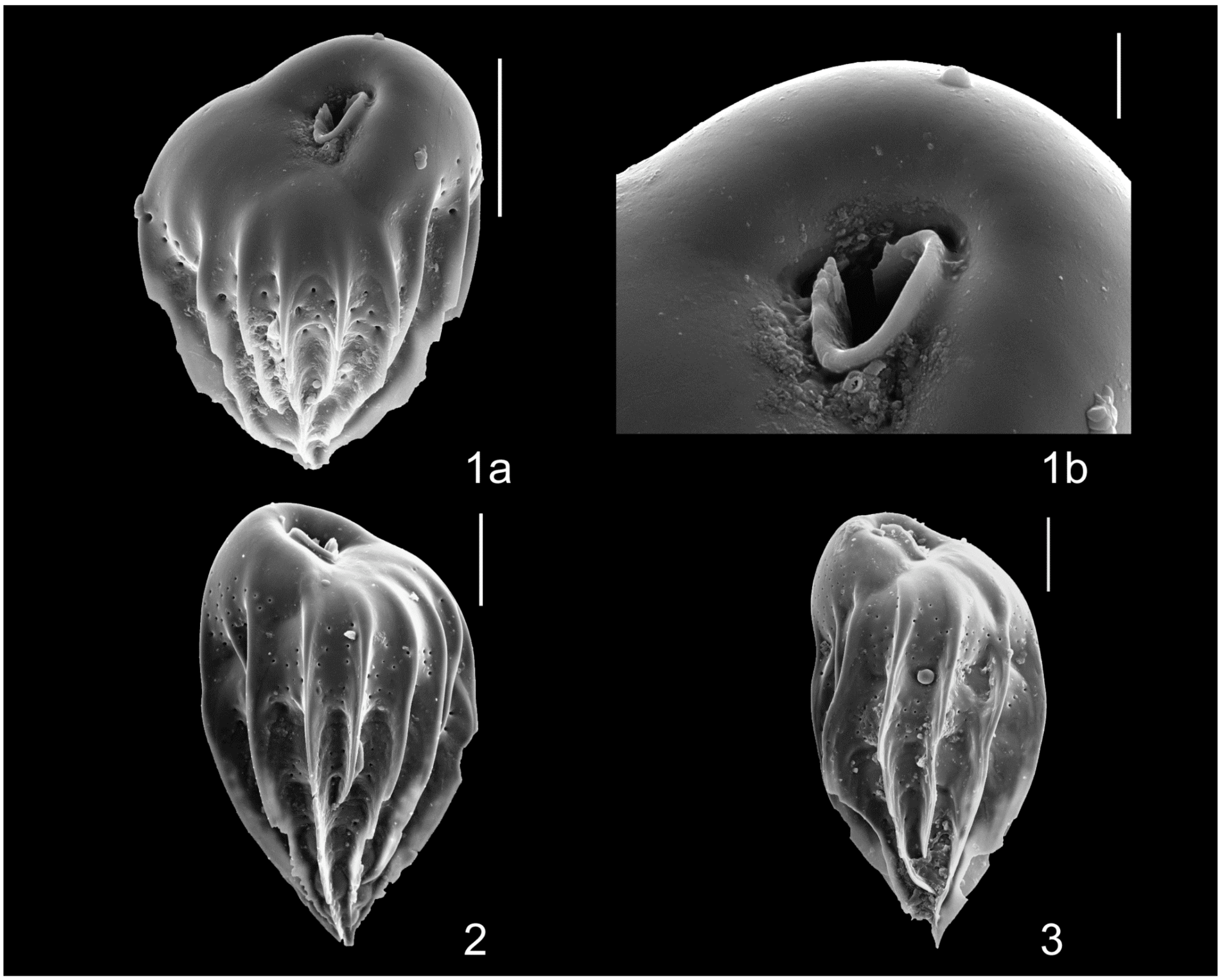

Plate 28

Scale bars = 50 µm
except in 1b (10 µm)

Bulimina marginata d'Orbigny

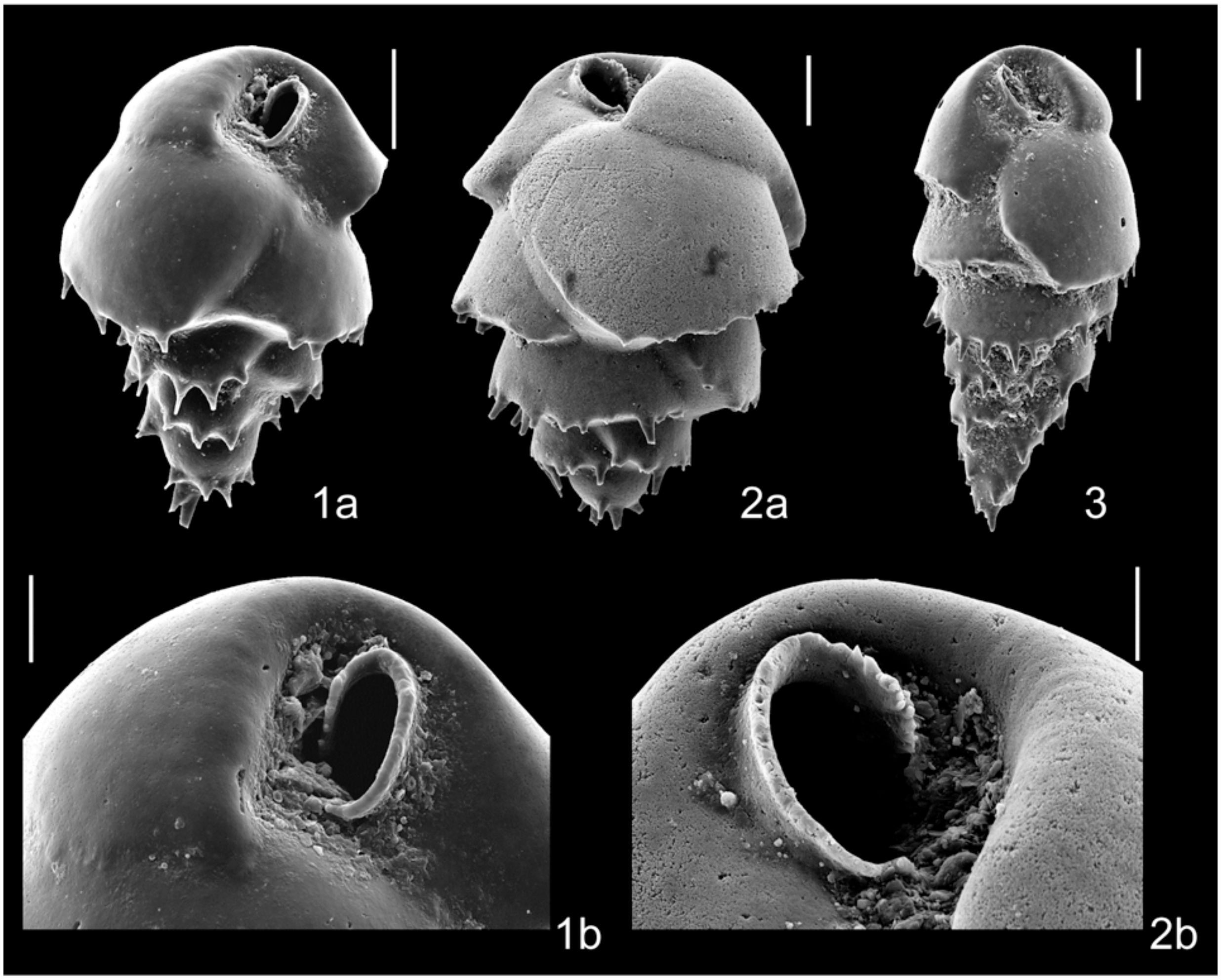

Plate 29

Scale bars = 50 μm
except in 1b & 2b (20 μm)

Bulimina mexicana Cushman

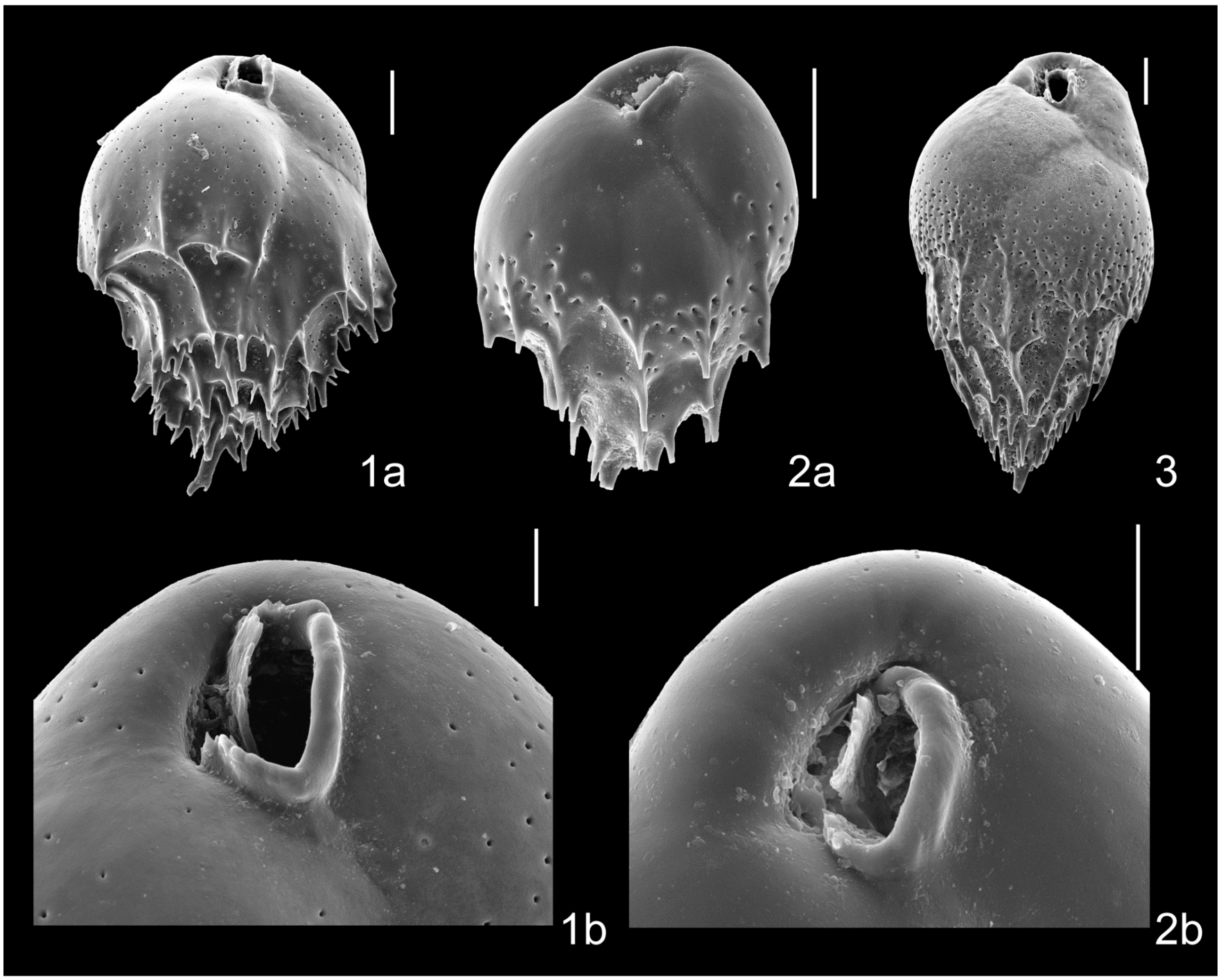

Plate 30

Scale bars = 50 μm
except in 1b & 2b (20 μm)

Buzasina ringens (Brady)

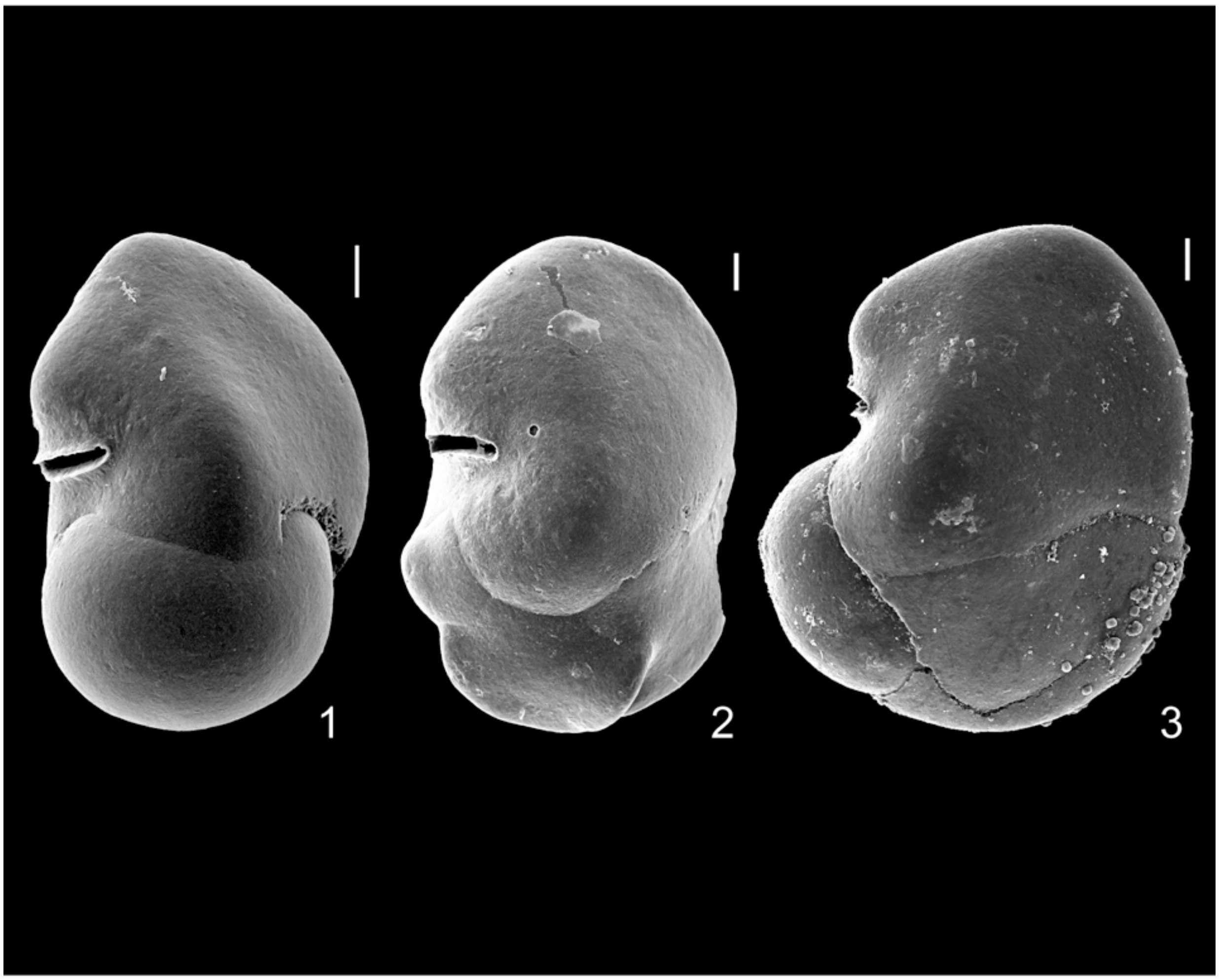

Plate 31

Scale bars = 50 µm

Calcituba polymorpha von Roboz

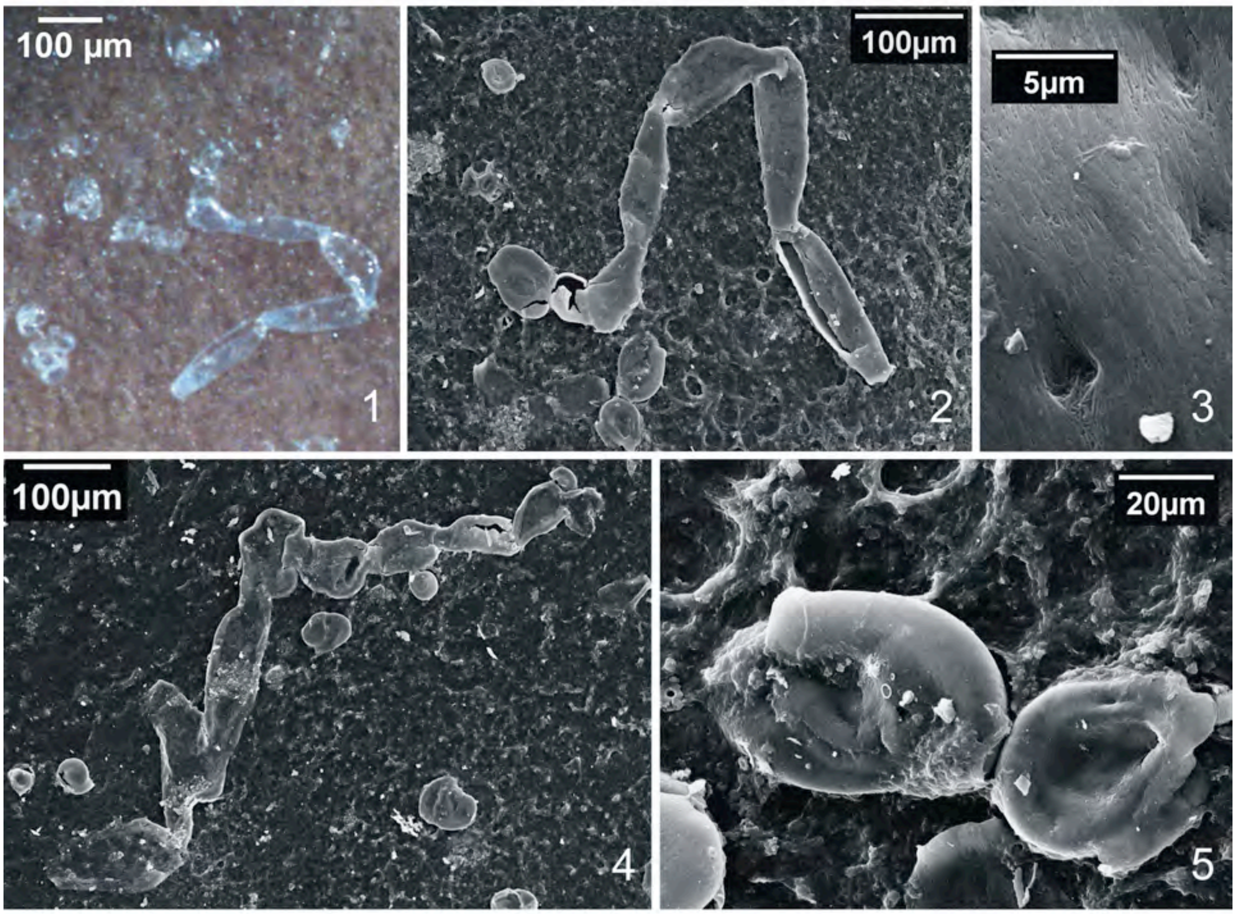

Plate 32

Cassidulina carinata Silvestri

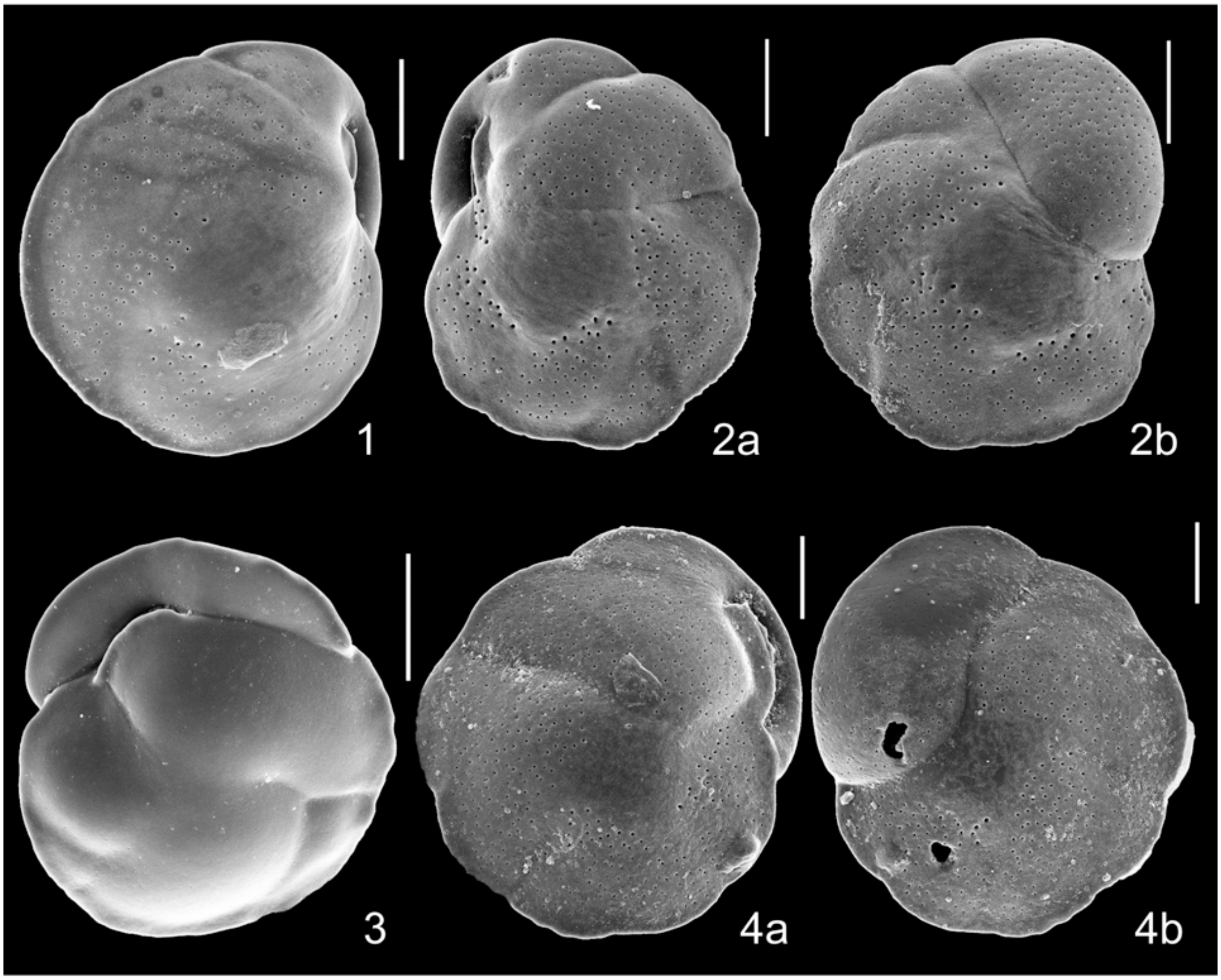

Plate 33

Scale bars = 50 μm

Cassidulina carinata Silvestri

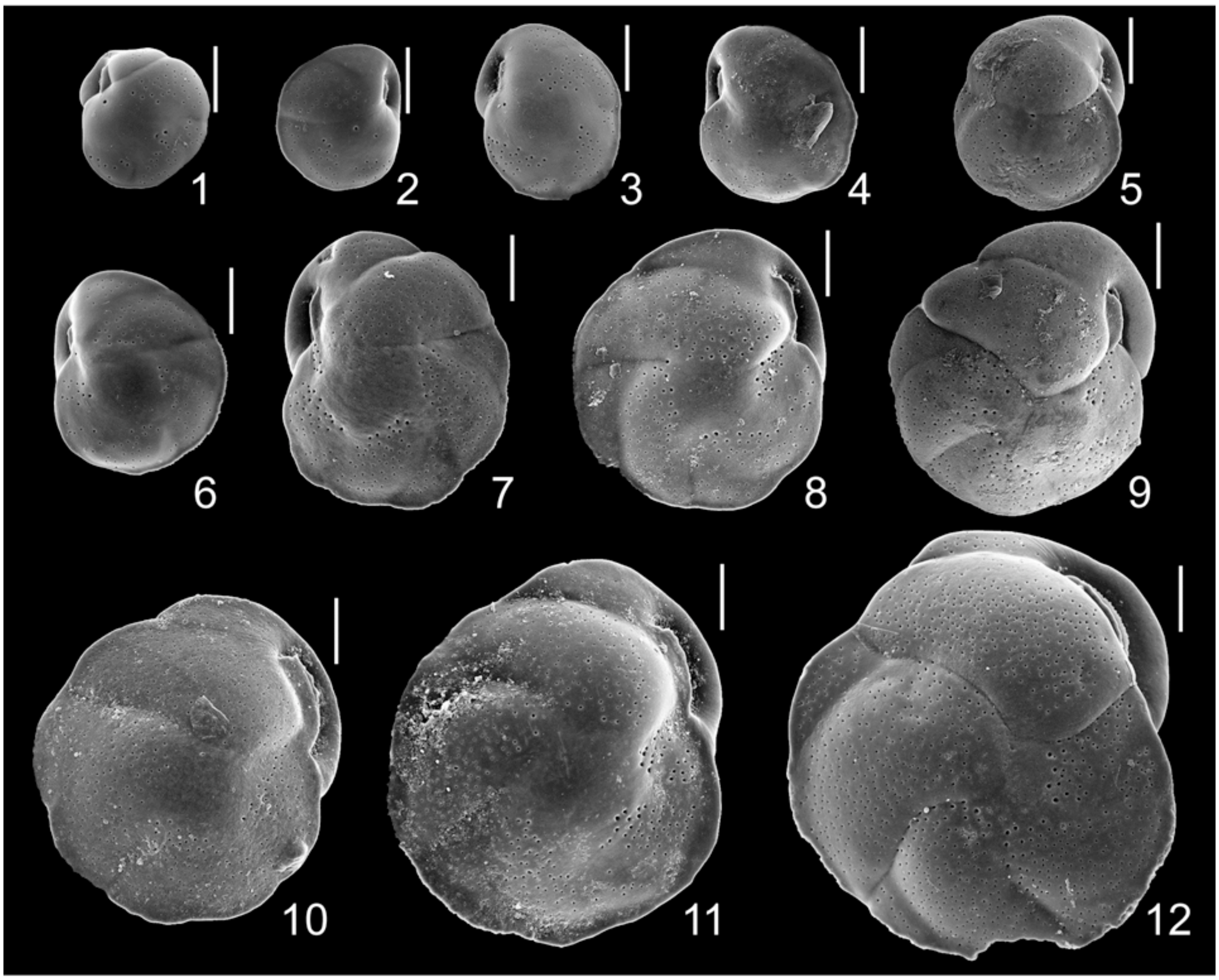

Plate 34

Scale bars = 50 µm

Cassidulina curvata Phleger and Parker

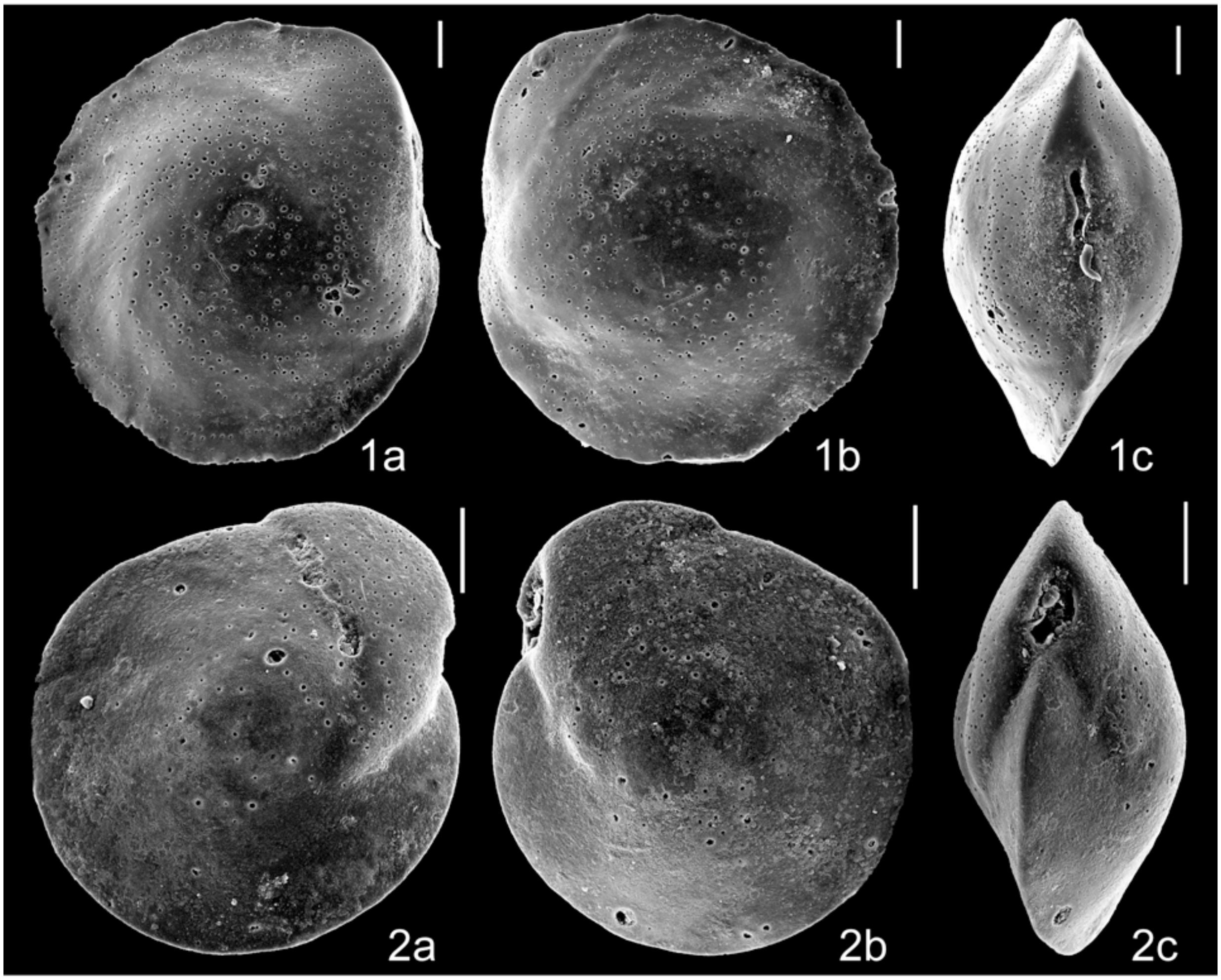

Plate 35

Scale bars = 50 μm

Cassidulina obtusa Williamson

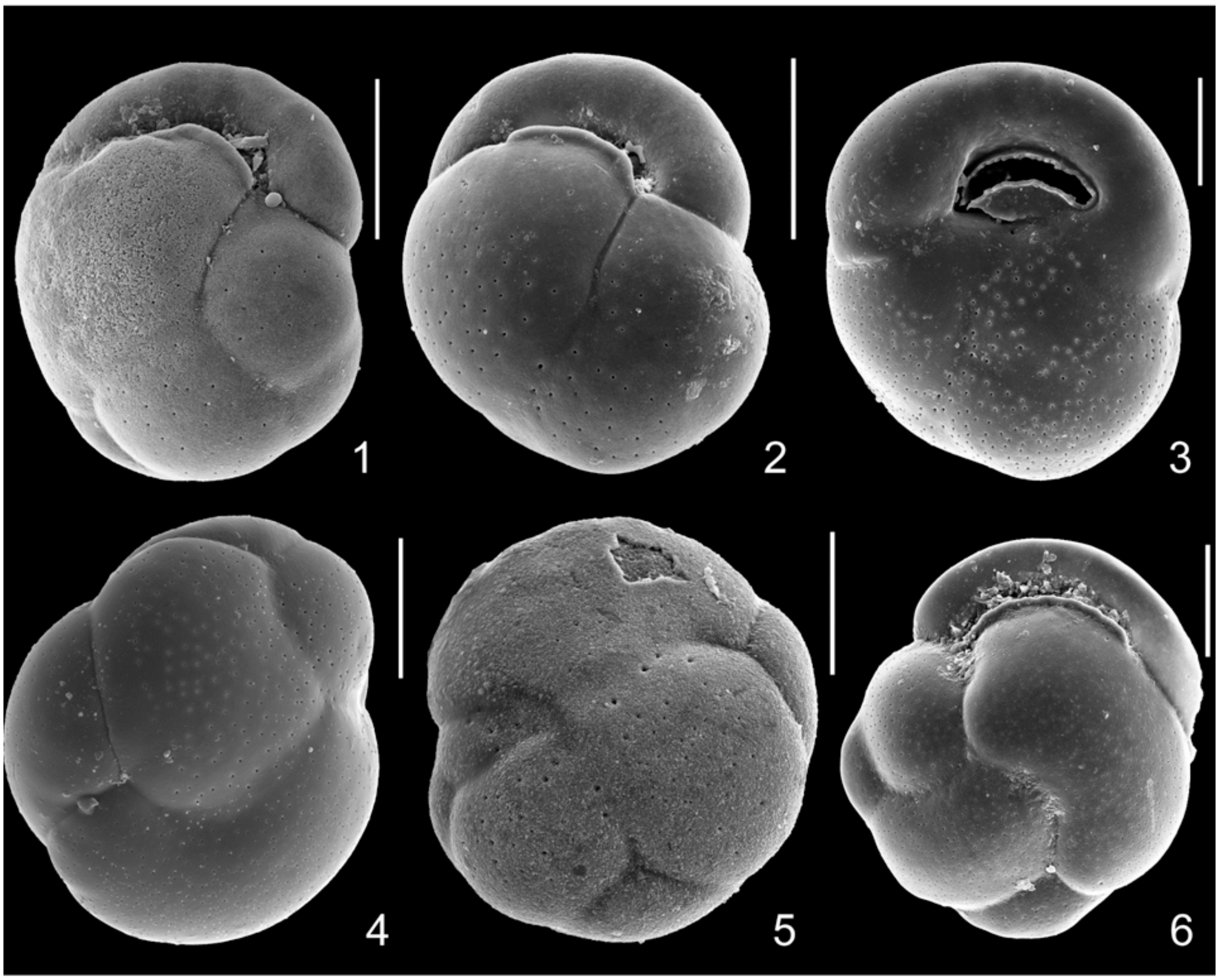

Plate 36

Scale bars = 50 μm

Cassidulinoides tenuis Phleger and Parker

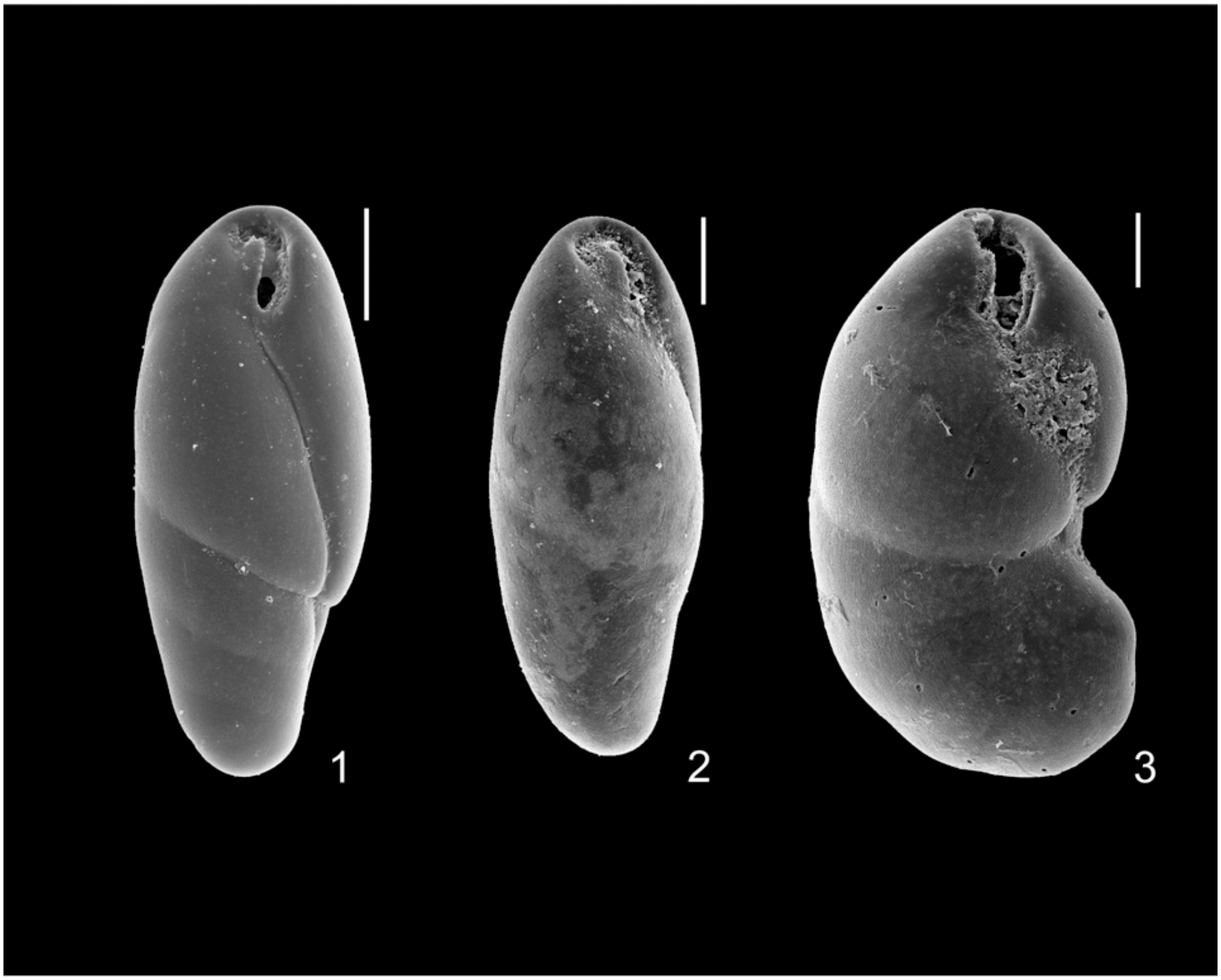

Plate 37 Scale bars = 50 μm

Chilostomella oolina Schwager

Plate 38 Scale bars = 50 μm

Cibicides lobatulus (Walker and Jacob)

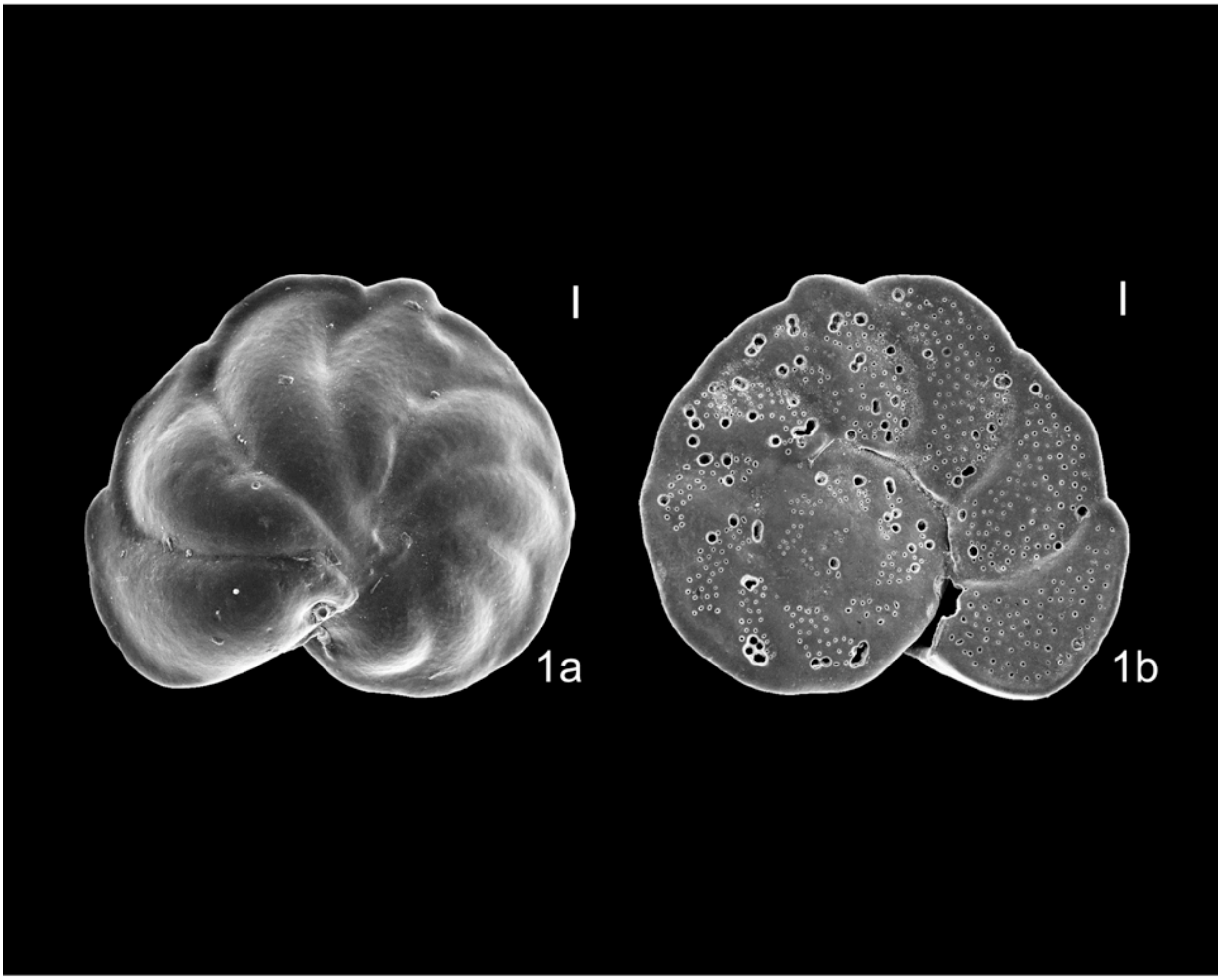

Plate 39

Scale bars = 50 μm

Cibicides wuellerstorfi (Schwager)

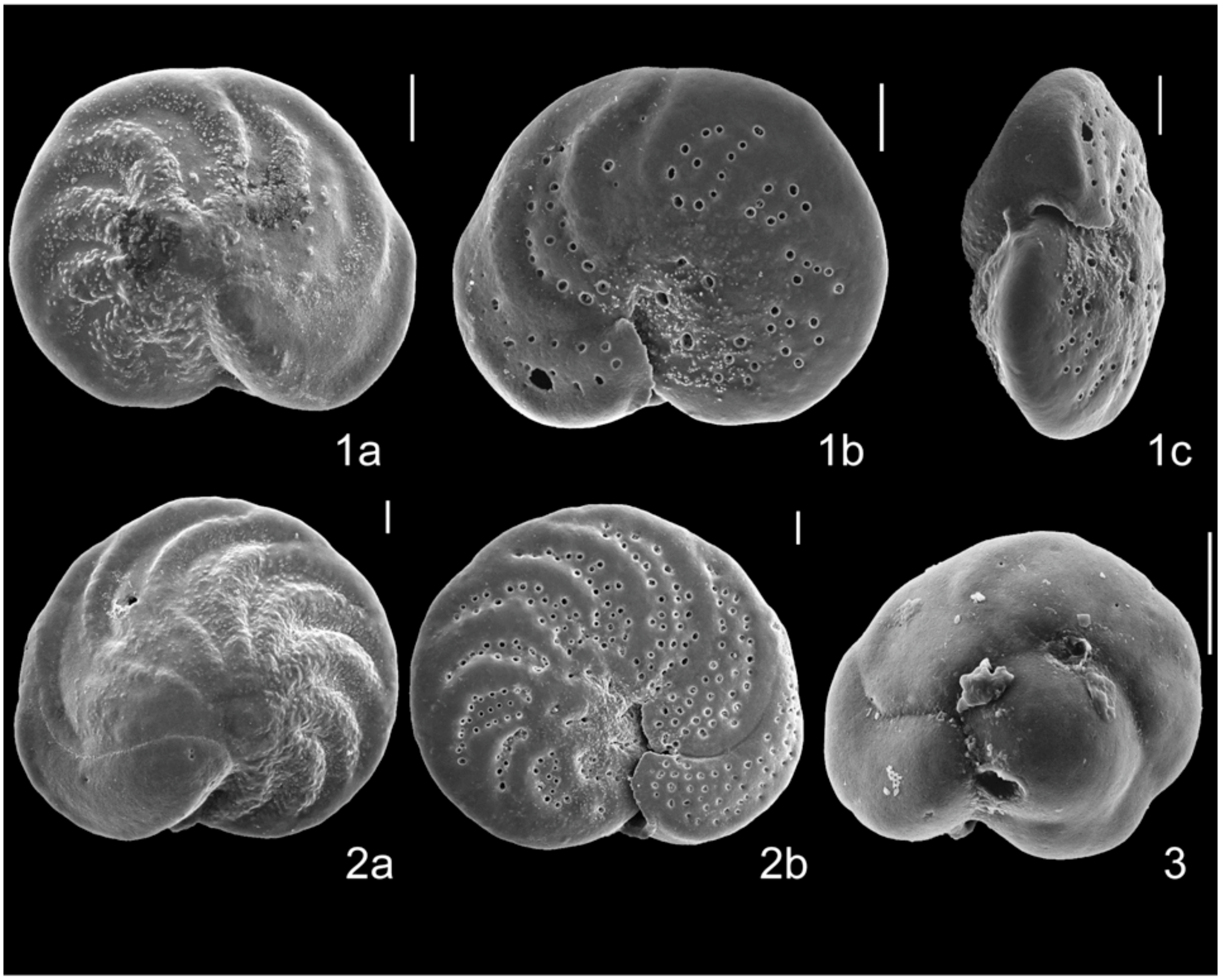

Plate 40

Scale bars = 50 µm

Cibicides wuellerstorfi (Schwager)

Plate 41

Cibicidoides pachyderma (Rzehak)

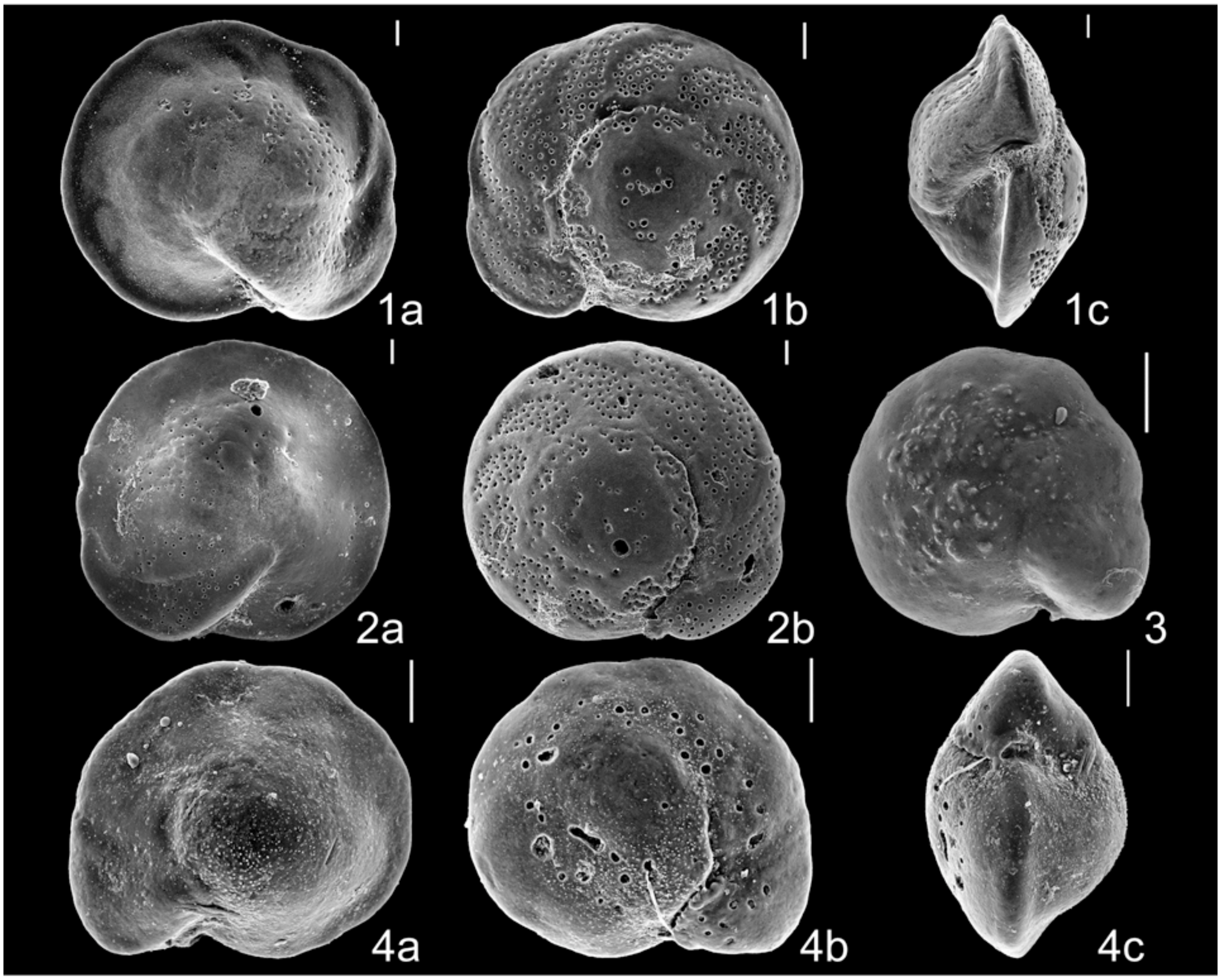

Plate 42 Scale bars = 50 μm

Cibicidoides pachyderma (Rzehak)

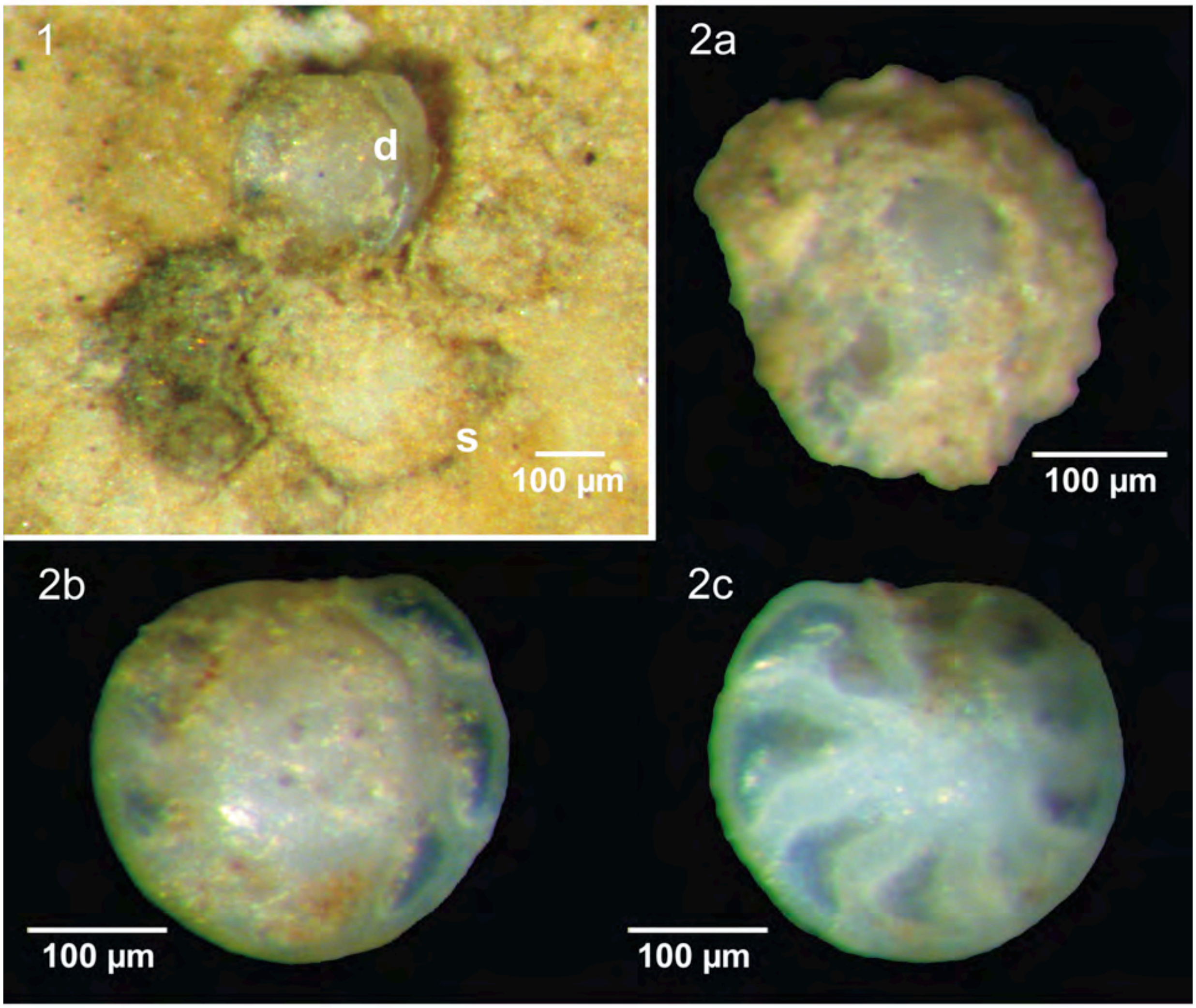

Plate 43

Cibicidoides robertsonianus (Brady)

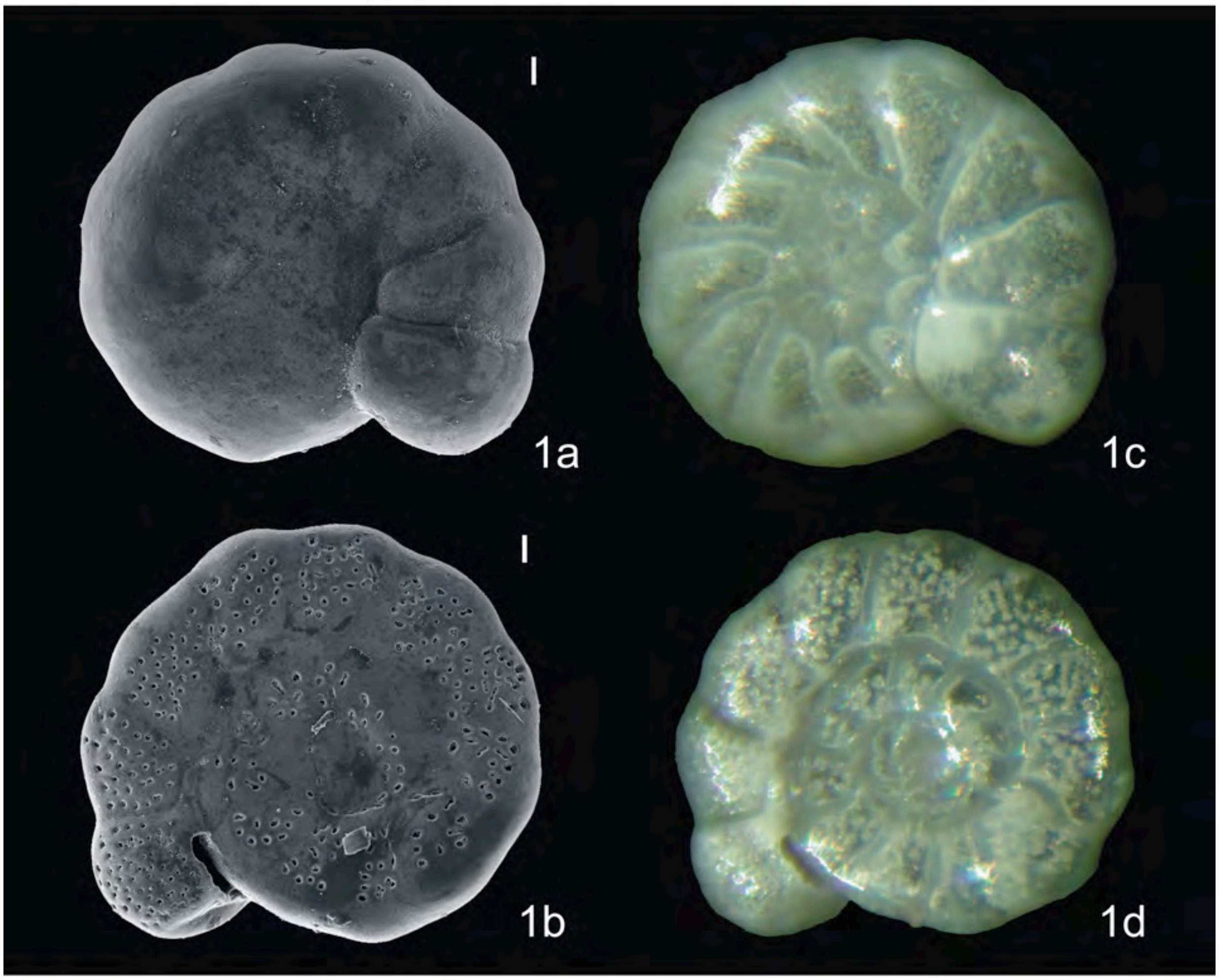

Plate 44 Scale bars = 50 μm

Cibicidoides robertsonianus (Brady)

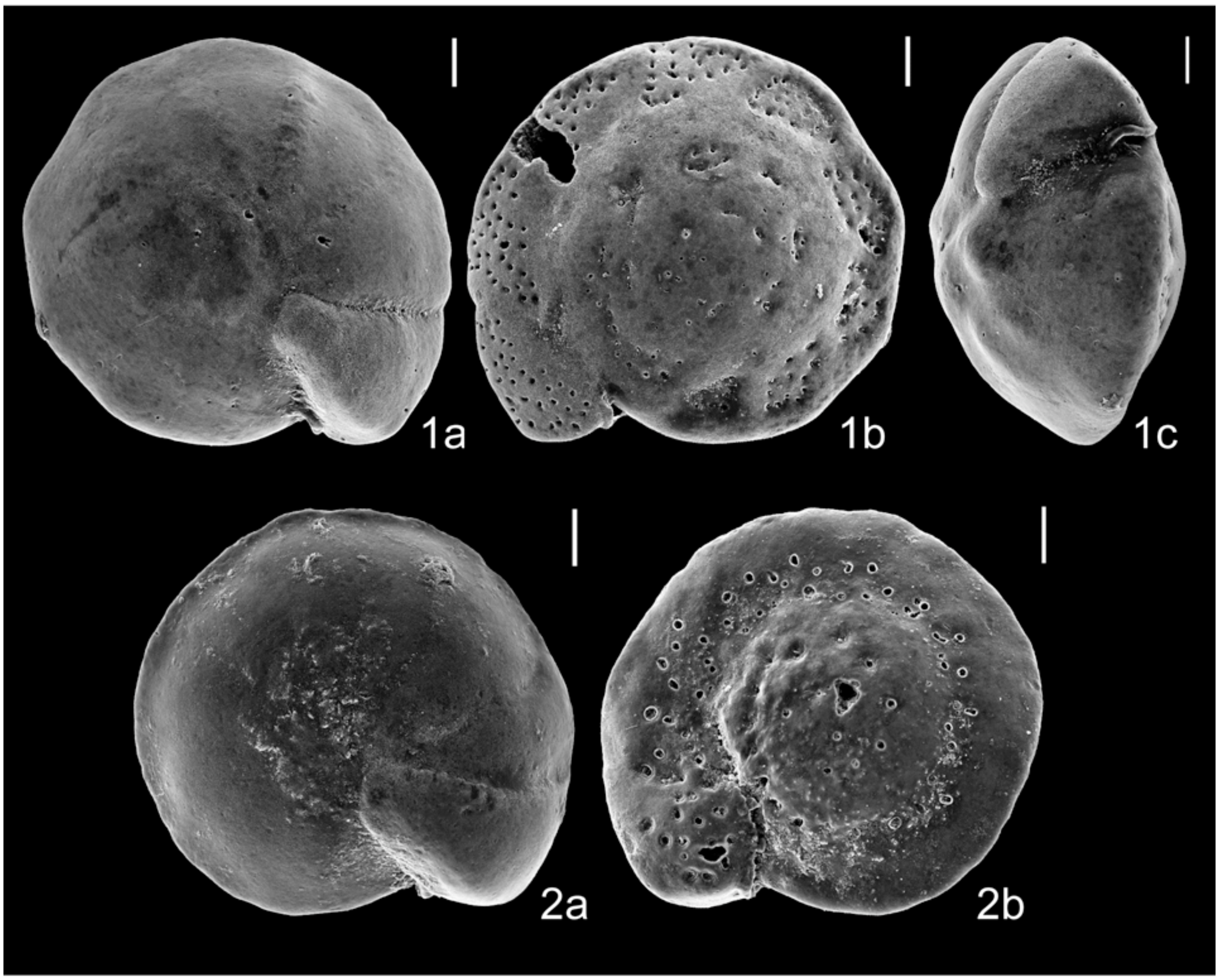

Plate 45

Scale bars = 50 μm

Cornuspira foliacea (Philippi)

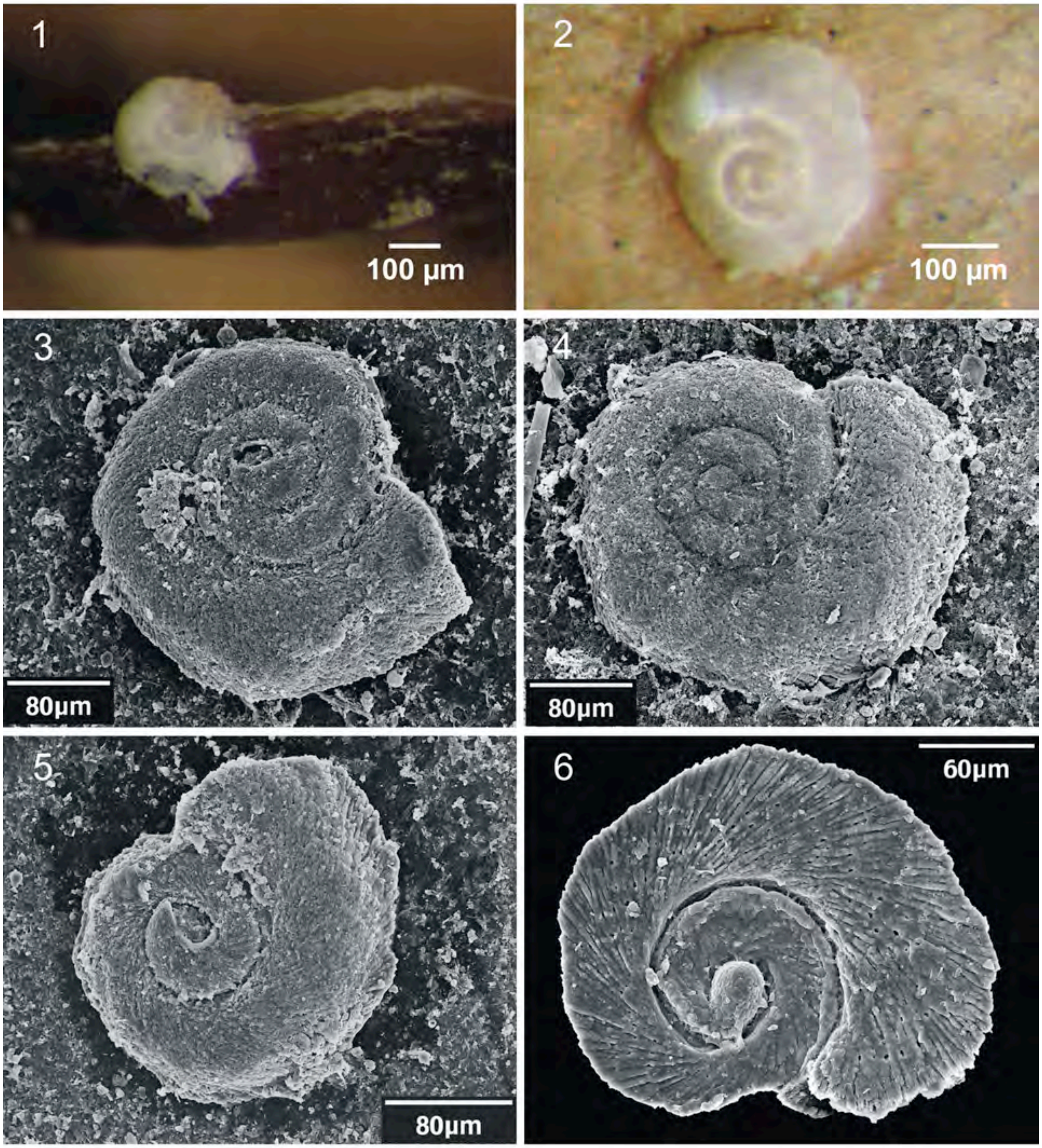

Plate 46

Cornuspira involvens (Reuss)

Plate 47 Scale bars = 50 μm

Cornuspira involvens (Reuss)

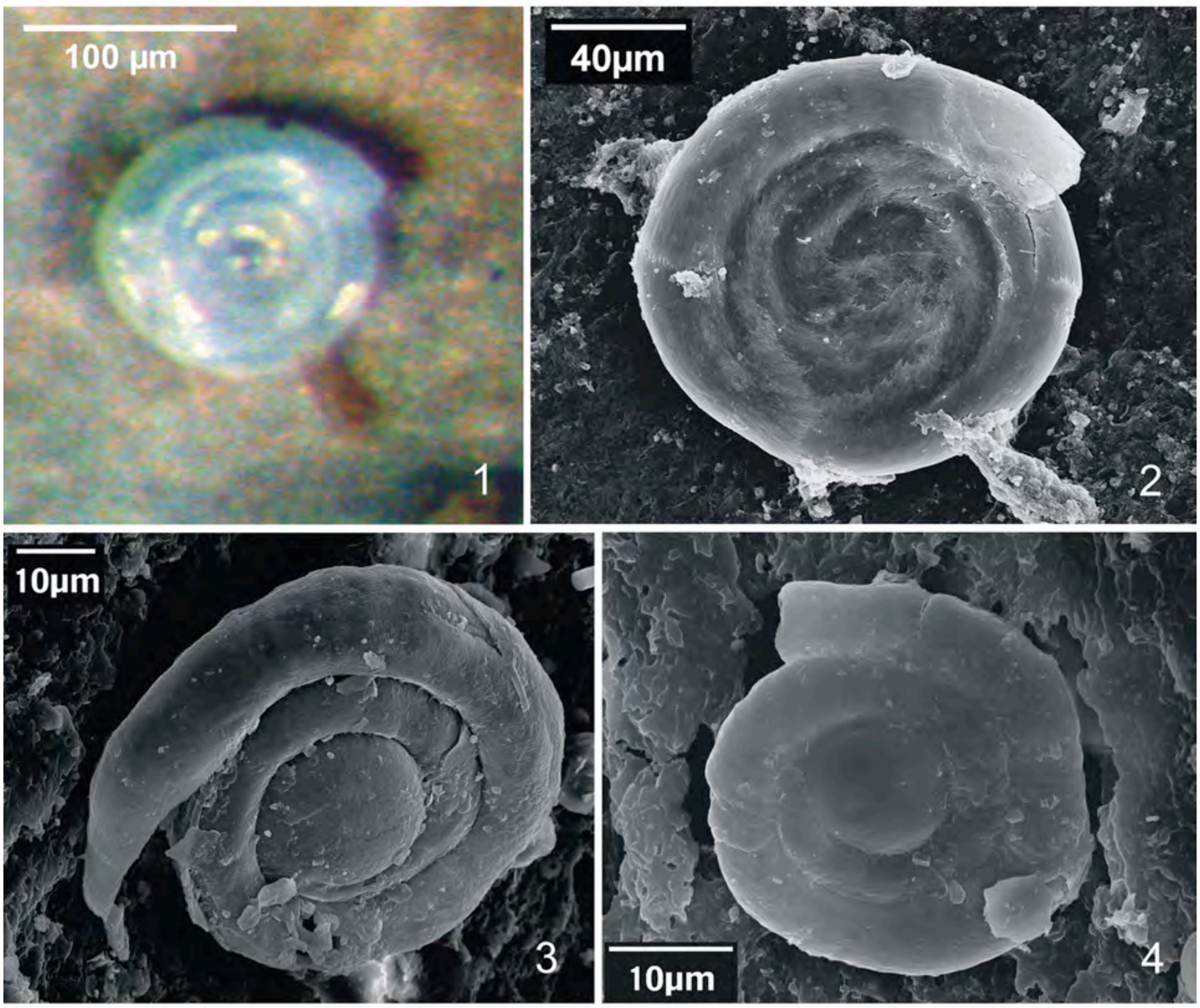

Plate 48

Cribromiliolinella subvalvularis (Parr)

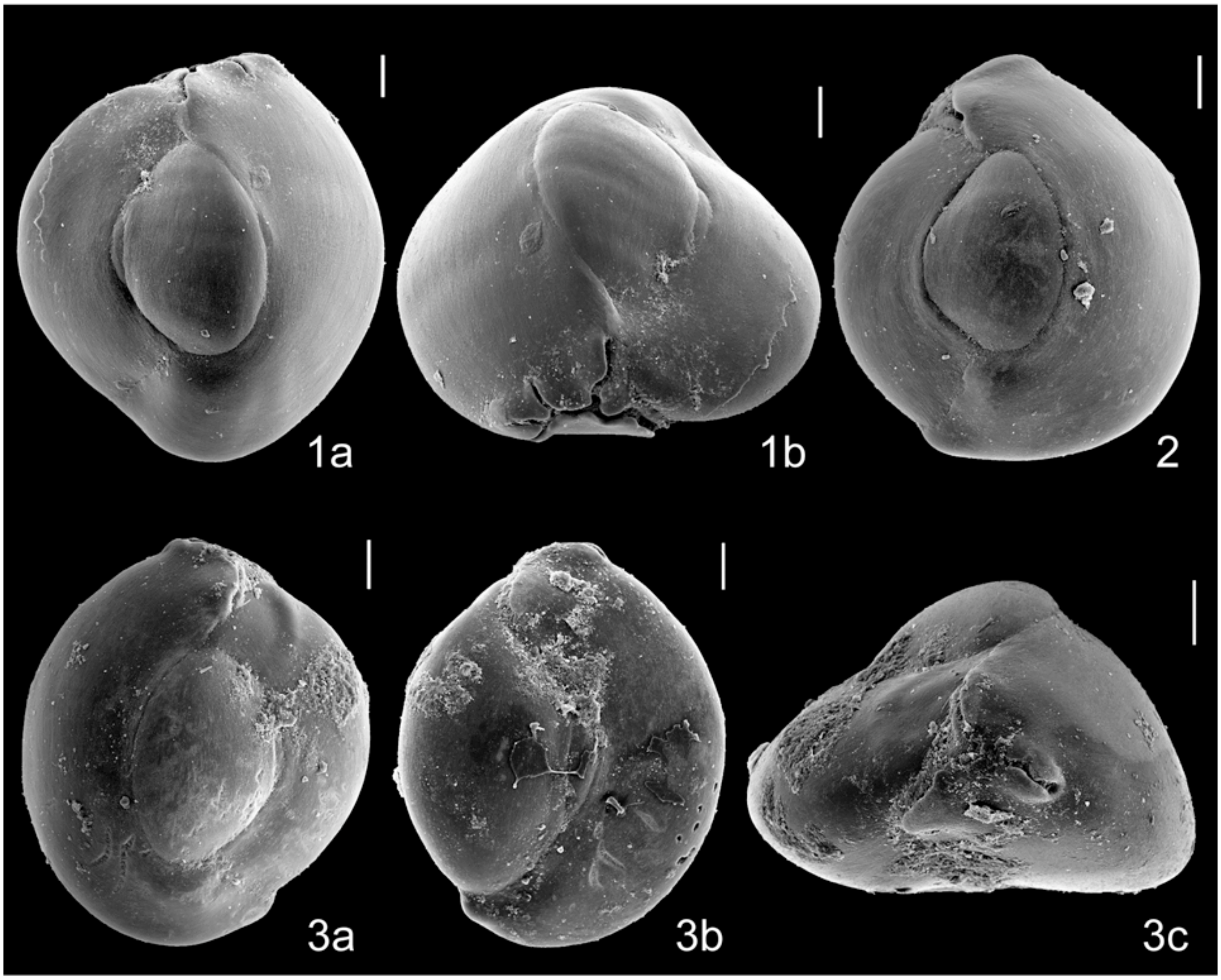

Plate 49

Scale bars = 50 µm

Cribrostomoides subglobosus (Cushman)

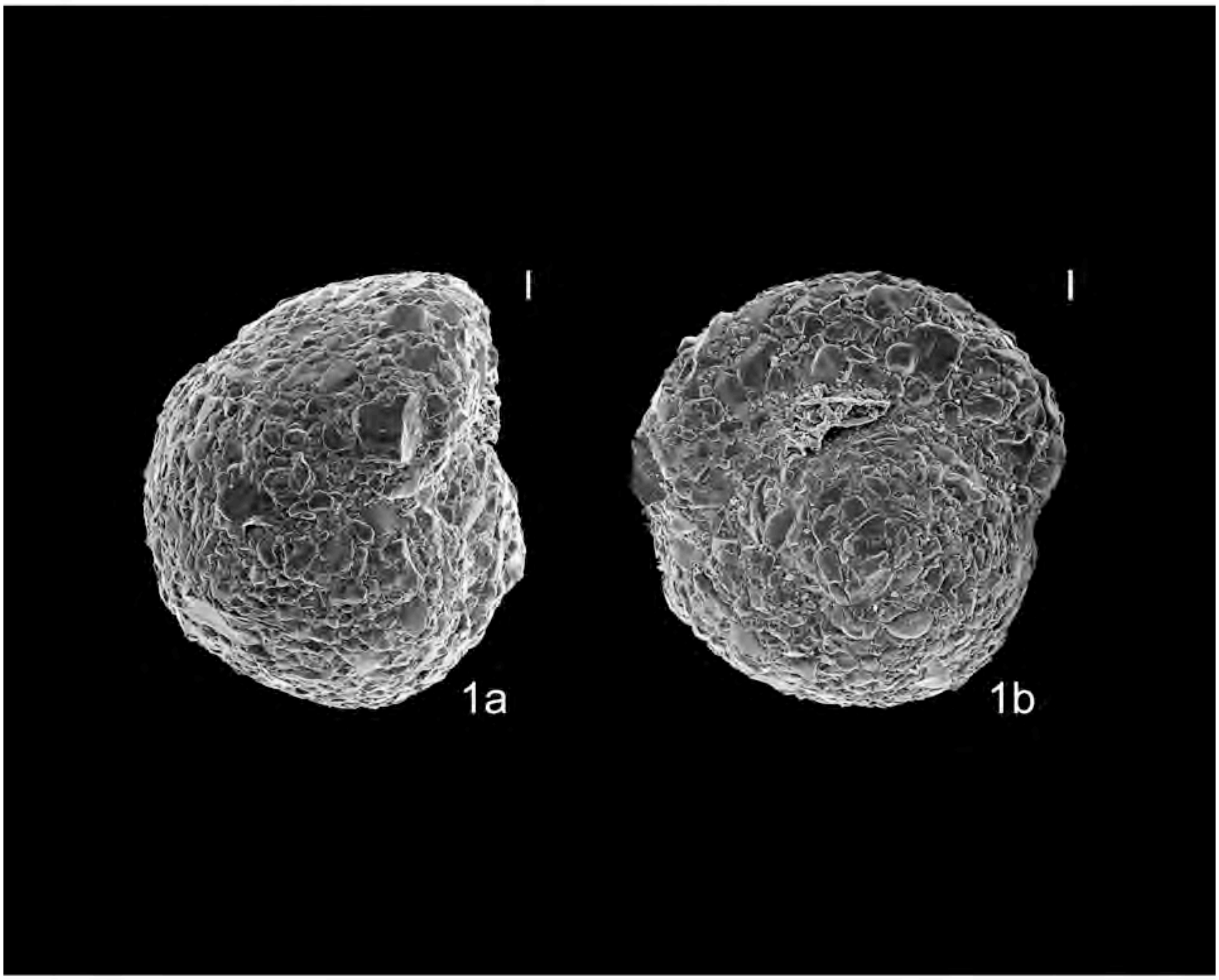

Plate 50

Scale bars = 50 μm

Cystammina pauciloculata (Brady)

Plate 51

Scale bars = 50 μm

Dentalina sp.

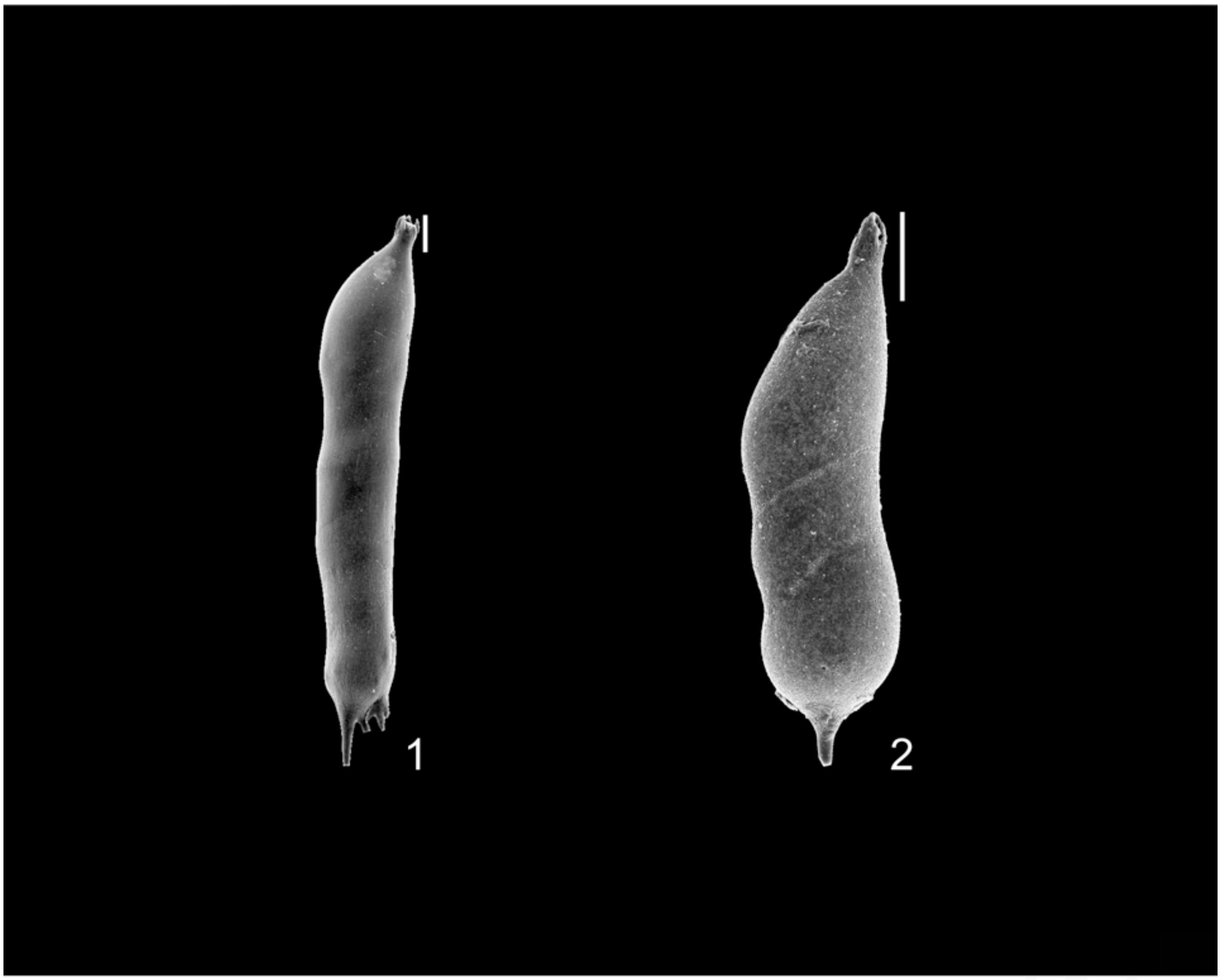

Plate 52 Scale bars = 50 μm

Deuterammina rotaliformis (Heron-Allen and Earland)

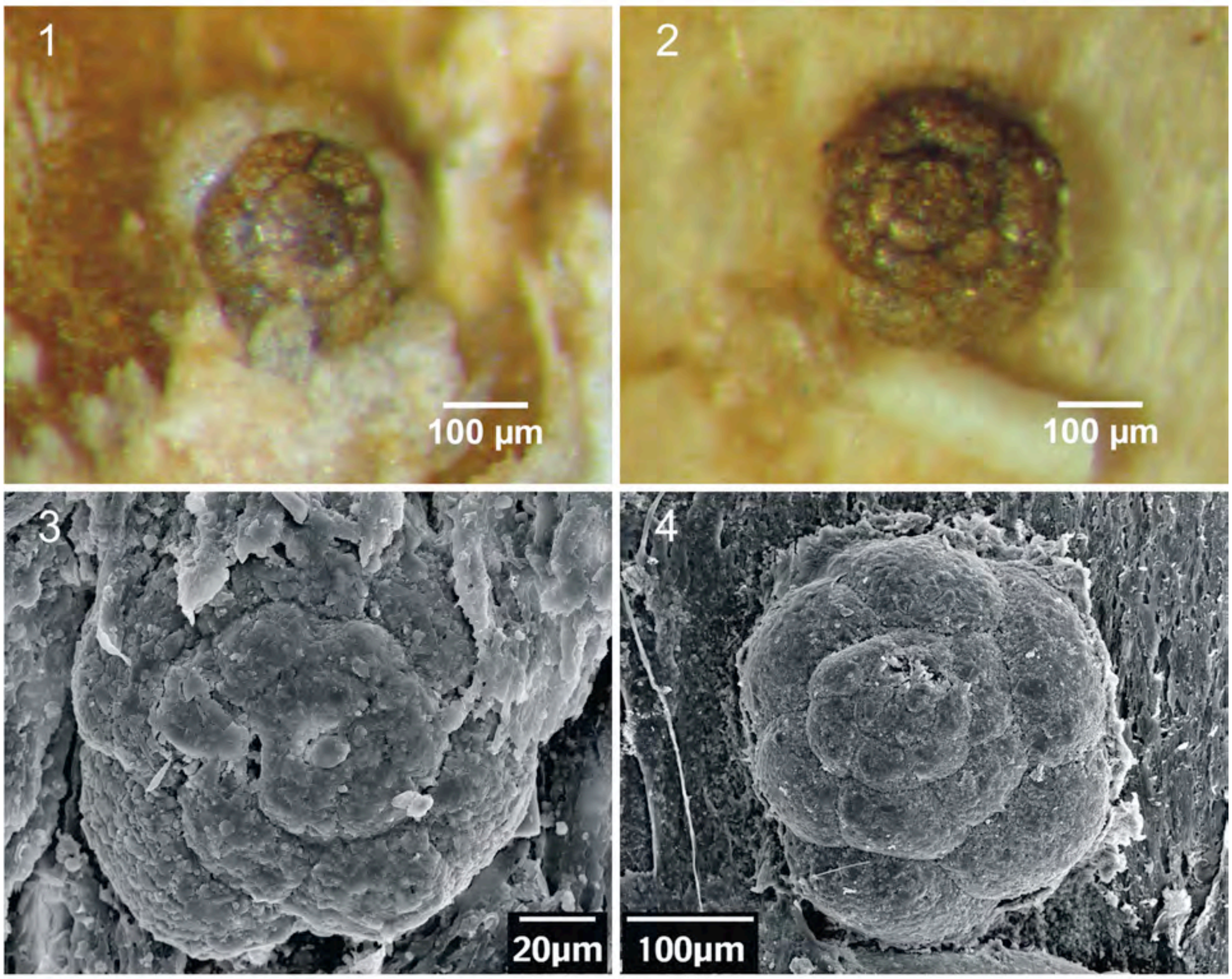

Plate 53

Discammina compressa (Goës)

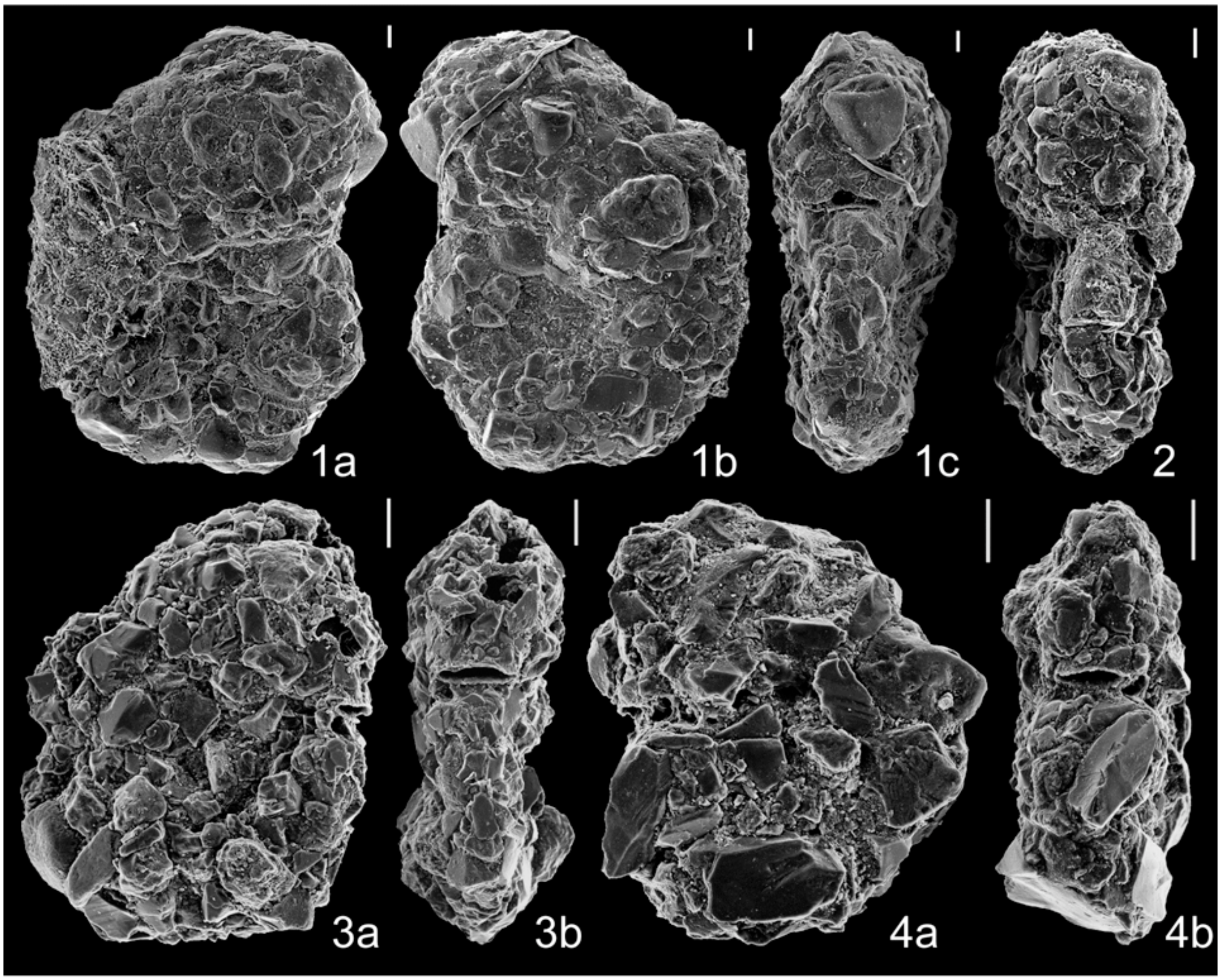

Plate 54

Scale bars = 50 µm

Discanomalina semipunctata (Bailey)

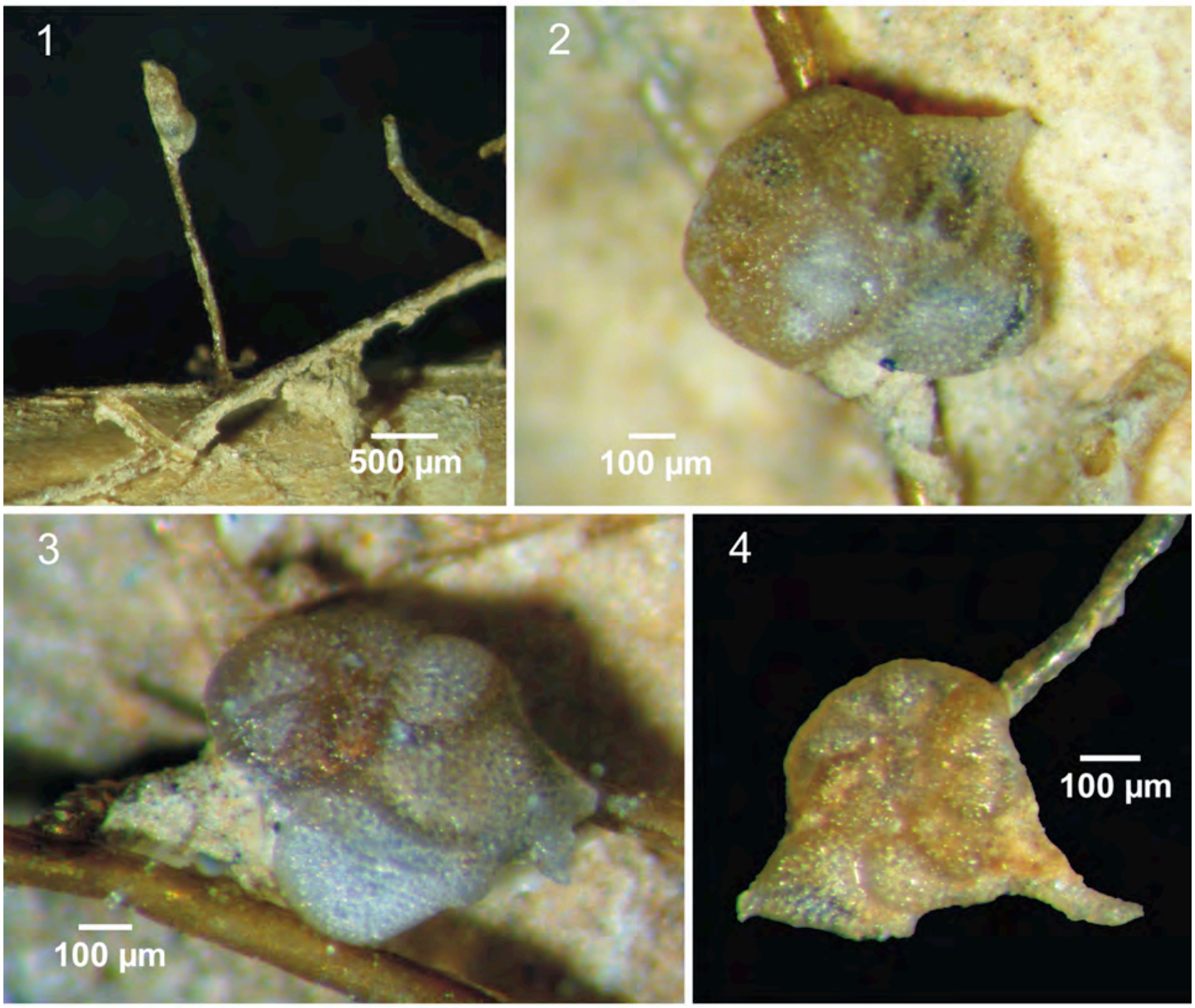

Plate 55

Discanomalina semipunctata (Bailey)

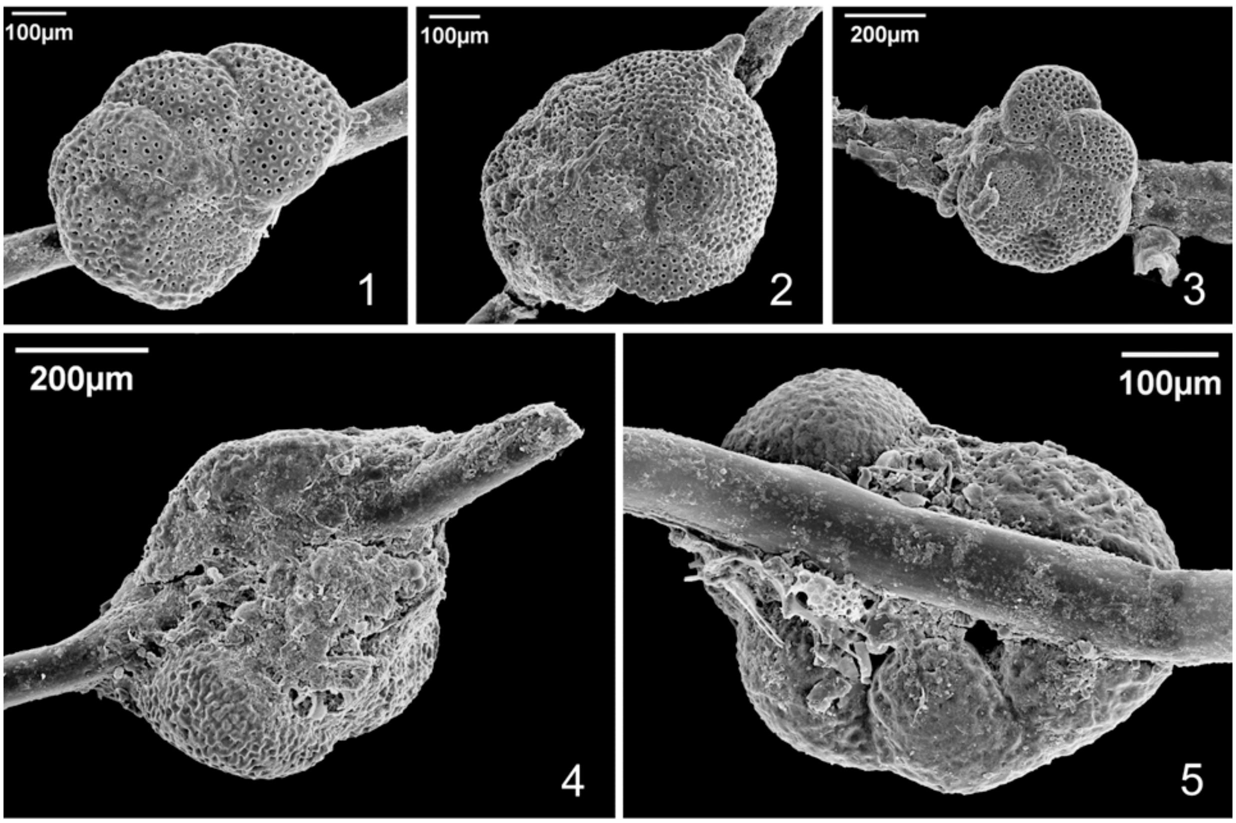

Plate 56

Dorothia scabra (Brady)

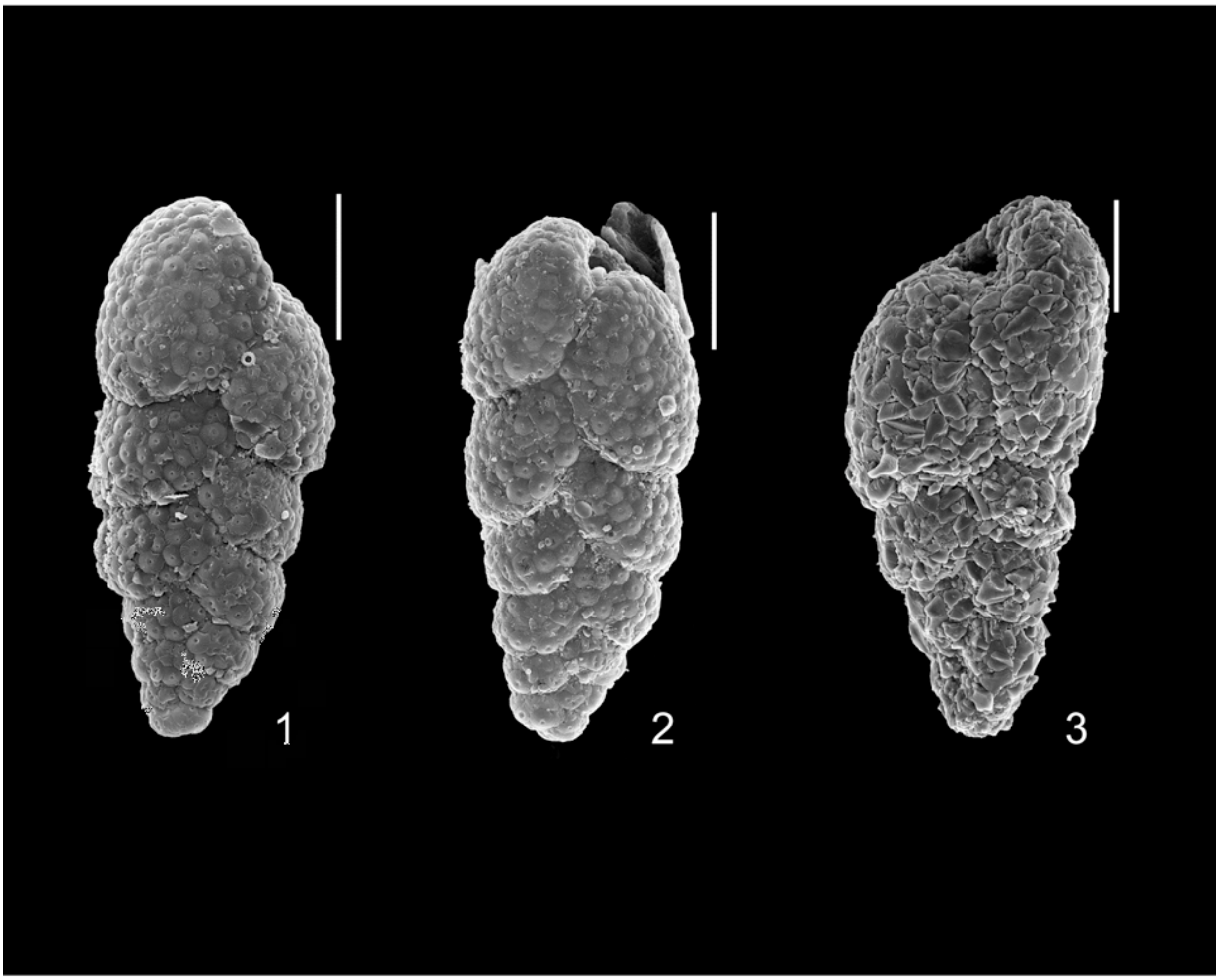

Plate 57

Scale bars = 50 μm

Eggerella bradyi (Cushman)

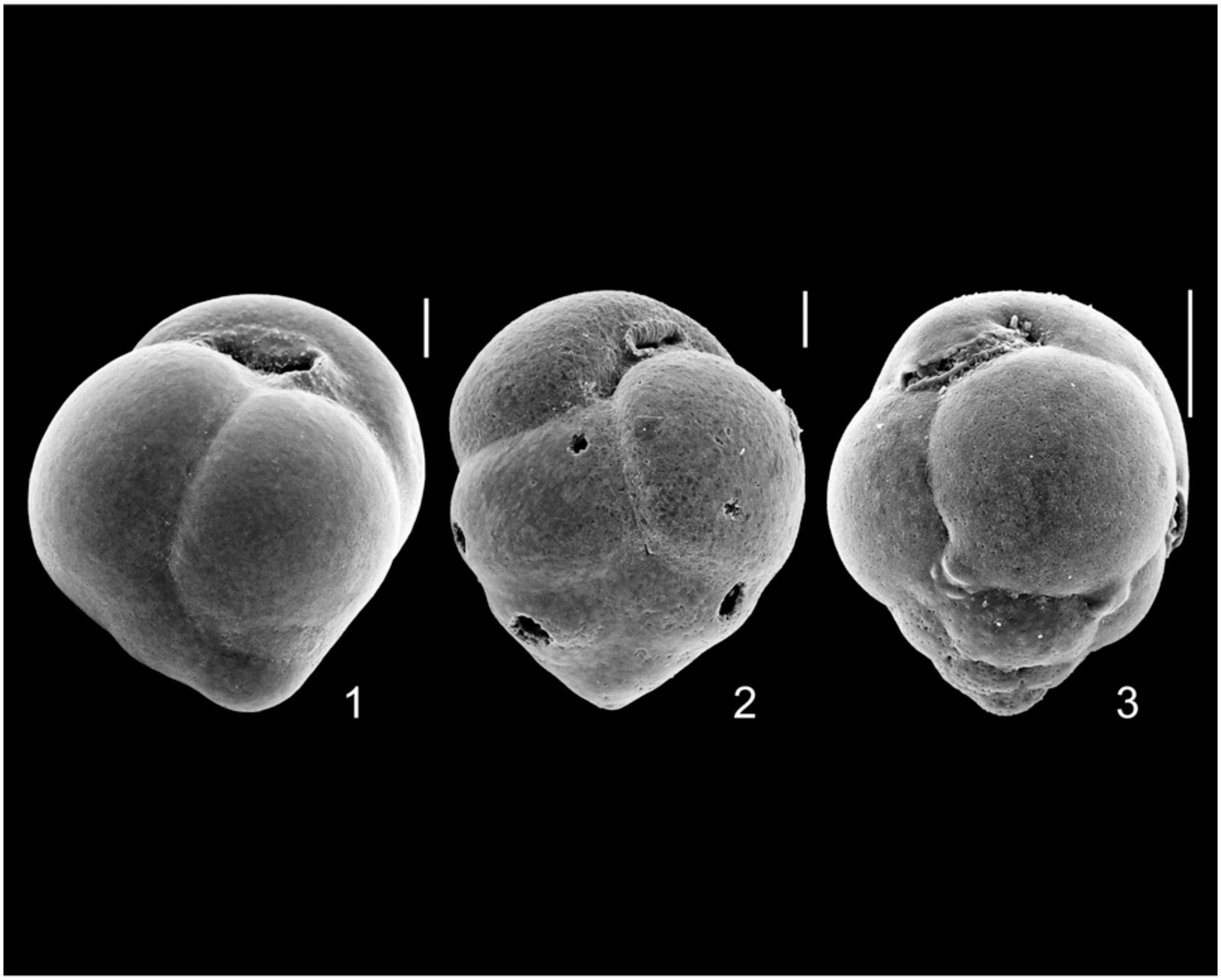

Plate 58

Scale bars = 50 μm

Epistominella exigua (Brady)

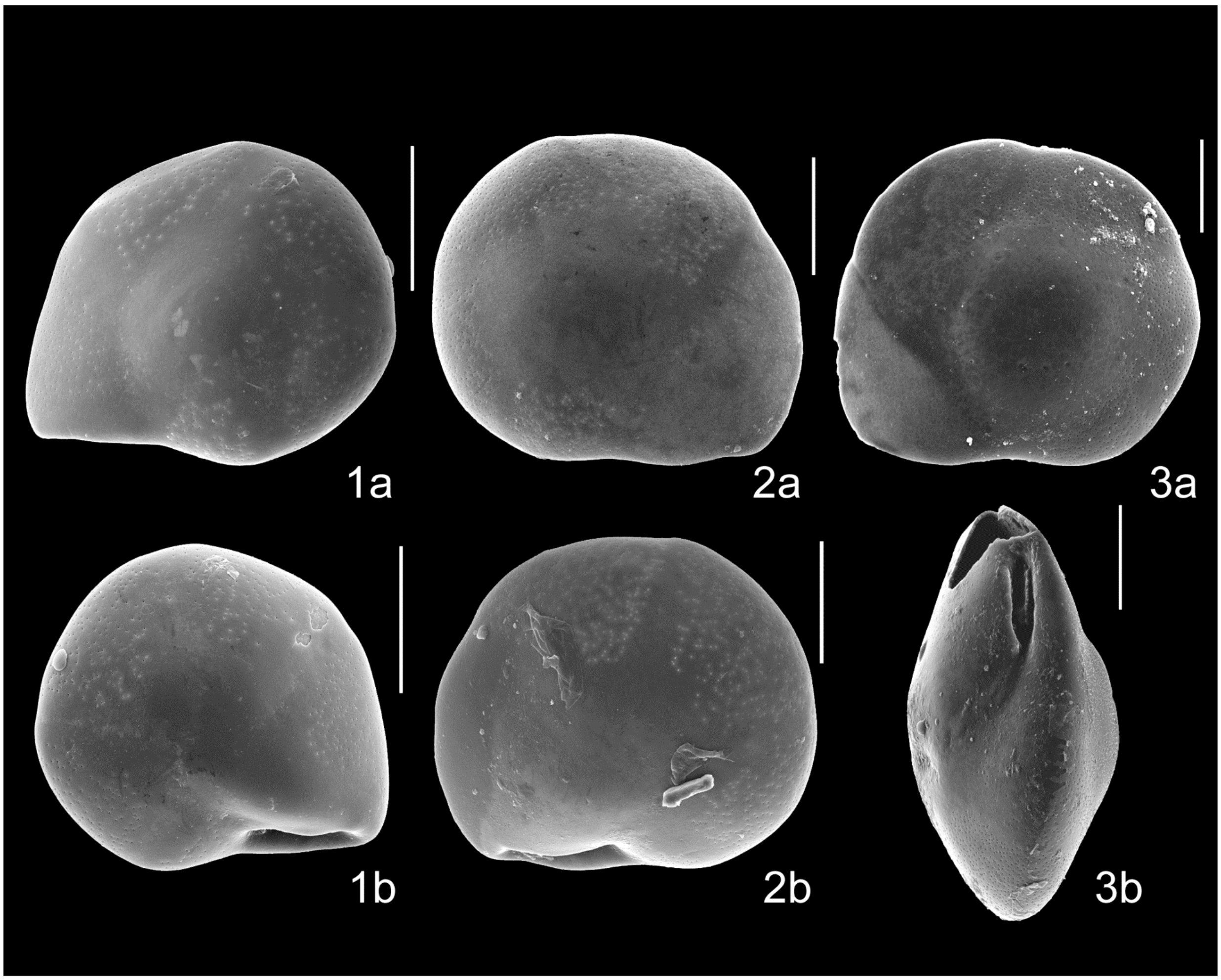

Plate 59

Scale bars = 50 μm

Epistominella vitrea Parker

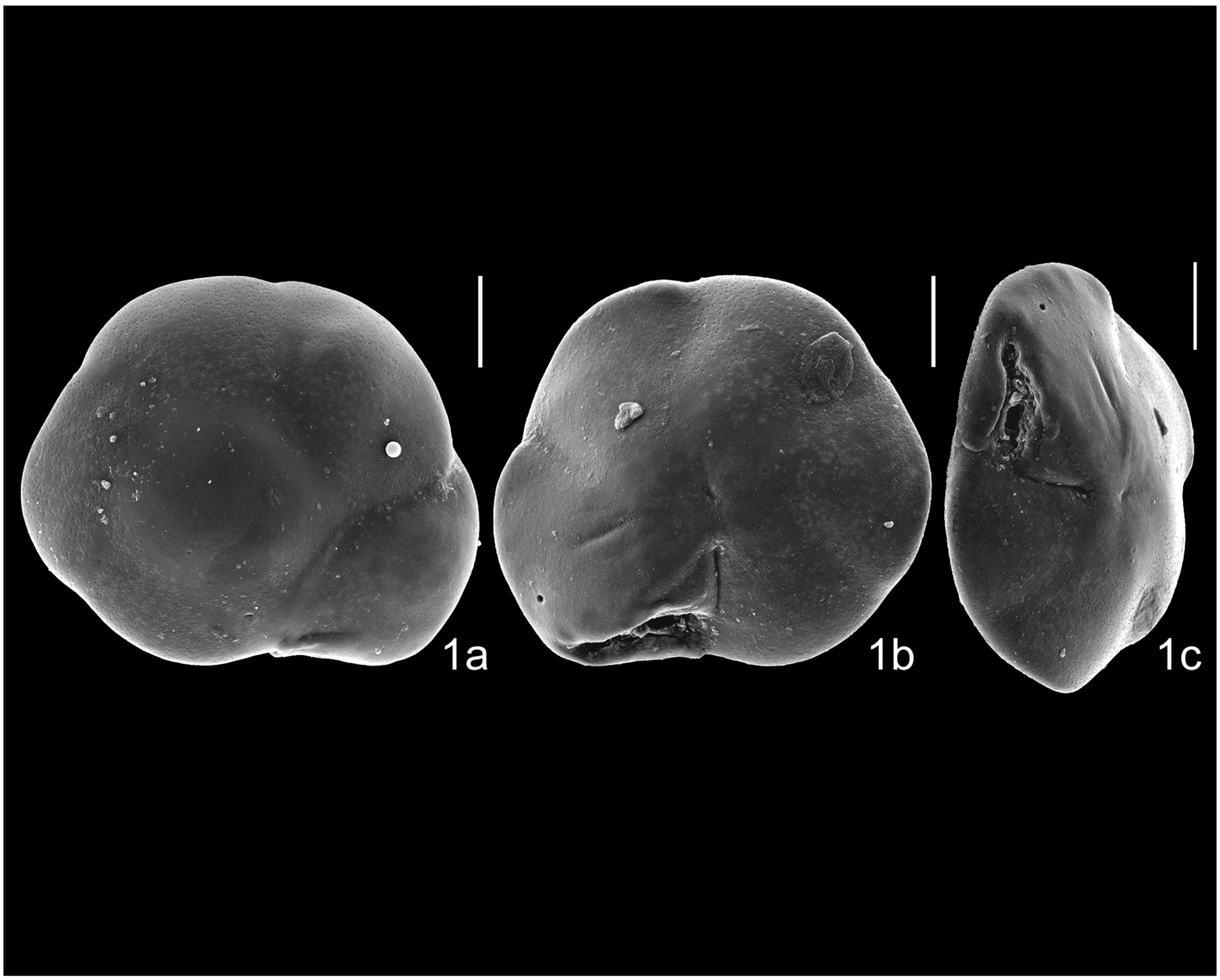

Plate 60

Scale bars = 50 μm

Eponides turgidus Phleger and Parker

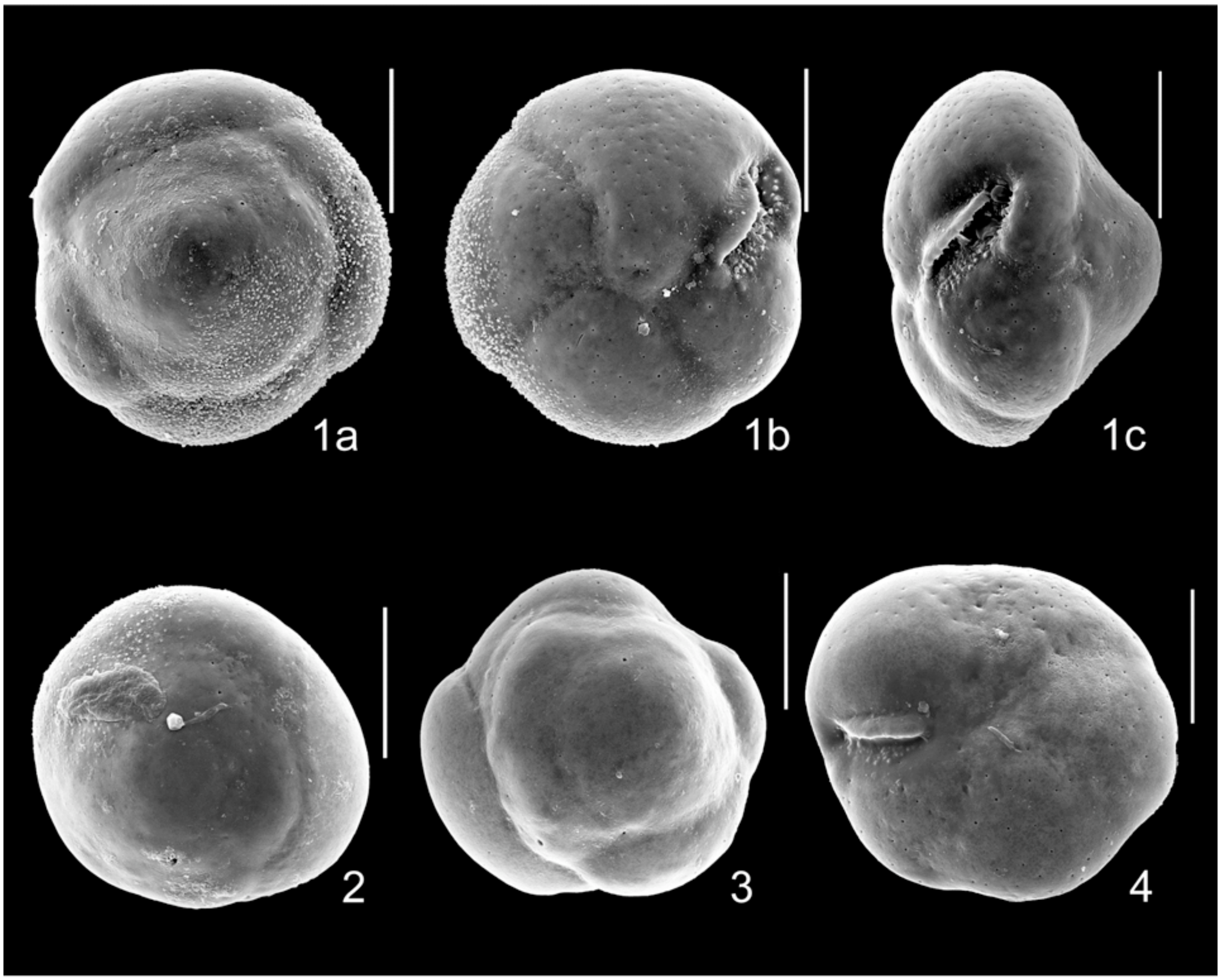

Plate 61

Scale bars = 50 μm

Eubuliminella morgani (Andersen)

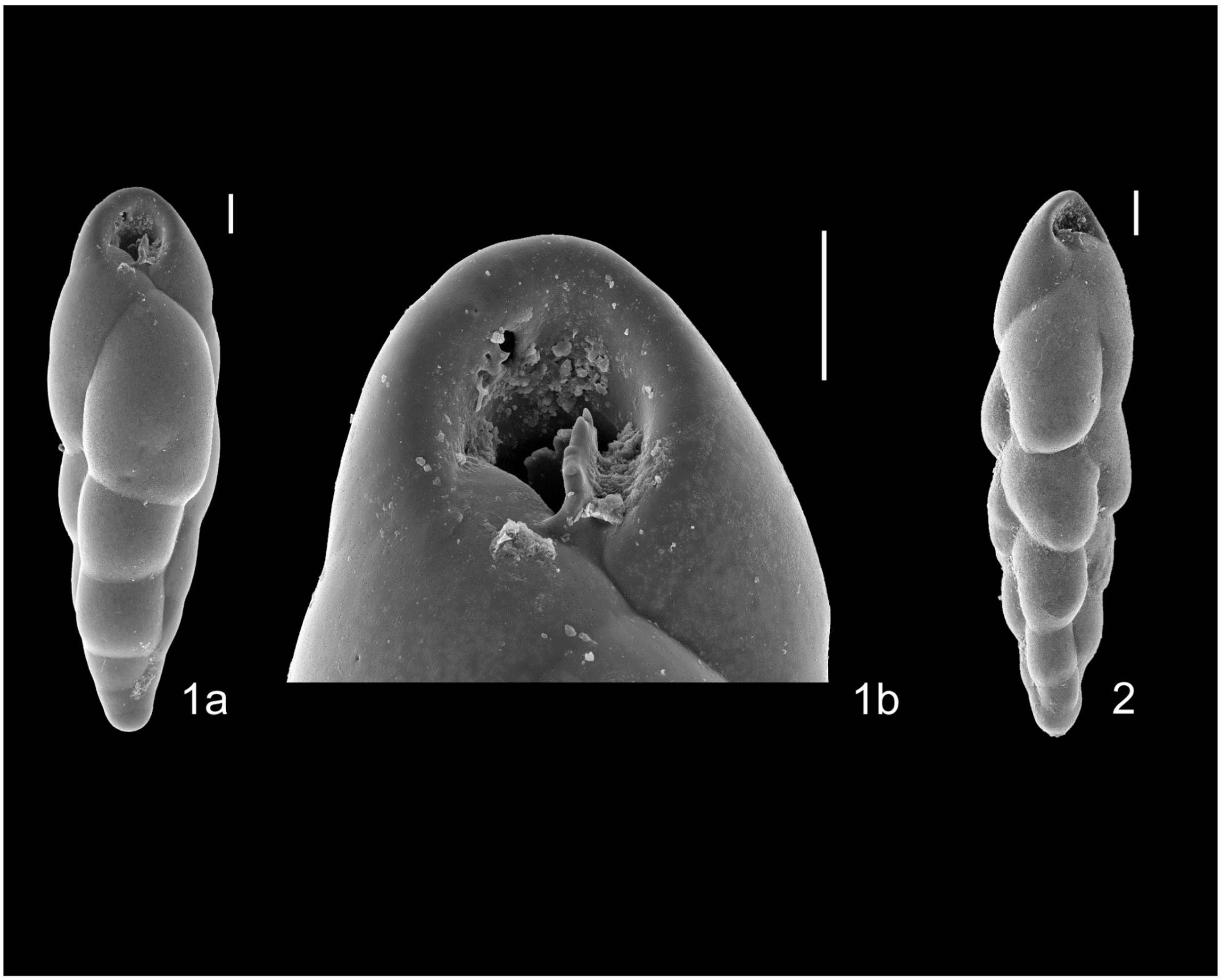

Plate 62

Scale bars = 50 μm

Fissurina fissa (Heron-Allen and Earland)

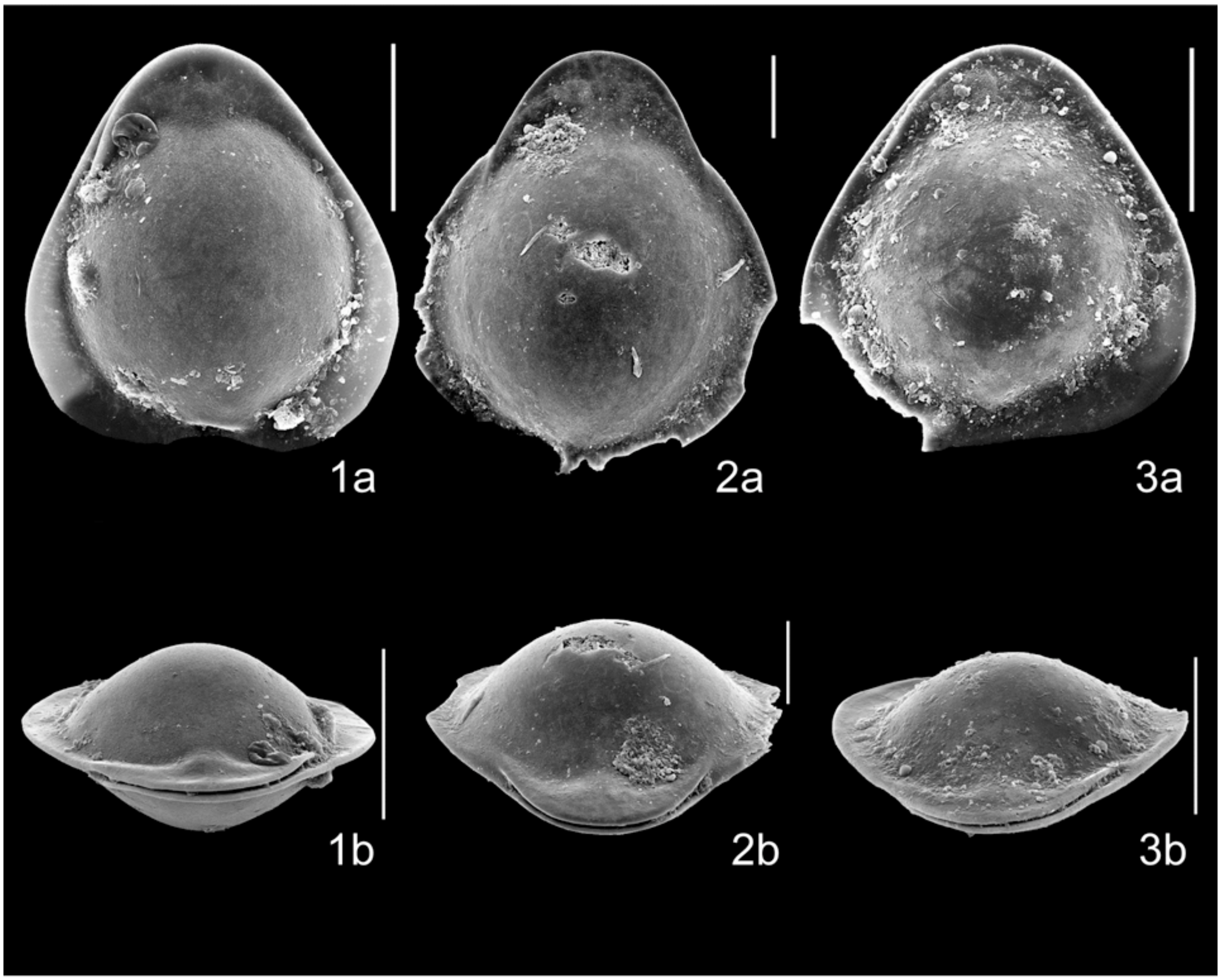

Plate 63

Scale bars = 50 μm

Fissurina sp. cf. *F. incomposita* (Patterson and Pettis)

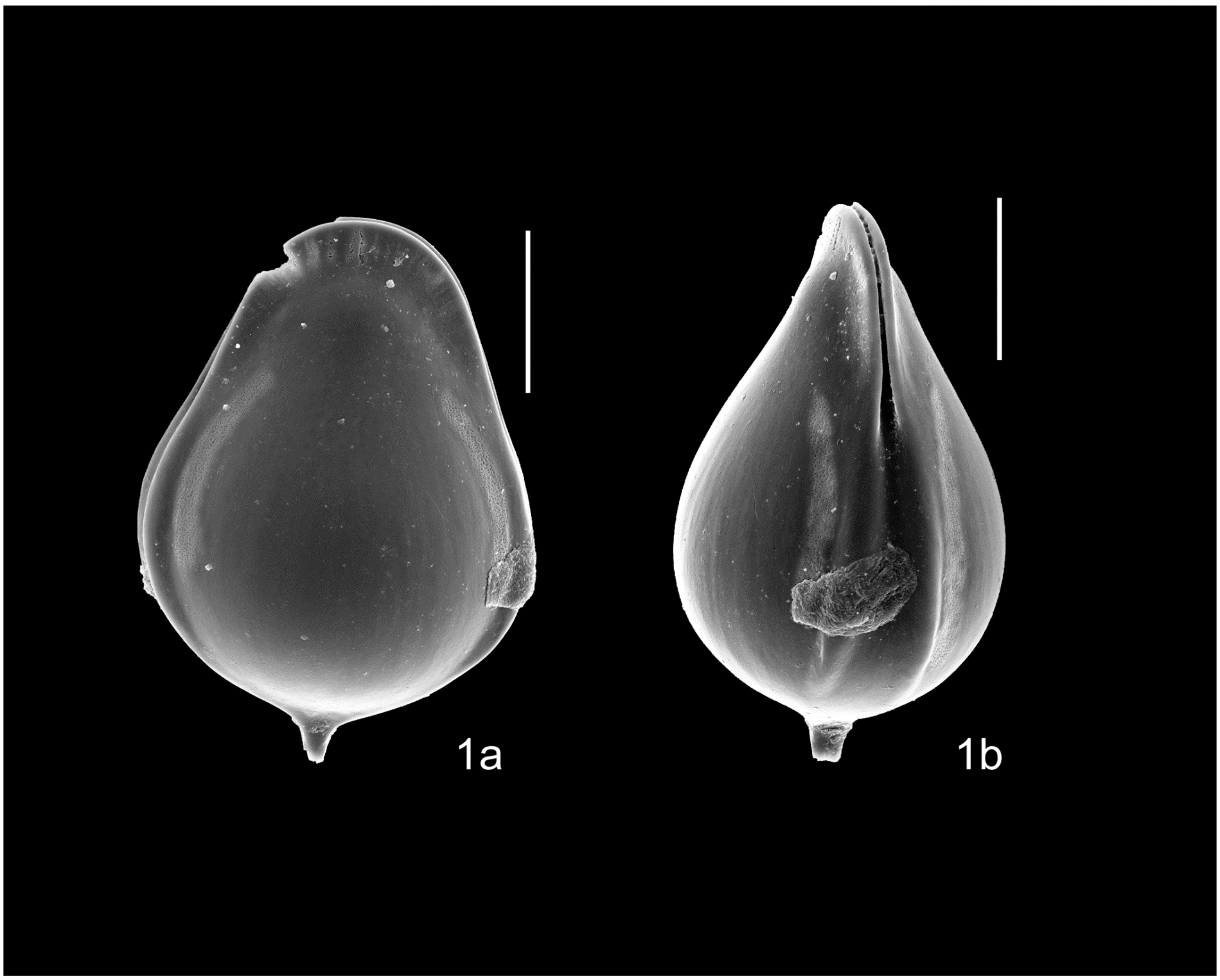

Plate 64

Scale bars = 50 μm

Fursenkoina seminuda (Natland)

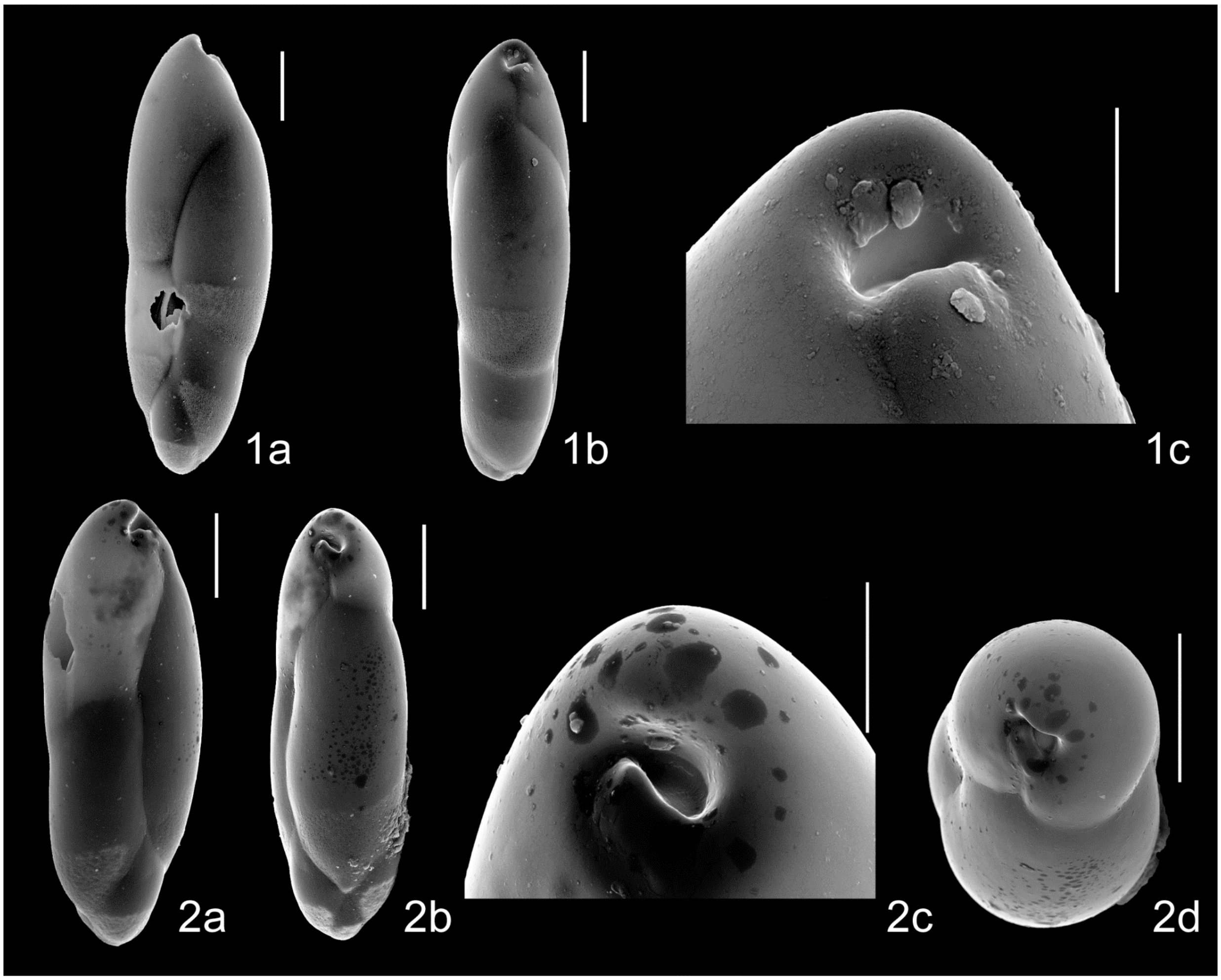

Plate 65

Scale bars = 50 μm
except in 1c & 2c (20 μm)

Gaudryina minuta Earland

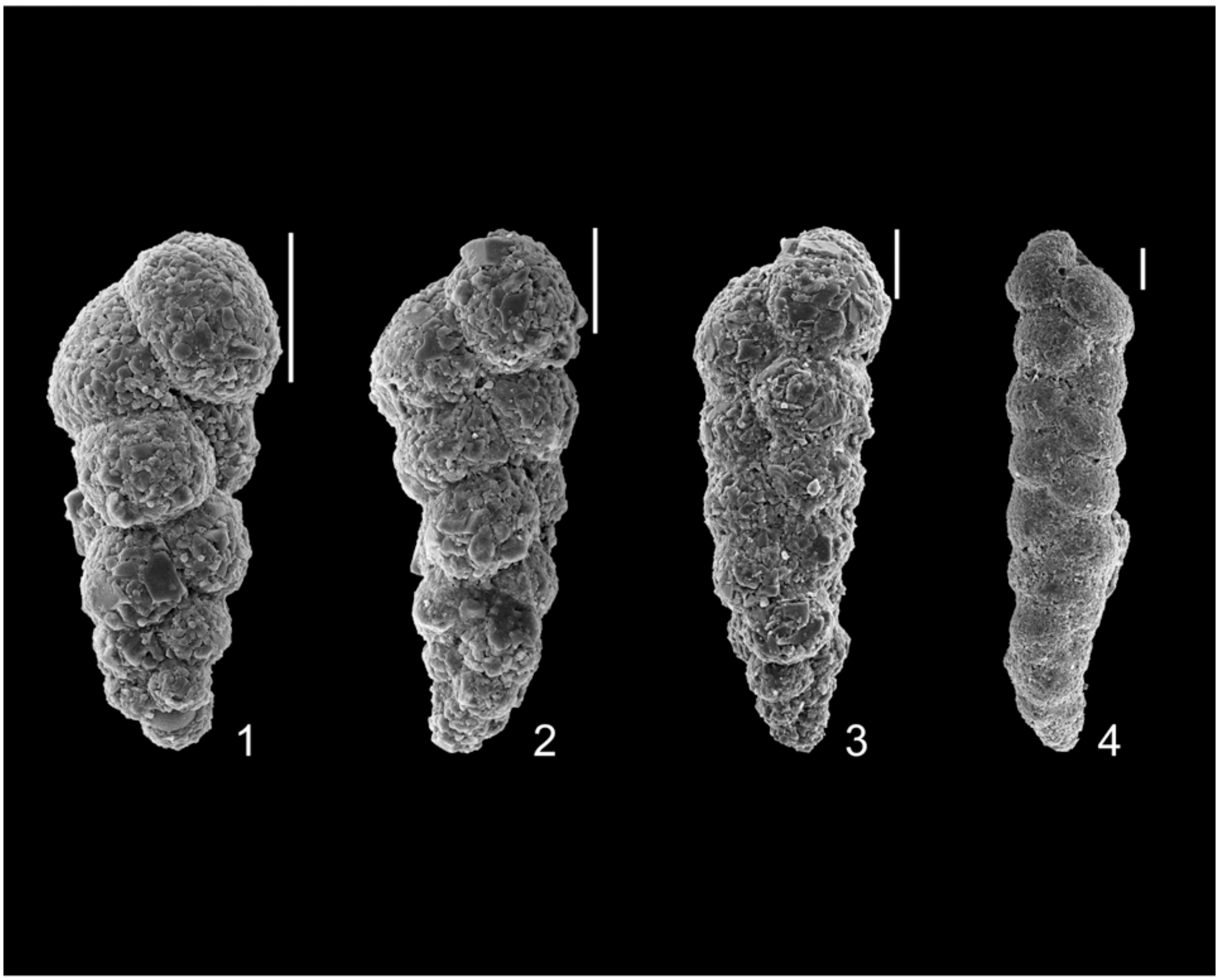

Plate 66

Scale bars = 50 μm

Gavelinopsis translucens (Phleger and Parker)

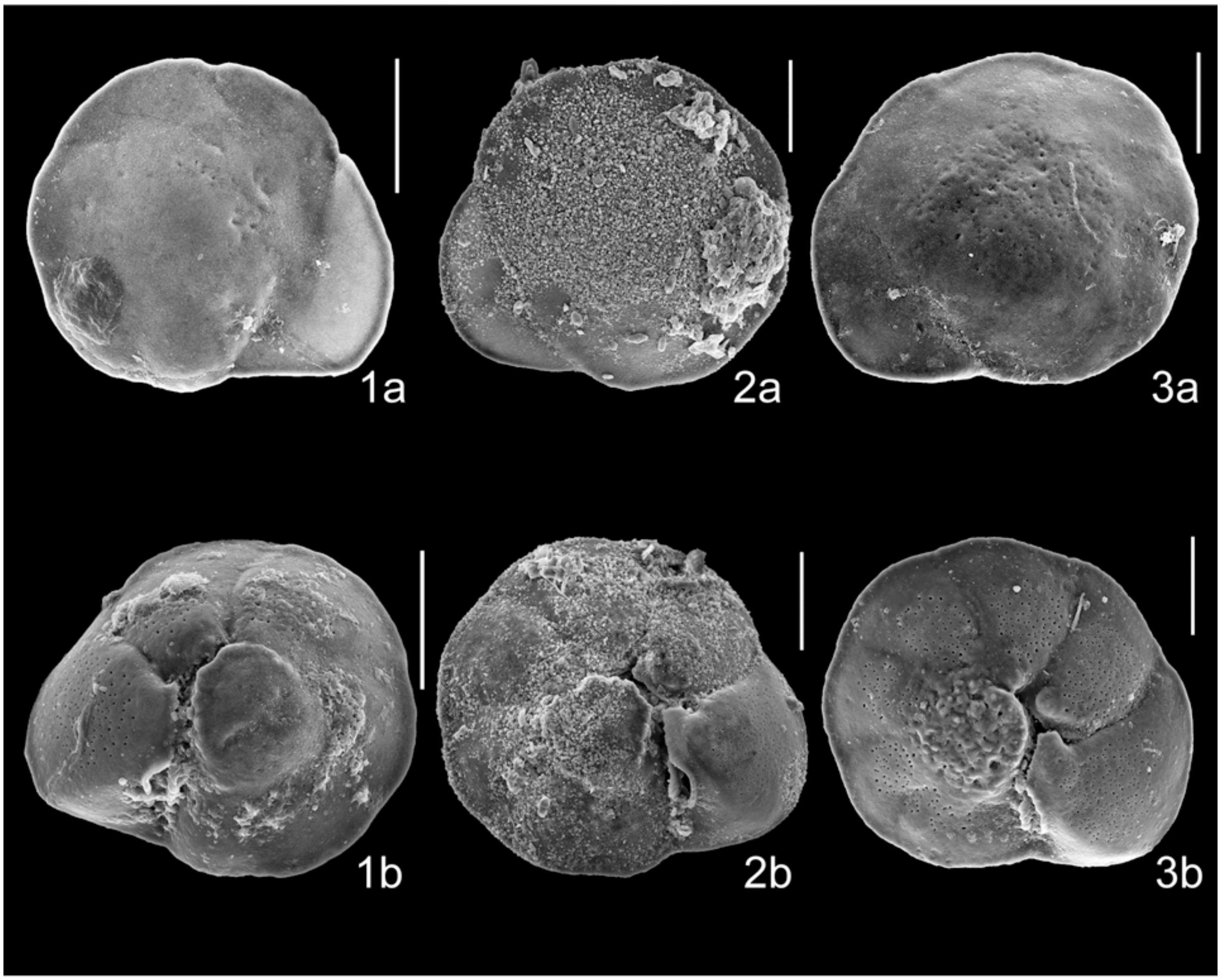

Plate 67 Scale bars = 50 μm

Globocassidulina subglobosa (Brady)

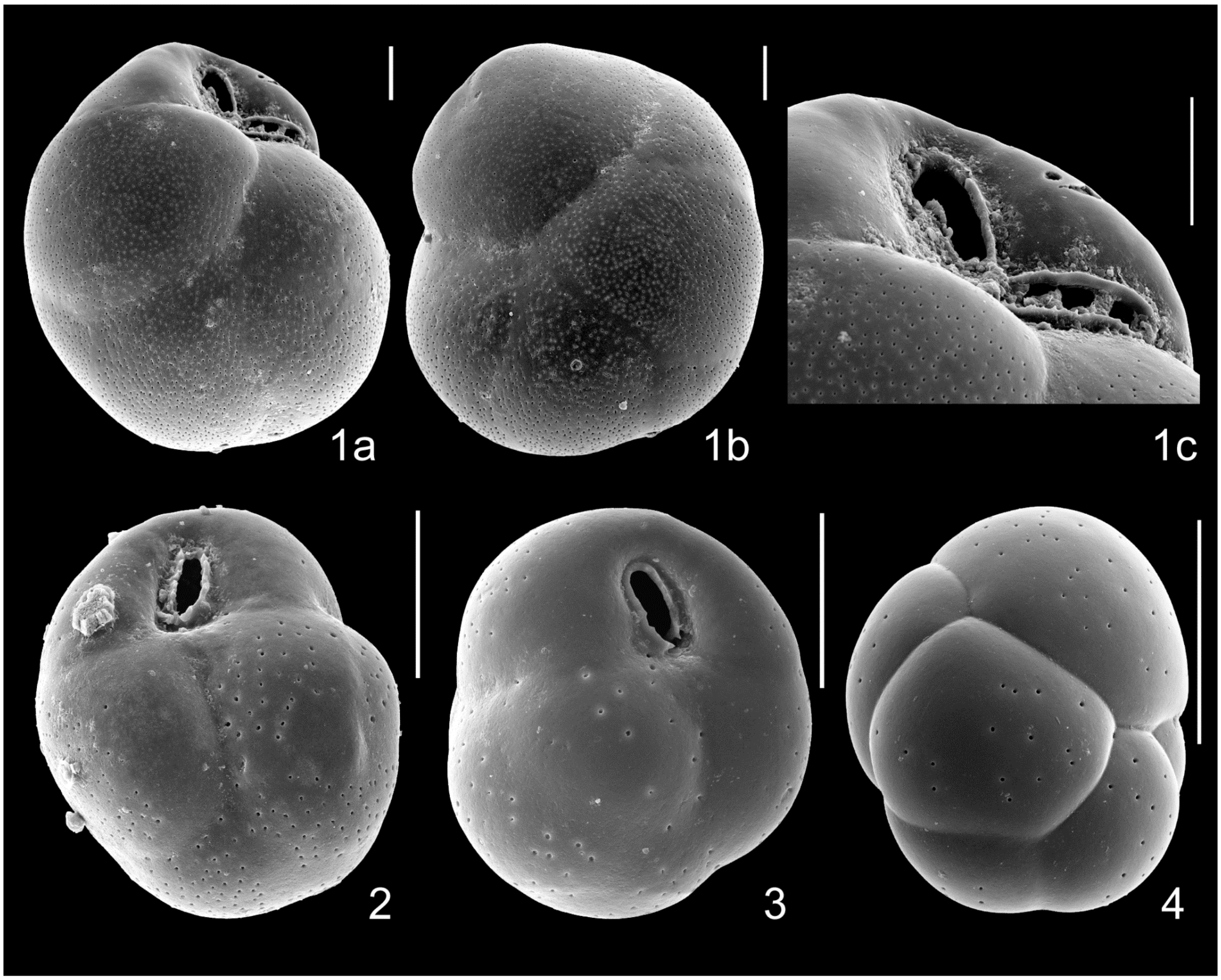

Plate 68

Scale bars = 50 μm

Glomospira gordialis (Jones and Parker)

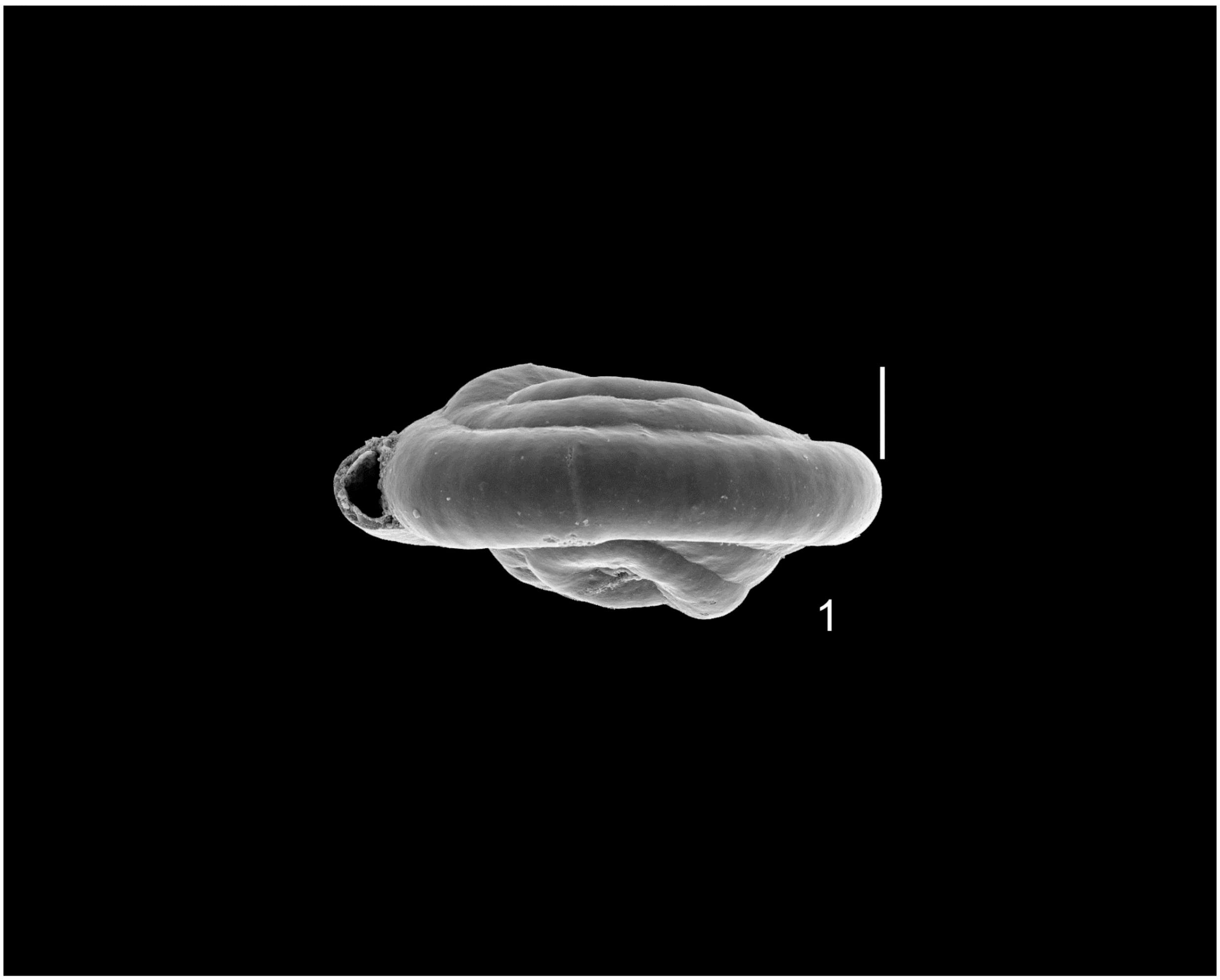

Plate 69

Scale bar = 50 µm

Glomospira irregularis (Grzybowski)

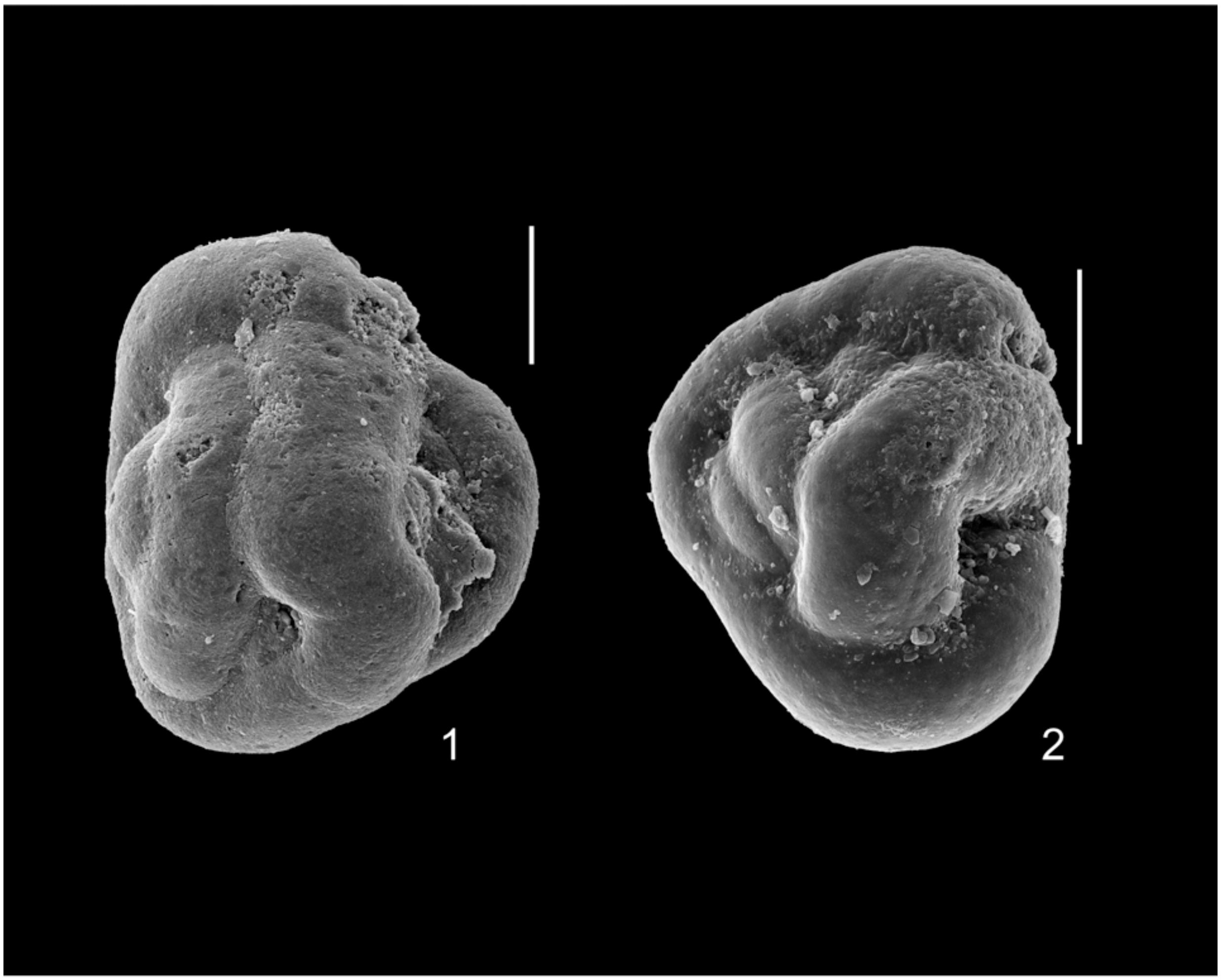

Plate 70

Scale bars = 50 μm

Gyroidina bradyi (Trauth)

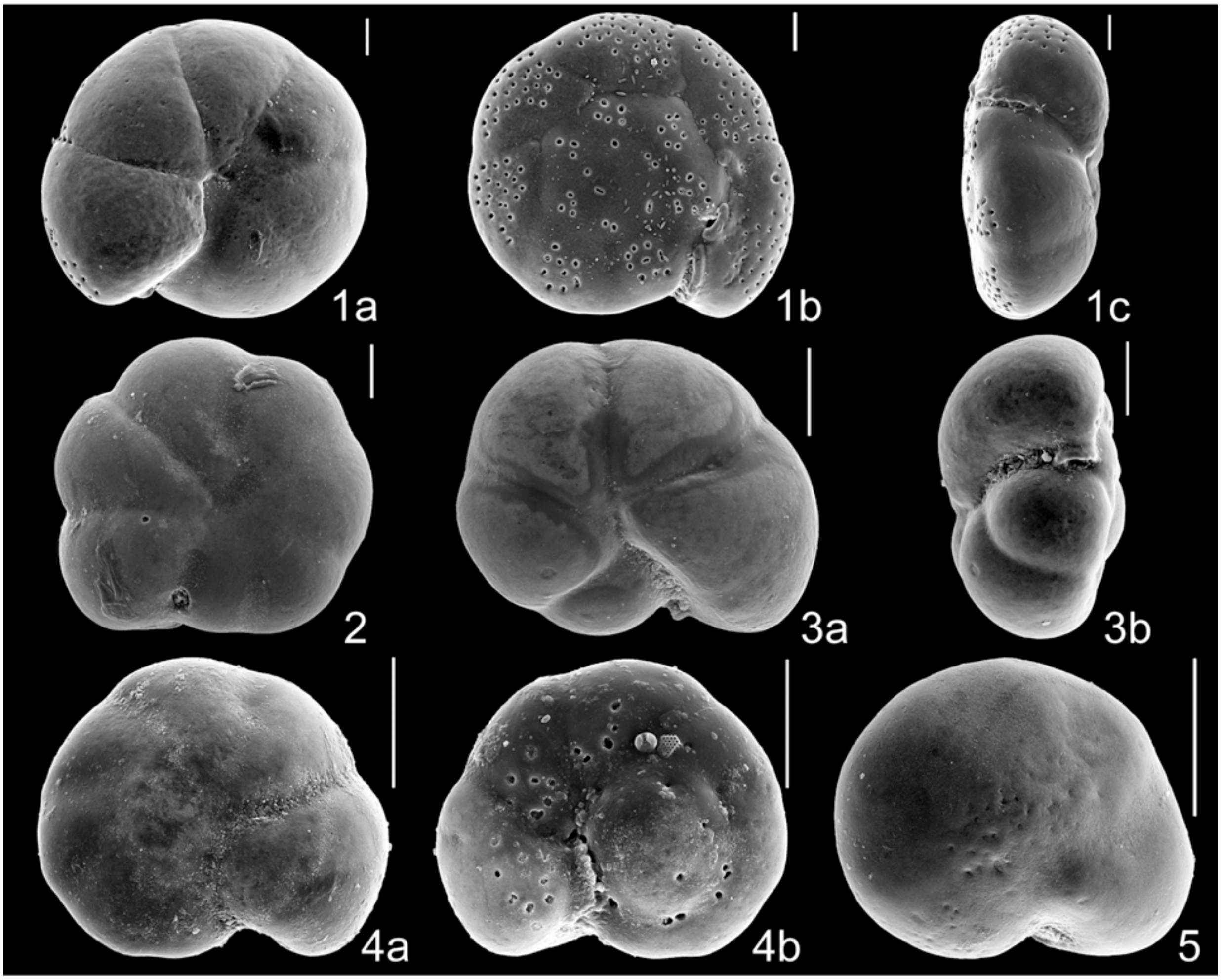

Plate 71

Scale bars = 50 µm

Gyroidina orbicularis (Parker, Jones, and Brady)

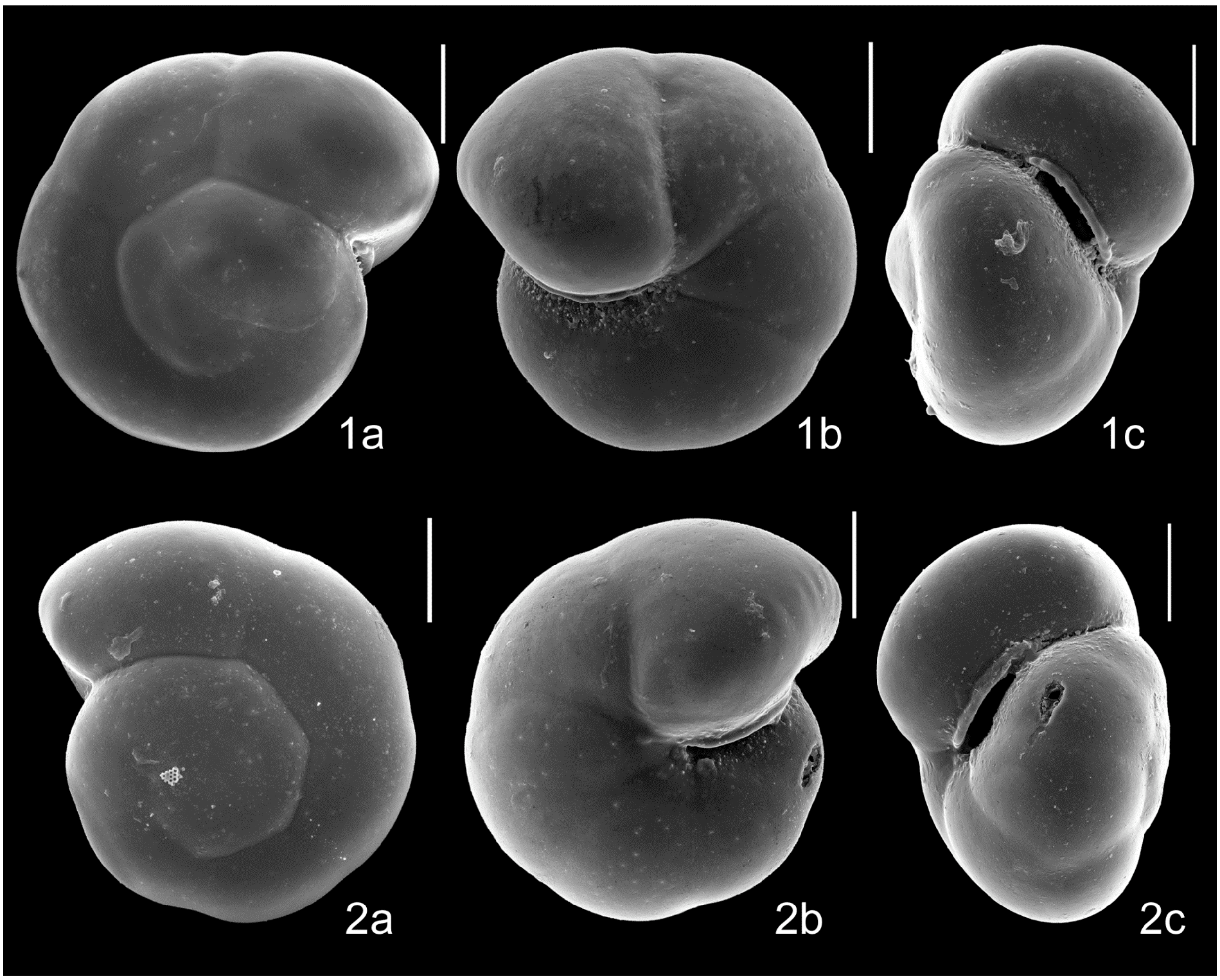

Plate 72

Scale bars = 50 μm

Gyroidinoides sp. cf. *G. polius* (Phleger and Parker)

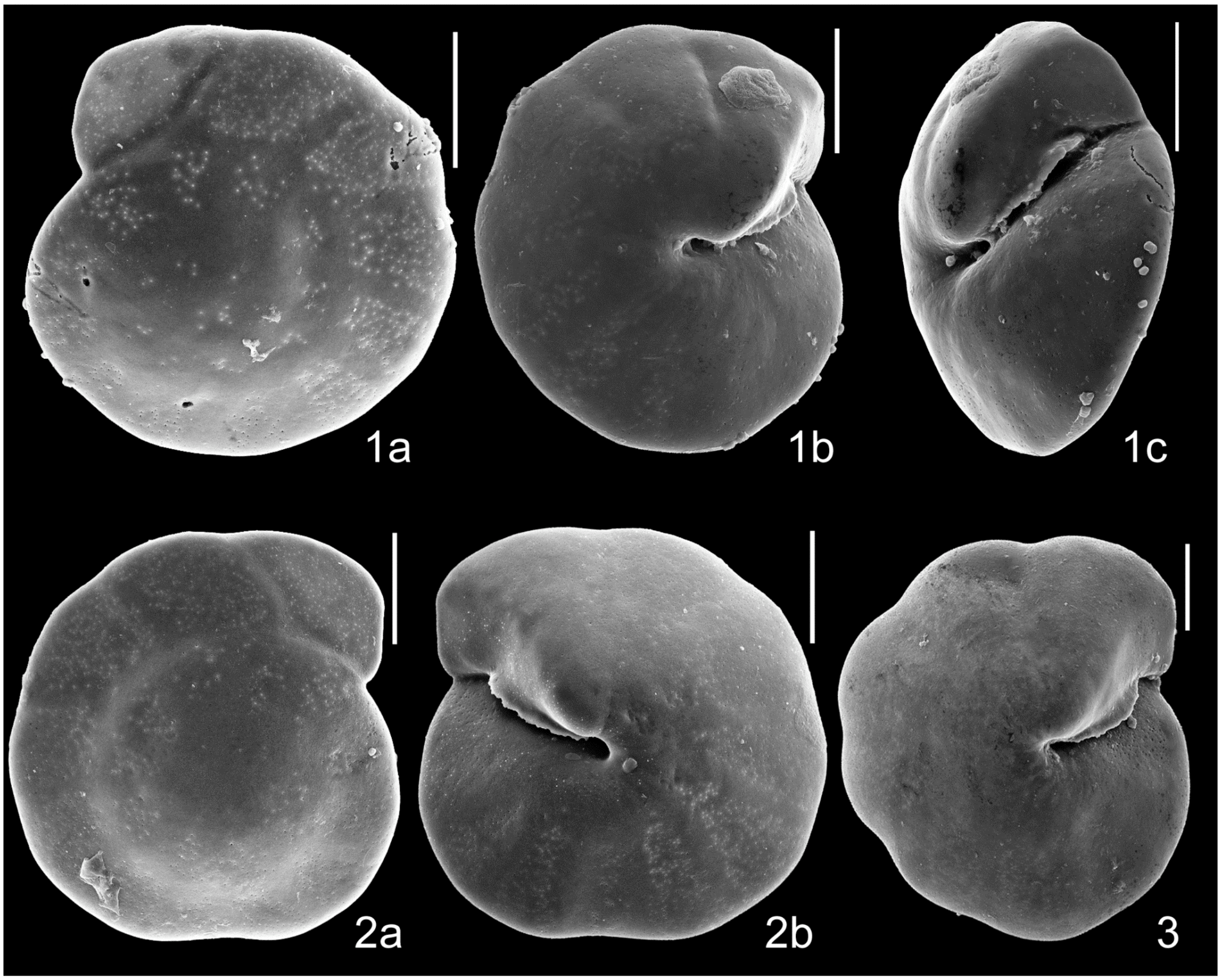

Plate 73

Scale bars = 50 μm

Gyroidinoides sp. cf. *G. regularis* (Phleger and Parker)

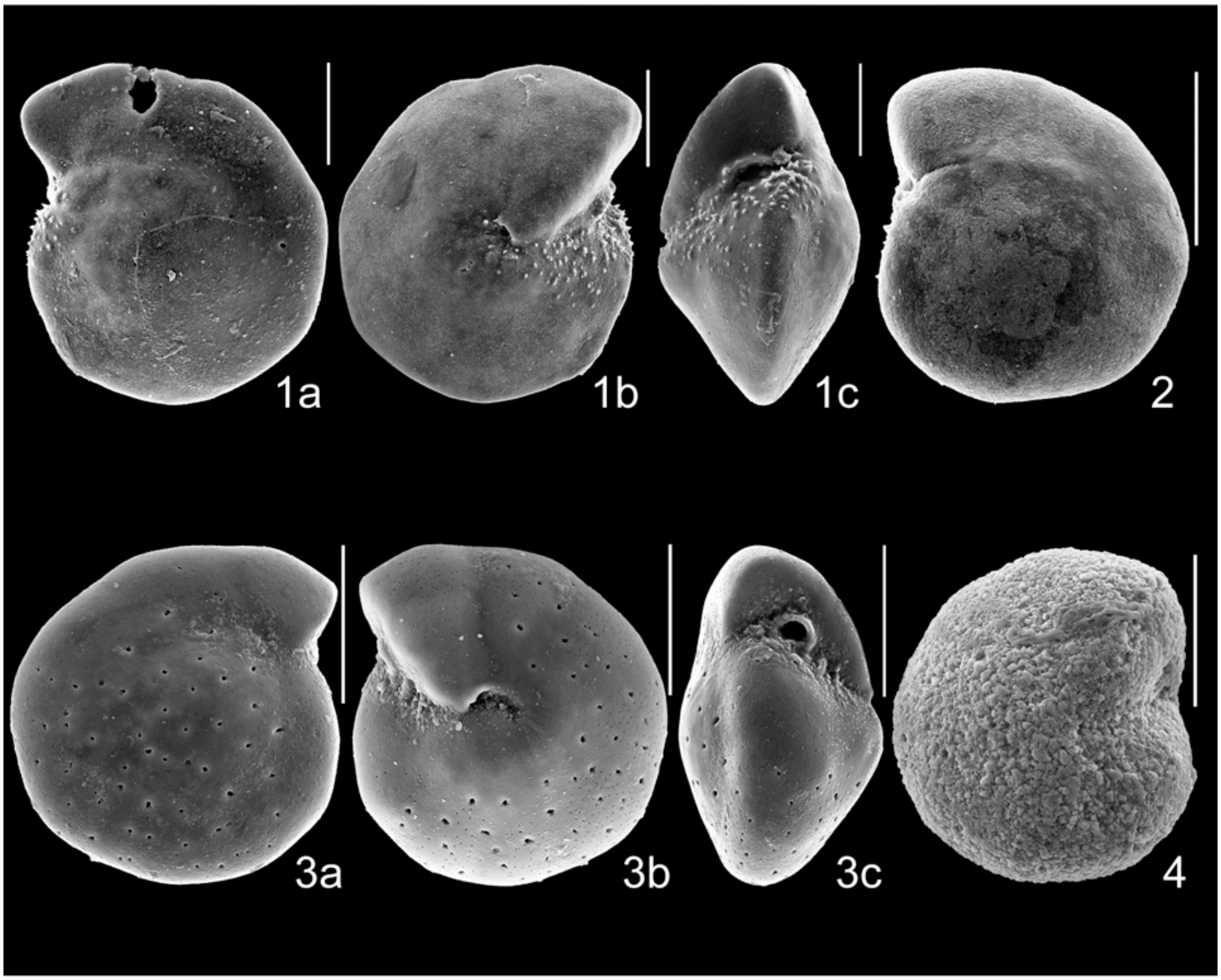

Plate 74 Scale bars = 50 μm

Haplophragmoides sp. cf. *H. kirki* Wickenden

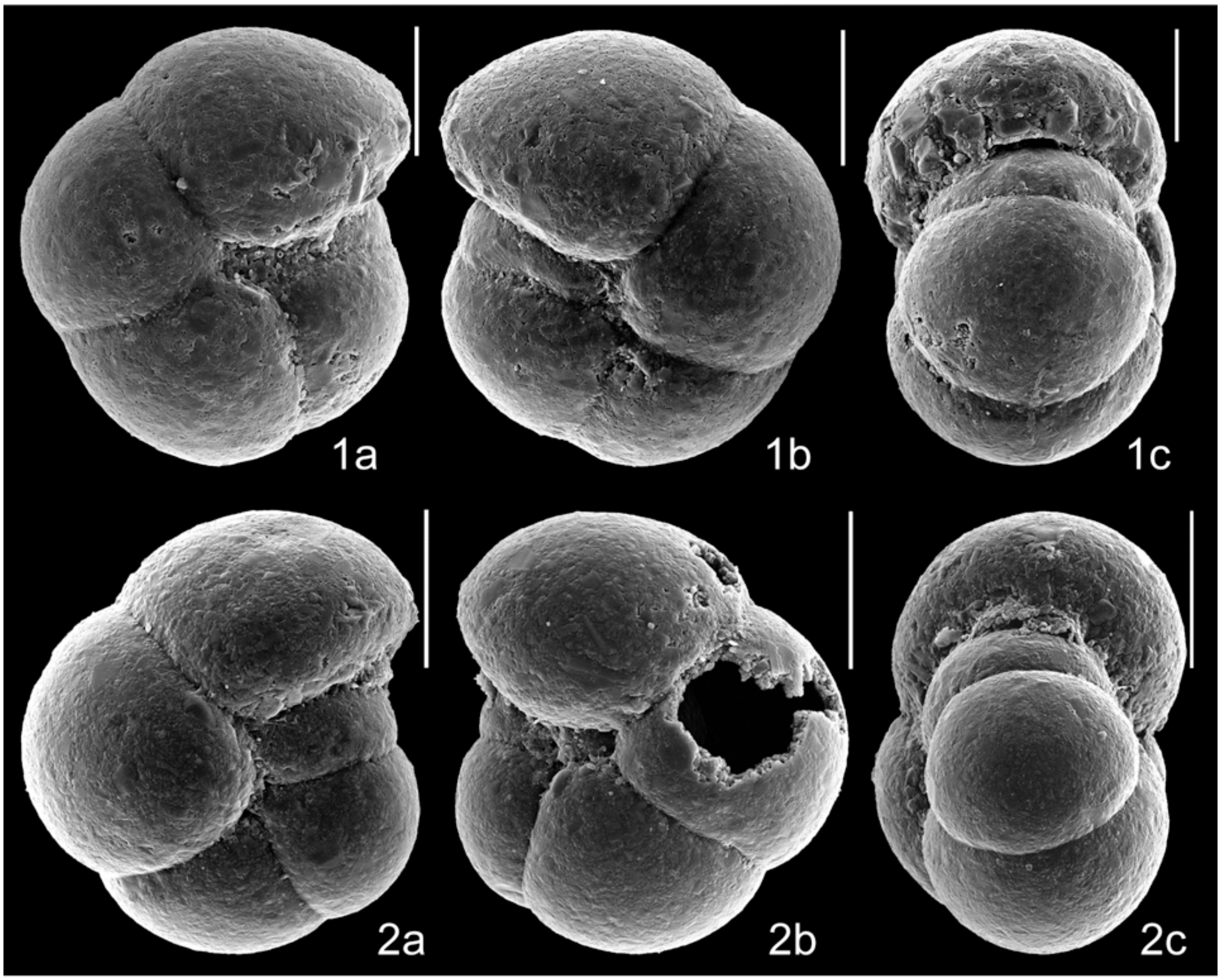

Plate 75 Scale bars = 50 μm

Haynesina germanica (Ehrenberg)

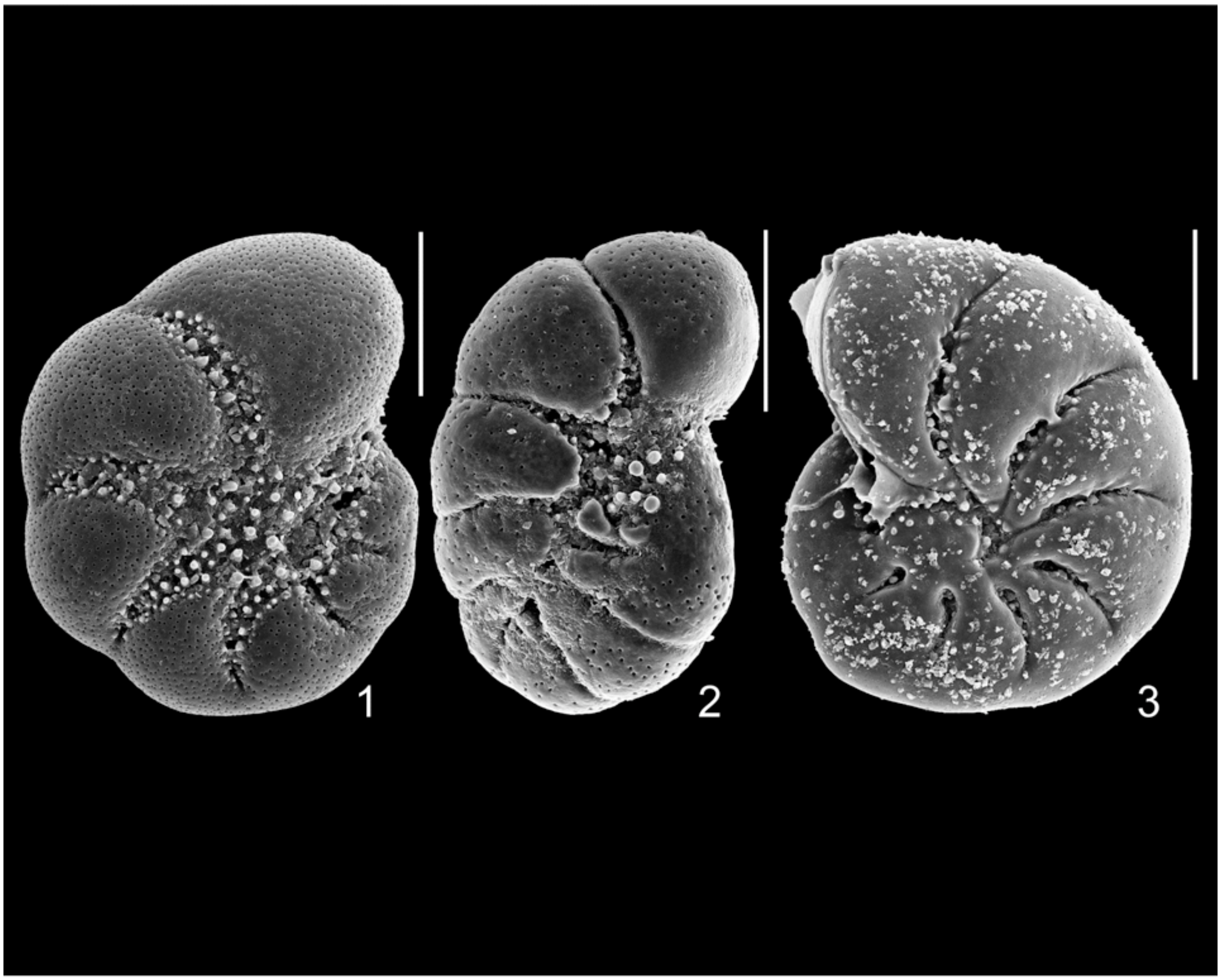

Plate 76

Scale bars = 50 μm

Hoeglundina elegans (d'Orbigny)

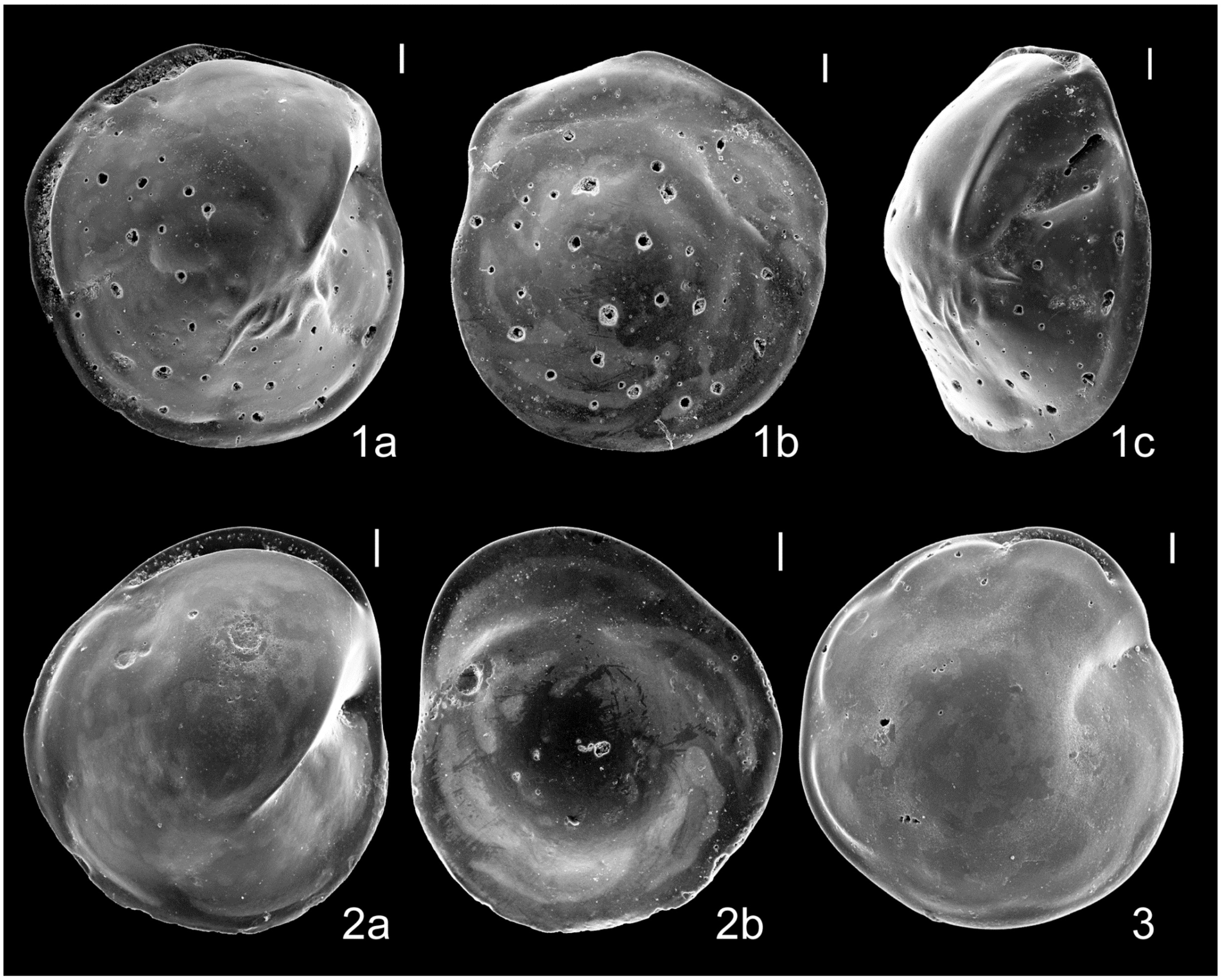

Plate 77 Scale bars = 50 μm

Hormosina pilulifera (Brady)

Plate 78 Scale bars = 50 μm

Hormosinella distans (Brady)

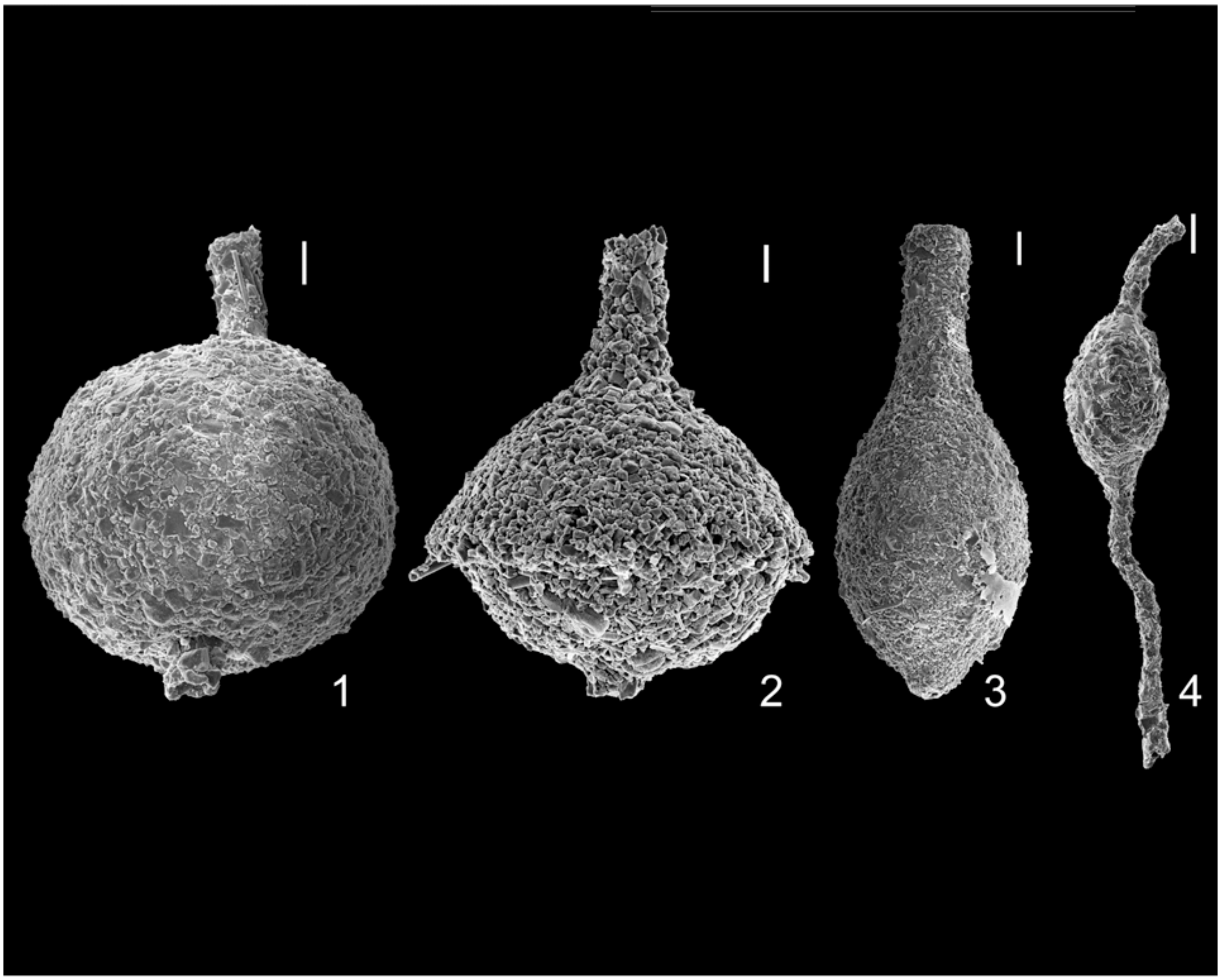

Plate 79

Scale bars = 50 μm

Hormosinella guttifera (Brady)

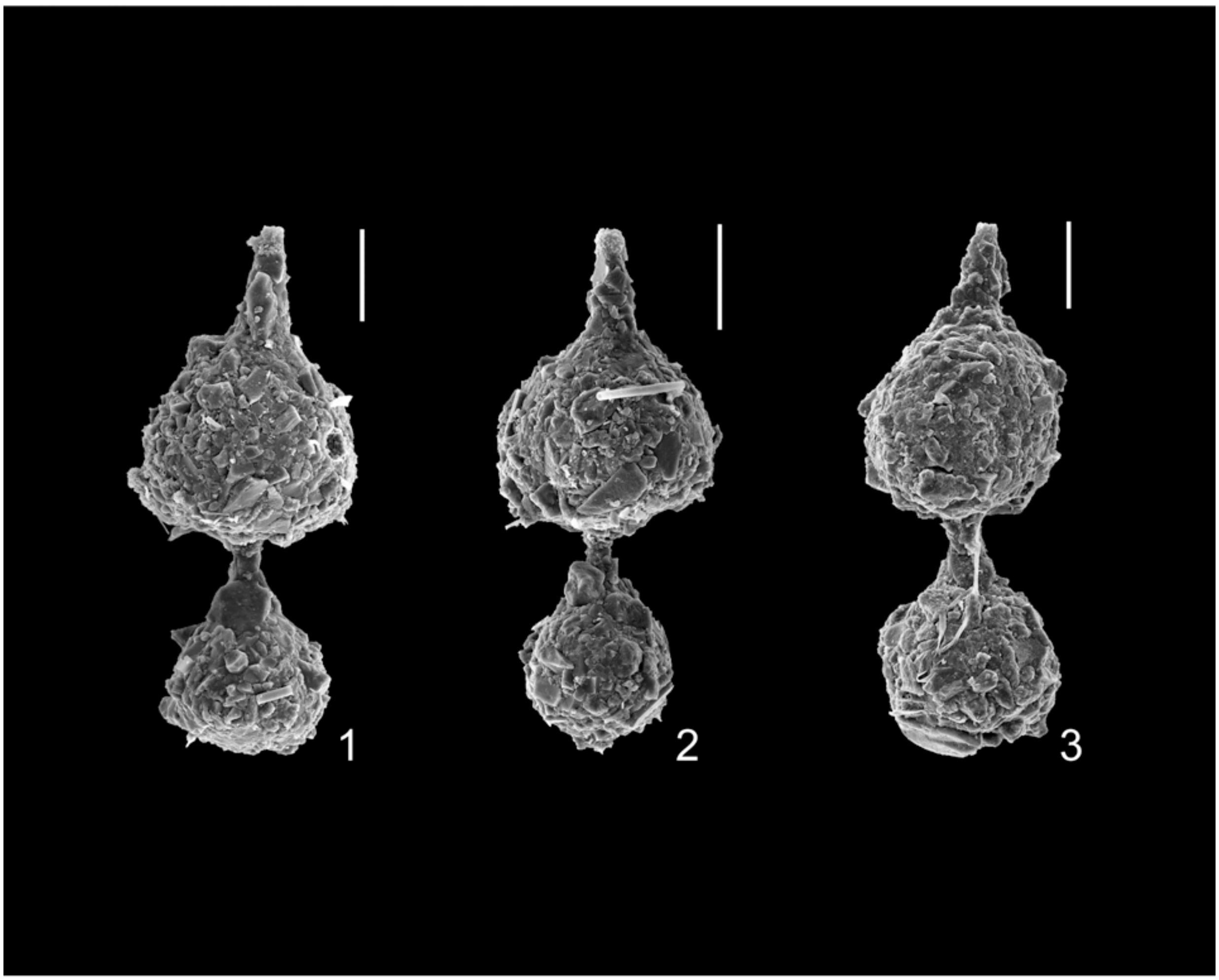

Plate 80

Scale bars = 50 μm

Hyperammina friabilis Brady

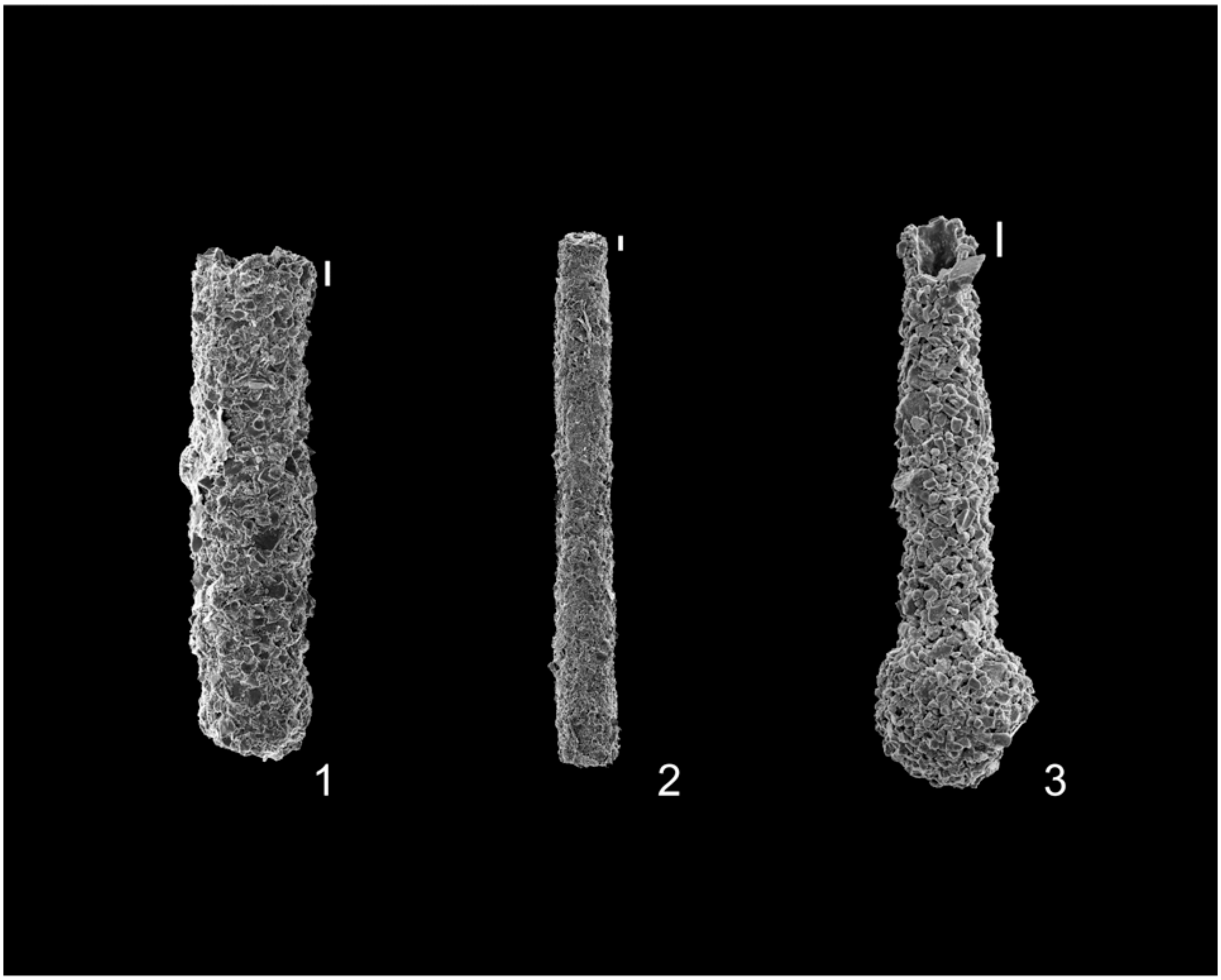

Plate 81

Scale bars = 50 μm

Hyperammina laevigata Wright

Plate 82

Scale bars = 50 μm

Hyperammina laevigata Wright

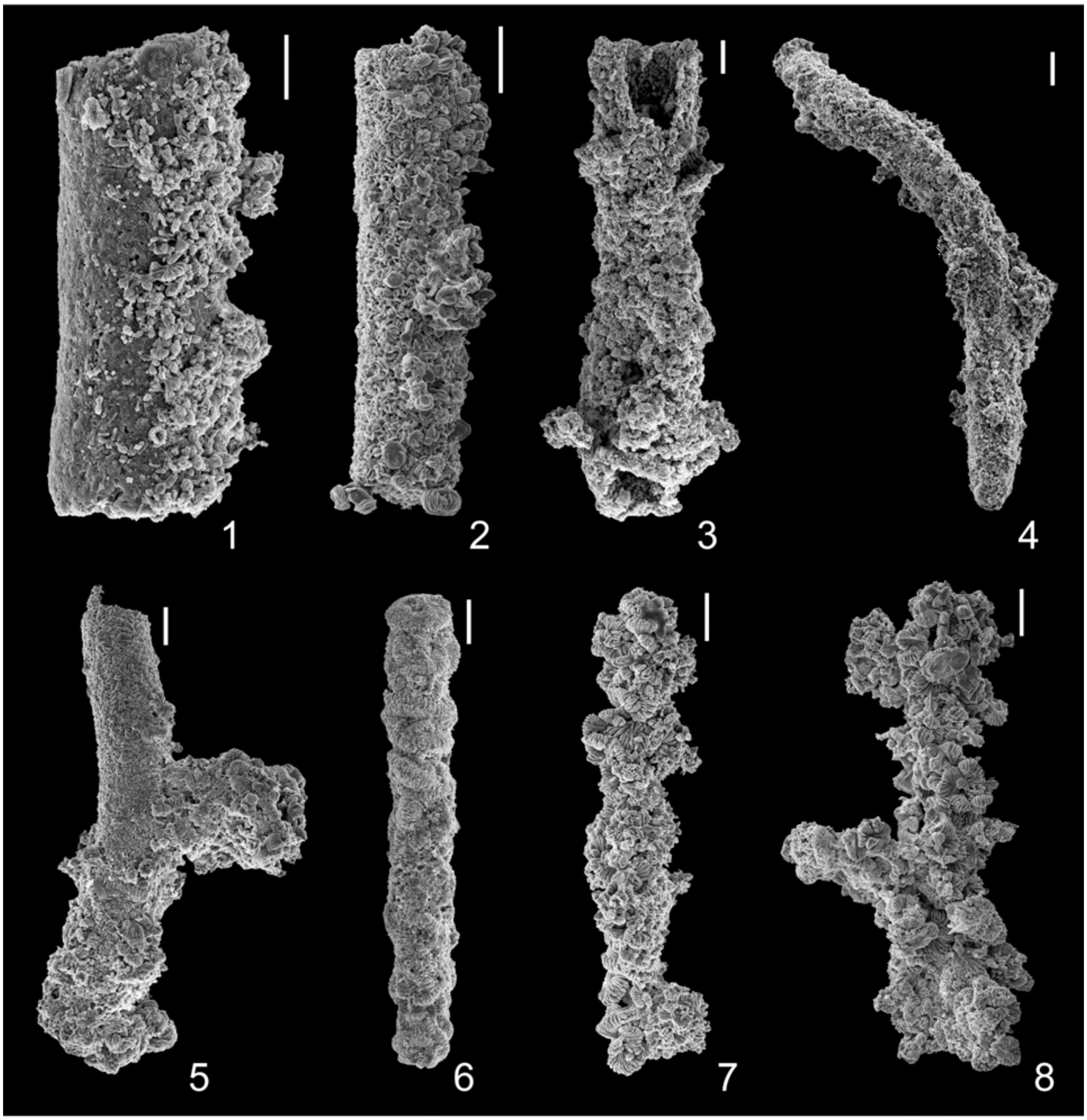

Plate 83

Scale bars = 50 μm

Hyperammina sp.

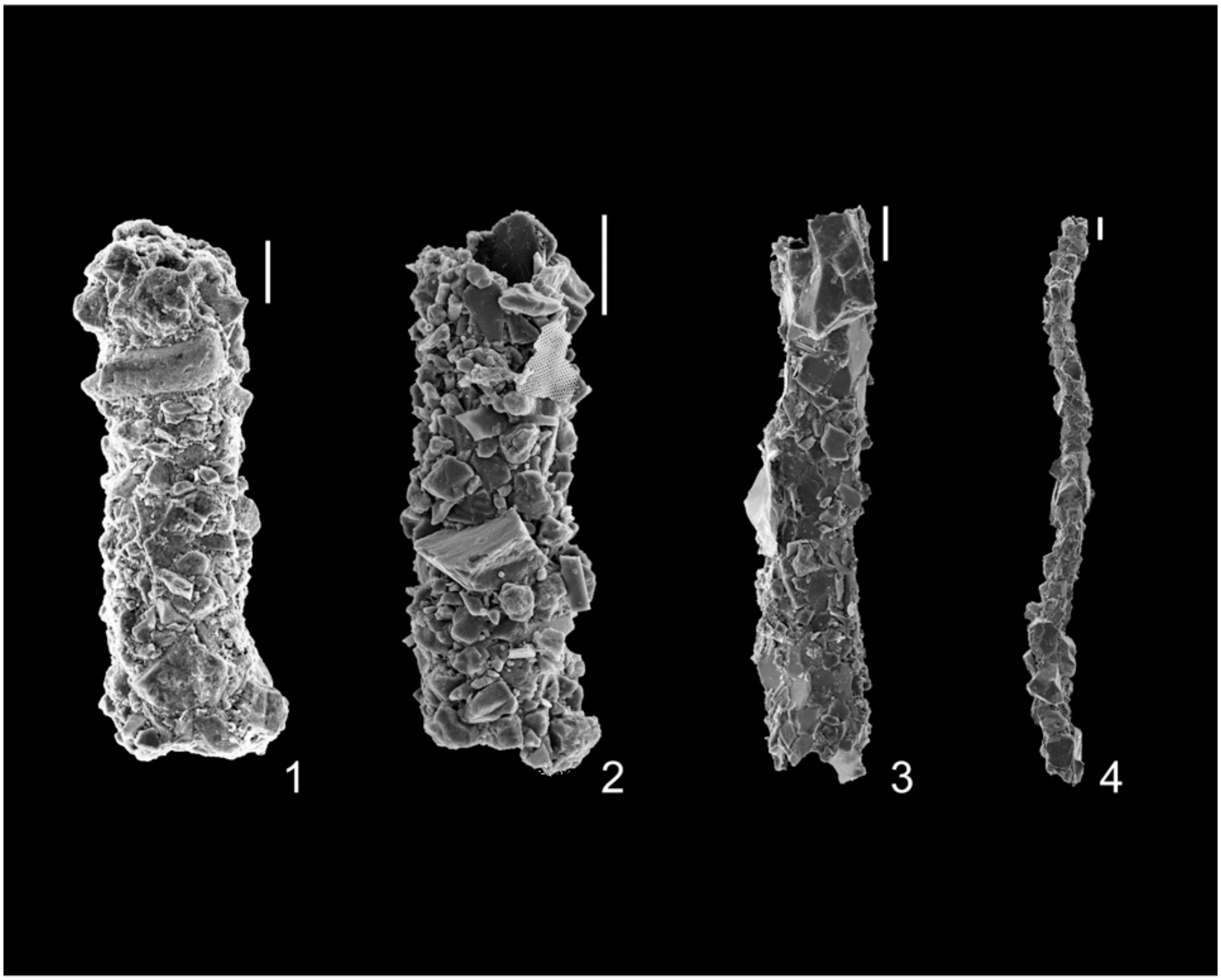

Plate 84

Scale bars = 50 μm

Ioanella tumidula (Brady)

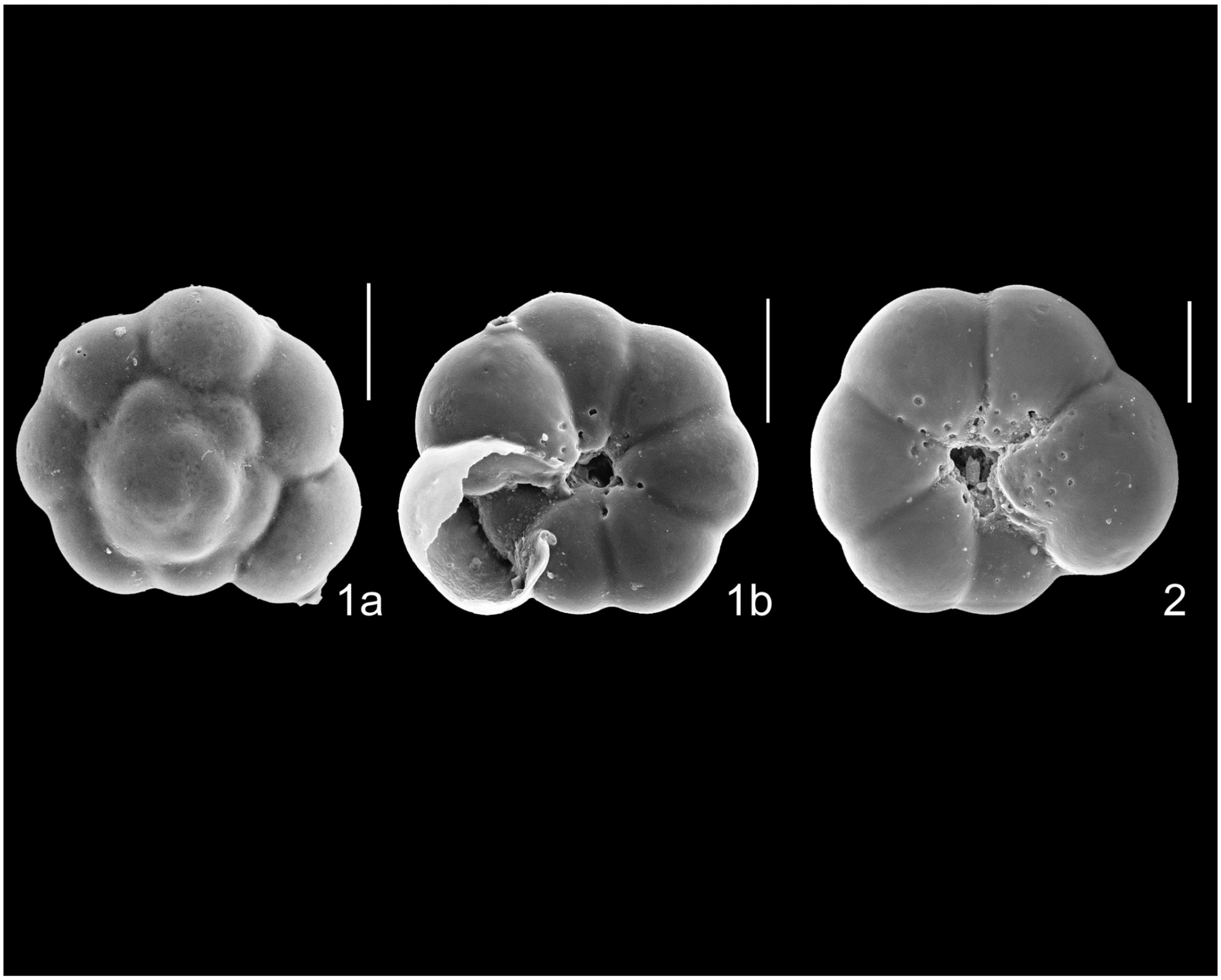

Plate 85

Scale bars = 50 μm

Karreriella bradyi (Cushman)

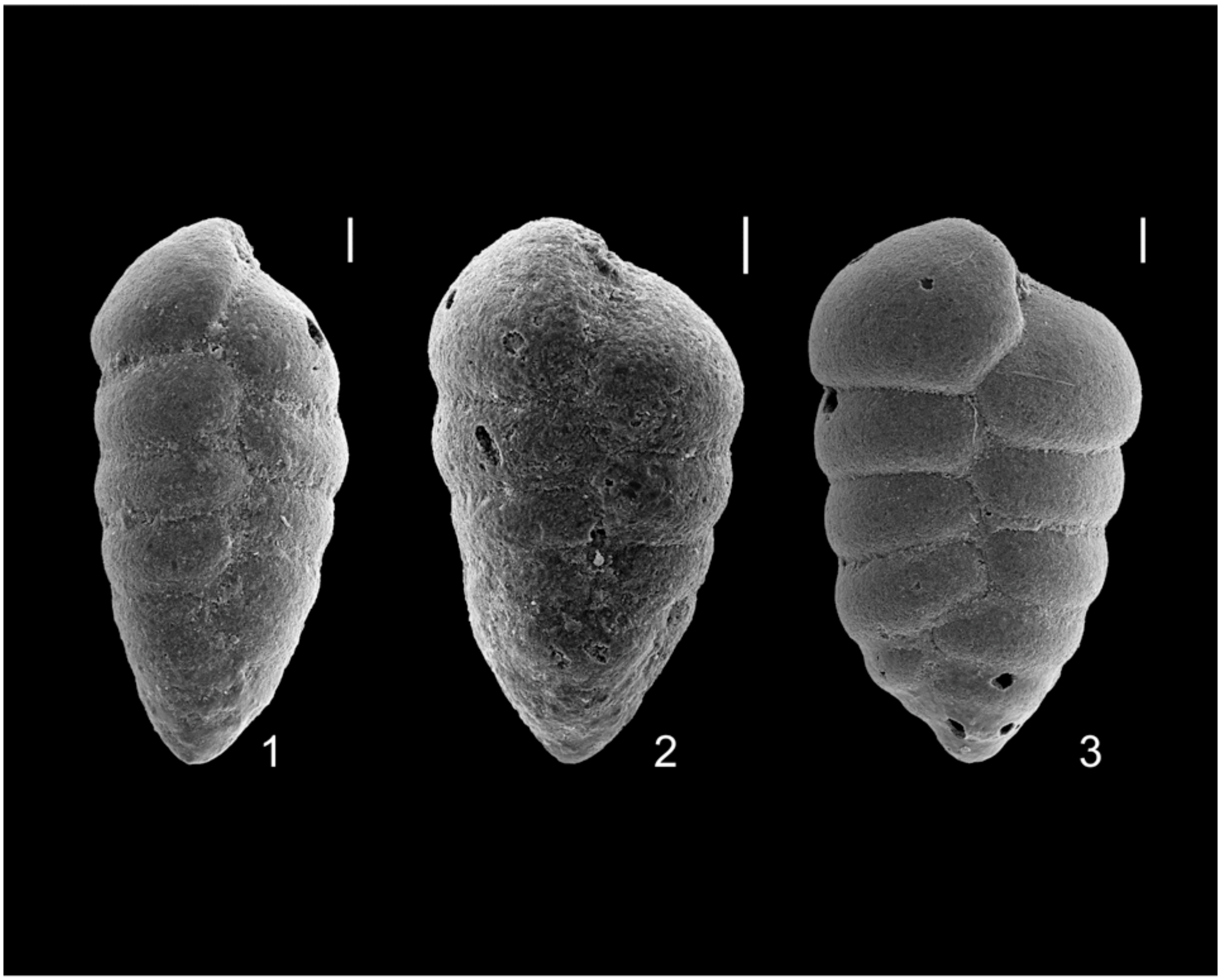

Plate 86

Scale bars = 50 μm

Karrerulina apicularis (Cushman)

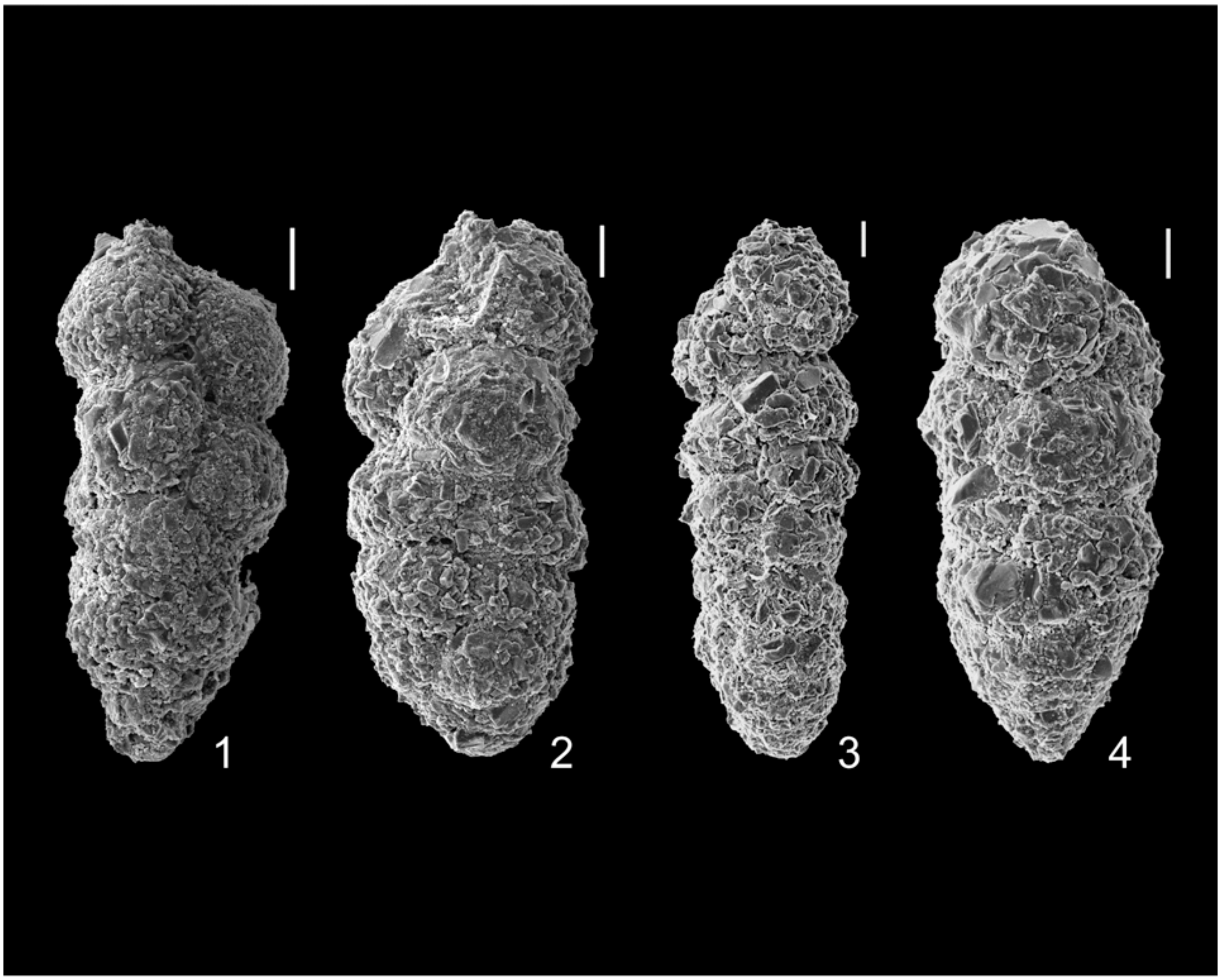

Plate 87

Scale bars = 50 μm

Lagena chrysalis Heron-Allen and Earland

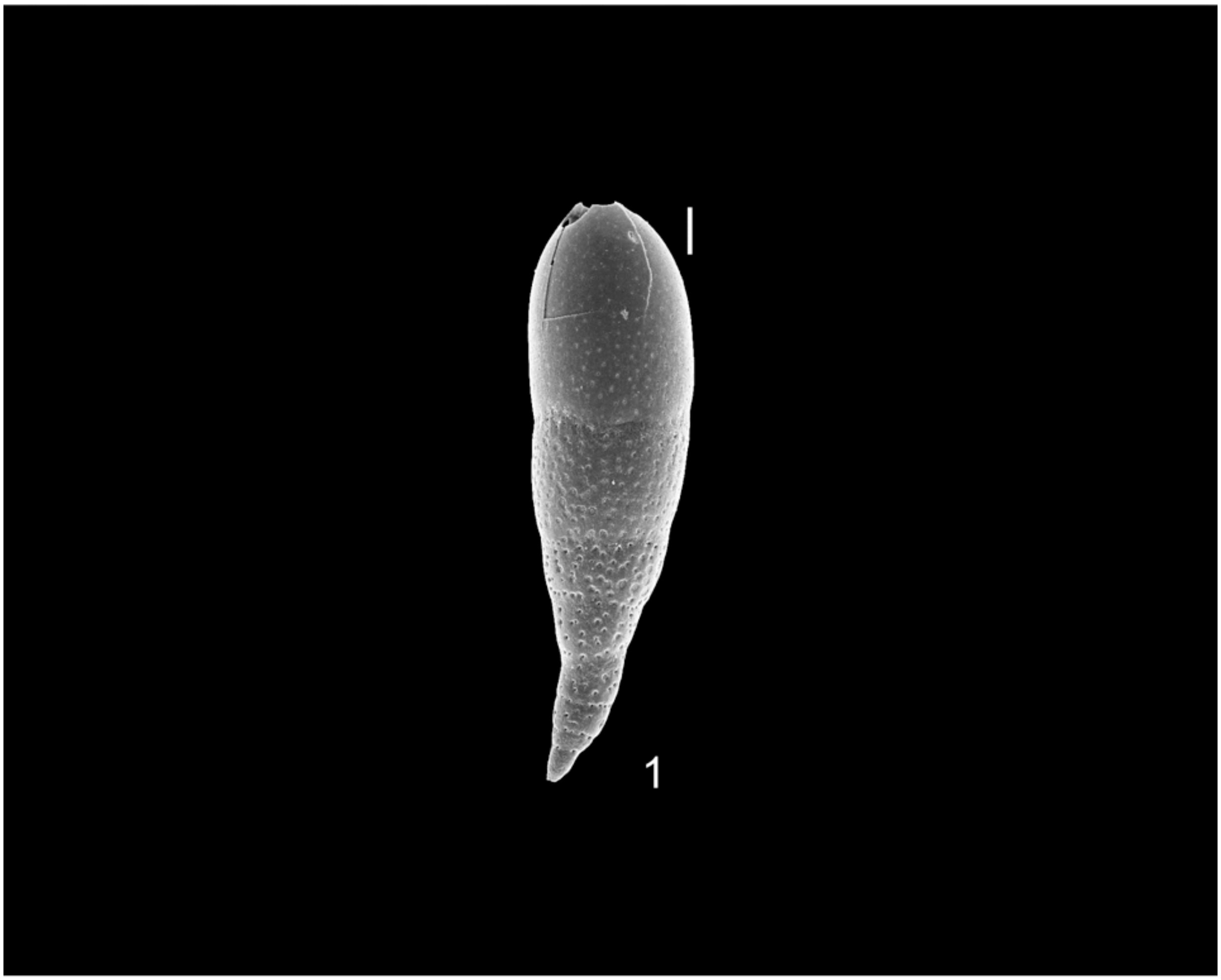

Plate 88 Scale bars = 50 μm

Lagena hispida Reuss

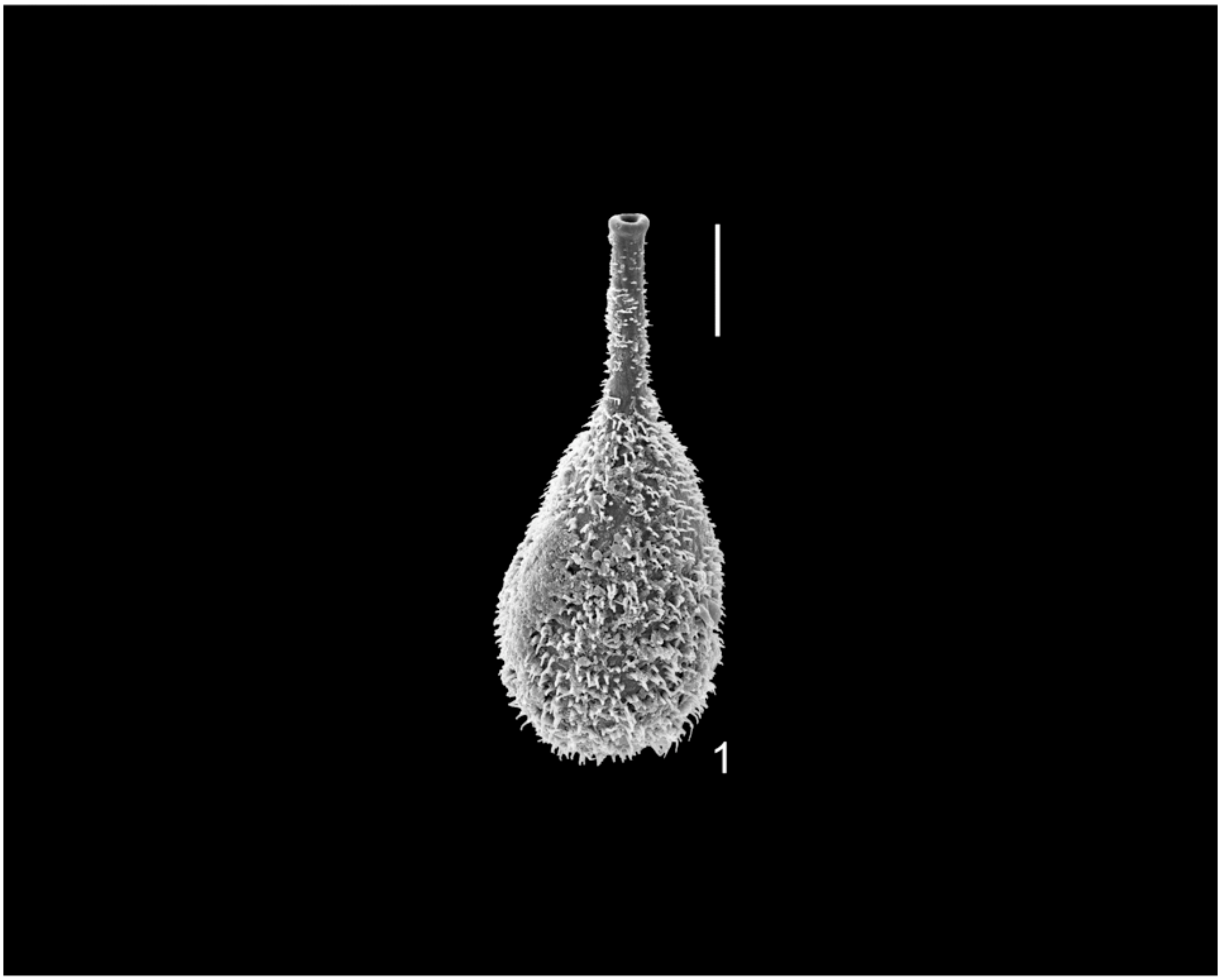

Plate 89

Scale bars = 50 μm

Lagena hispidula Cushman

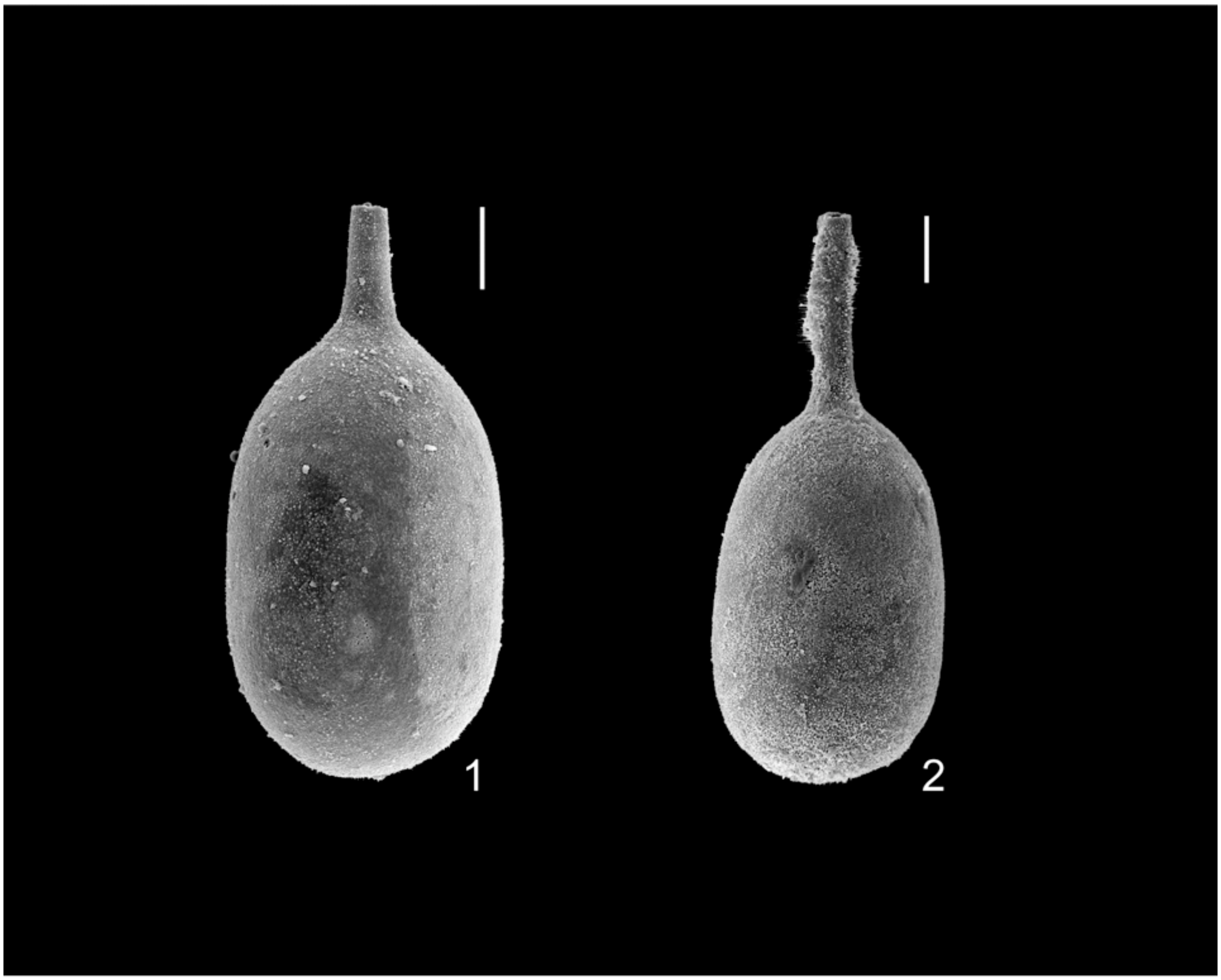

Plate 90 Scale bars = 50 μm

Lagenammina difflugiformis (Brady)

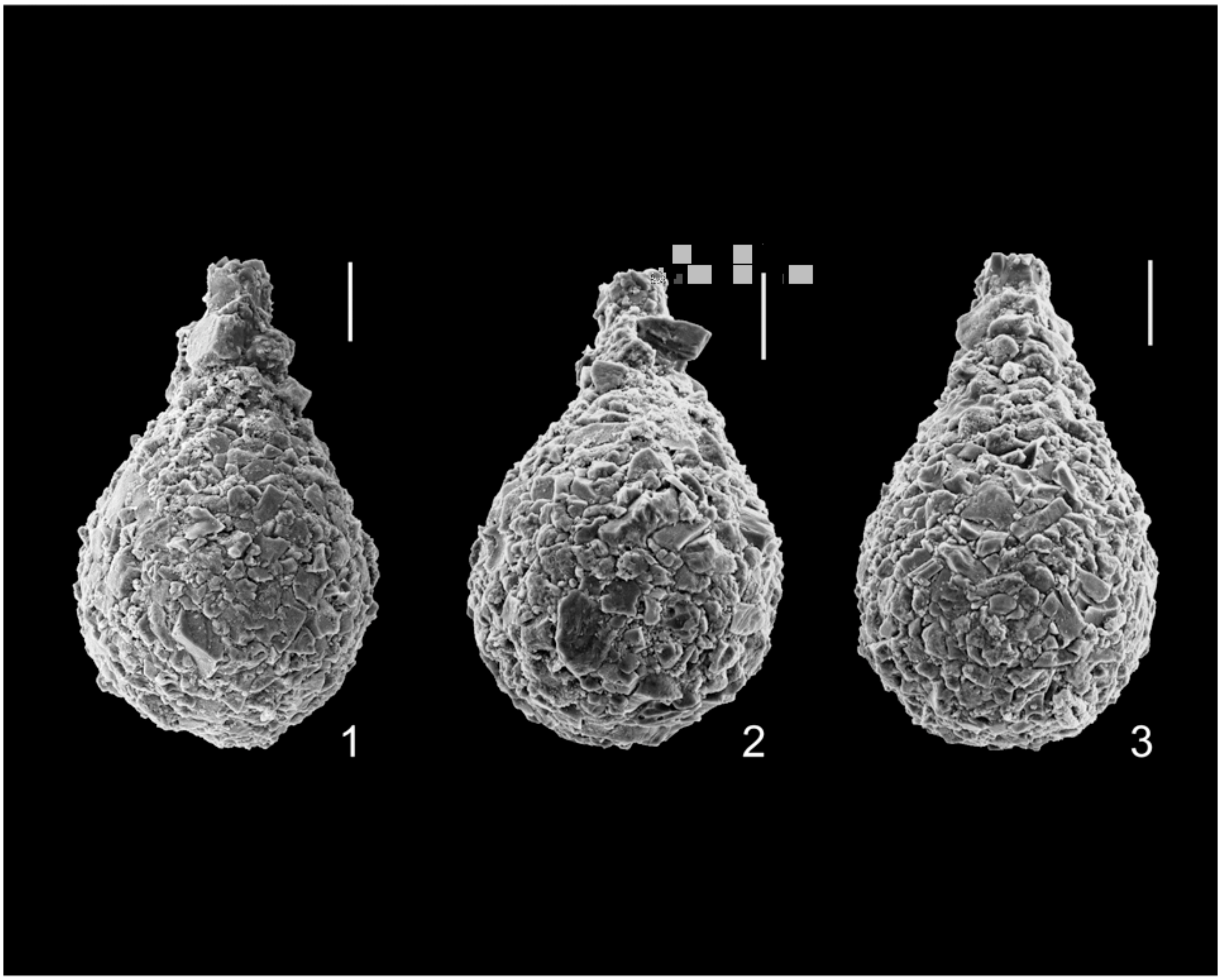

Plate 91

Scale bars = 50 µm

Lagenammina laguncula Rhumbler

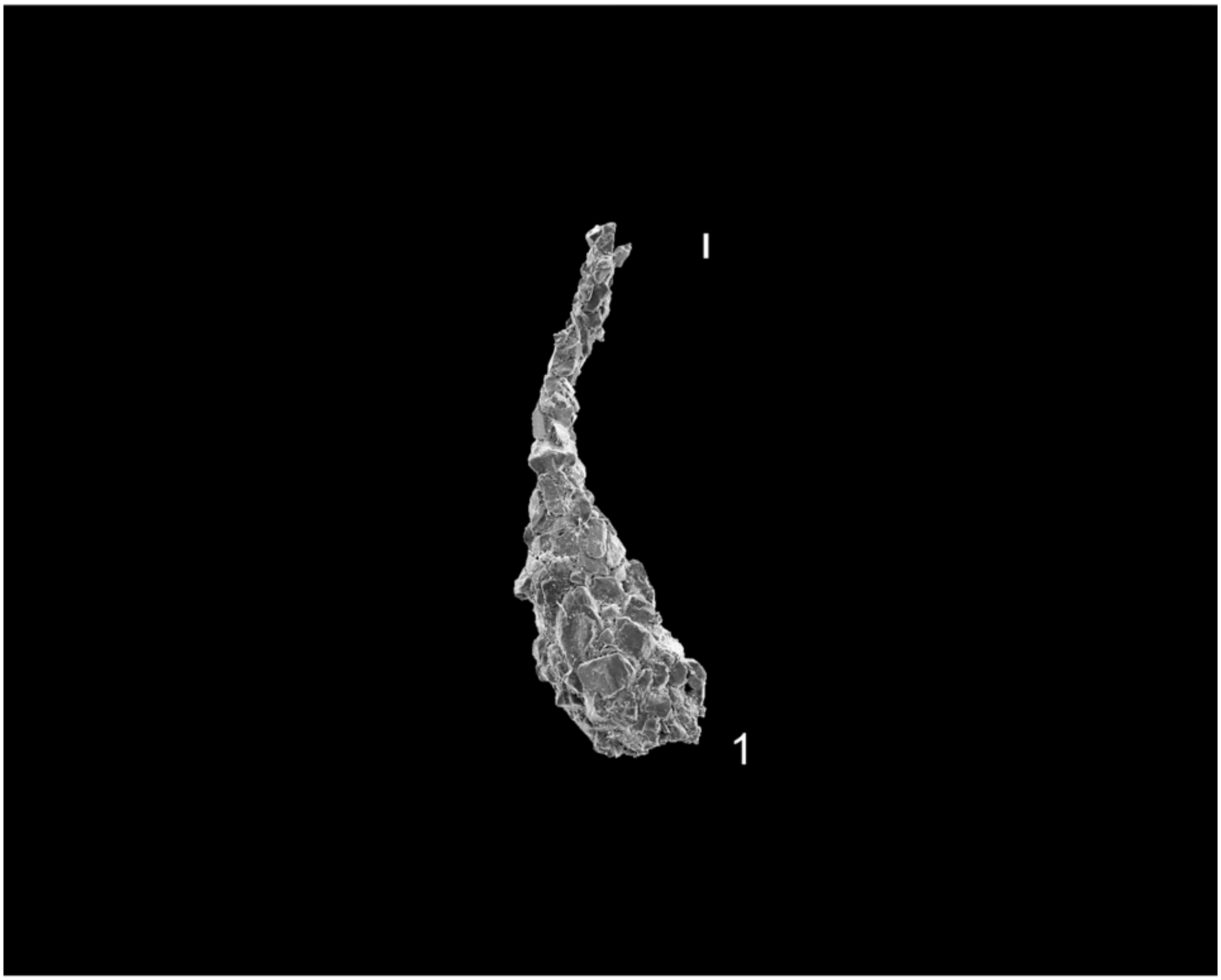

Plate 92

Scale bar = 50 μm

Lagenammina tubulata (Rhumbler)

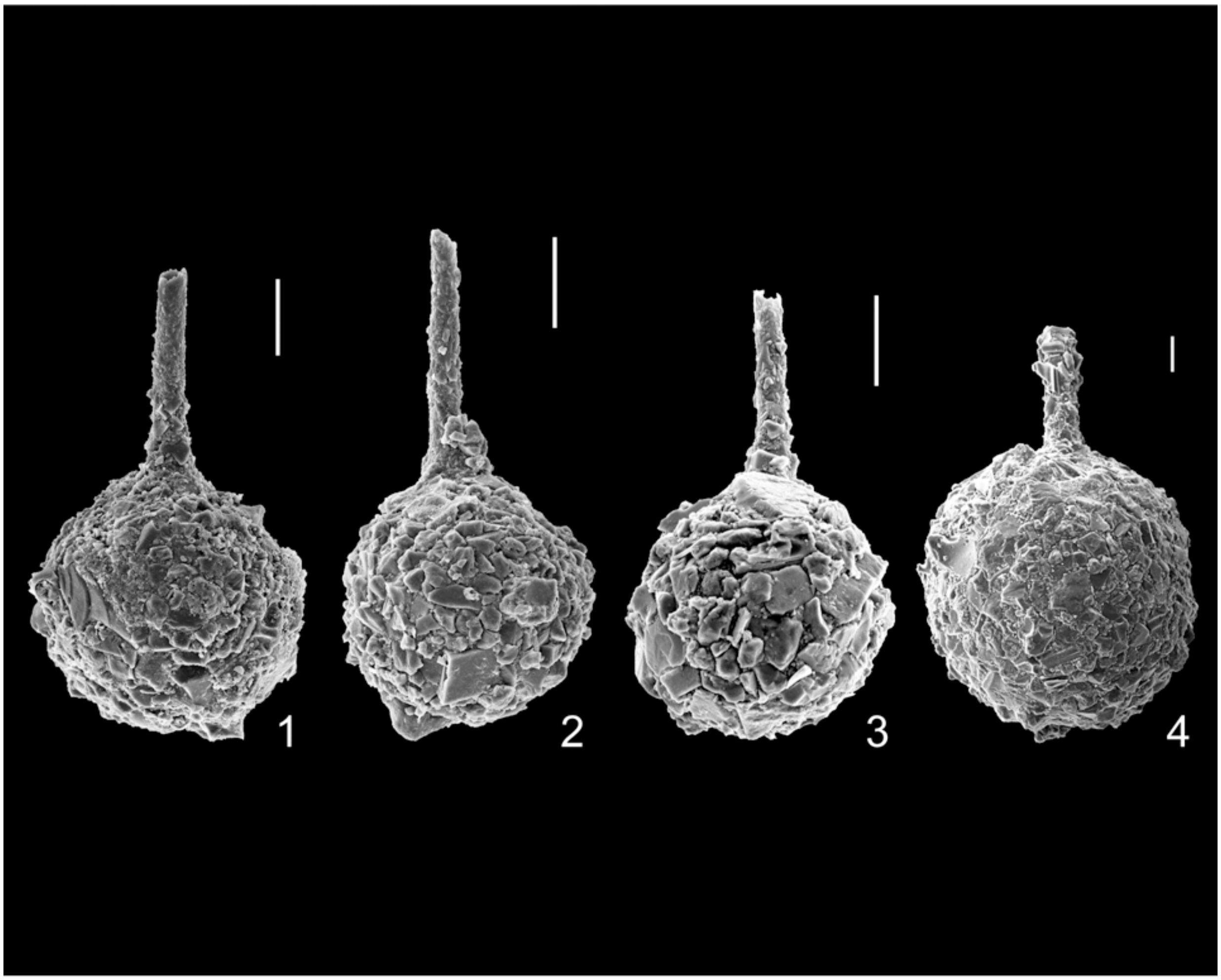

Plate 93

Scale bars = 50 μm

Laminononion tumidum (Cushman and Edwards)

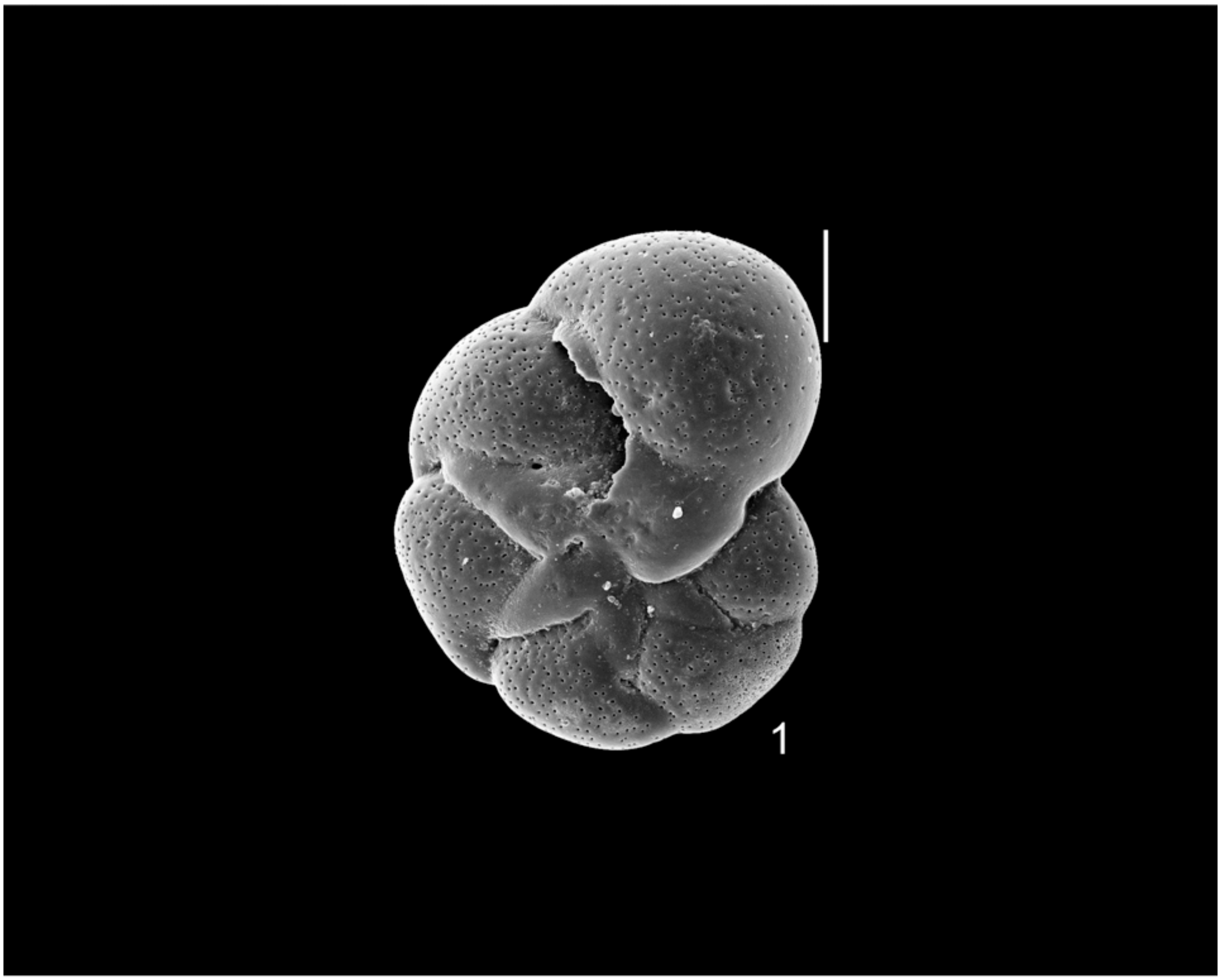

Plate 94

Scale bars = 50 μm

Laminononion tumidum (Cushman and Edwards)

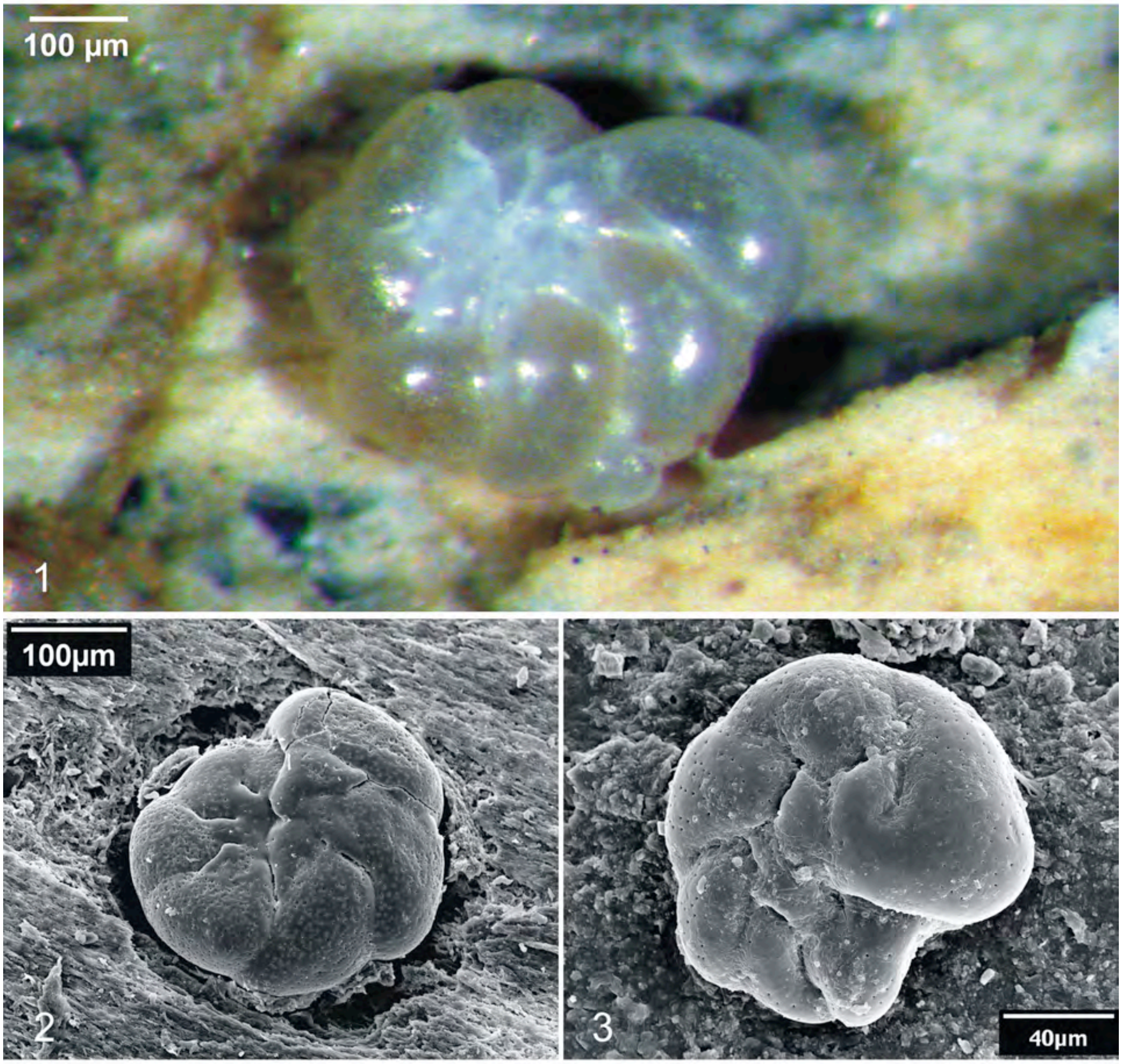

Plate 95

Laticarinina pauperata (Parker and Jones)

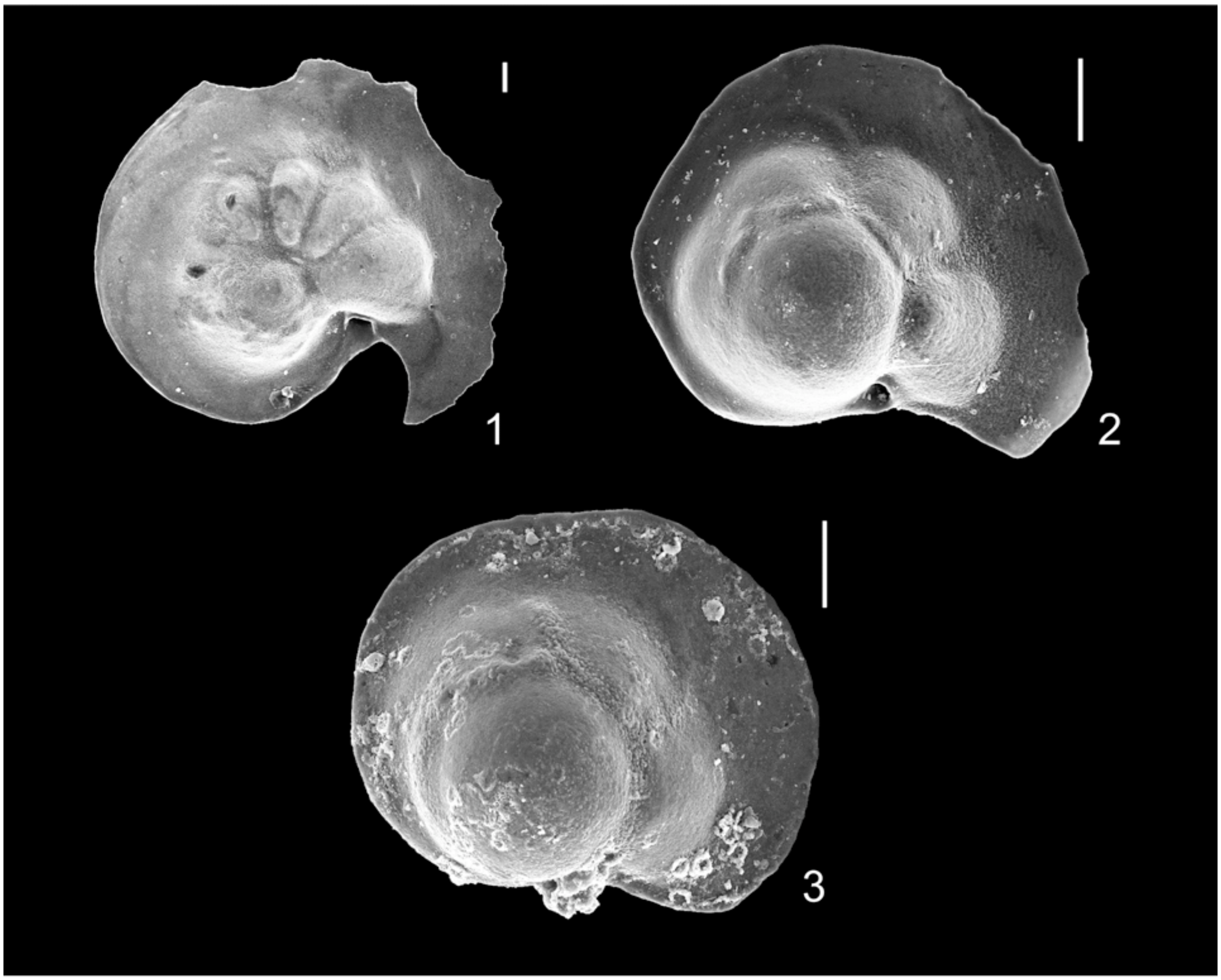

Plate 96 Scale bars = 50 μm

Lenticulina calcar (Linnaeus)

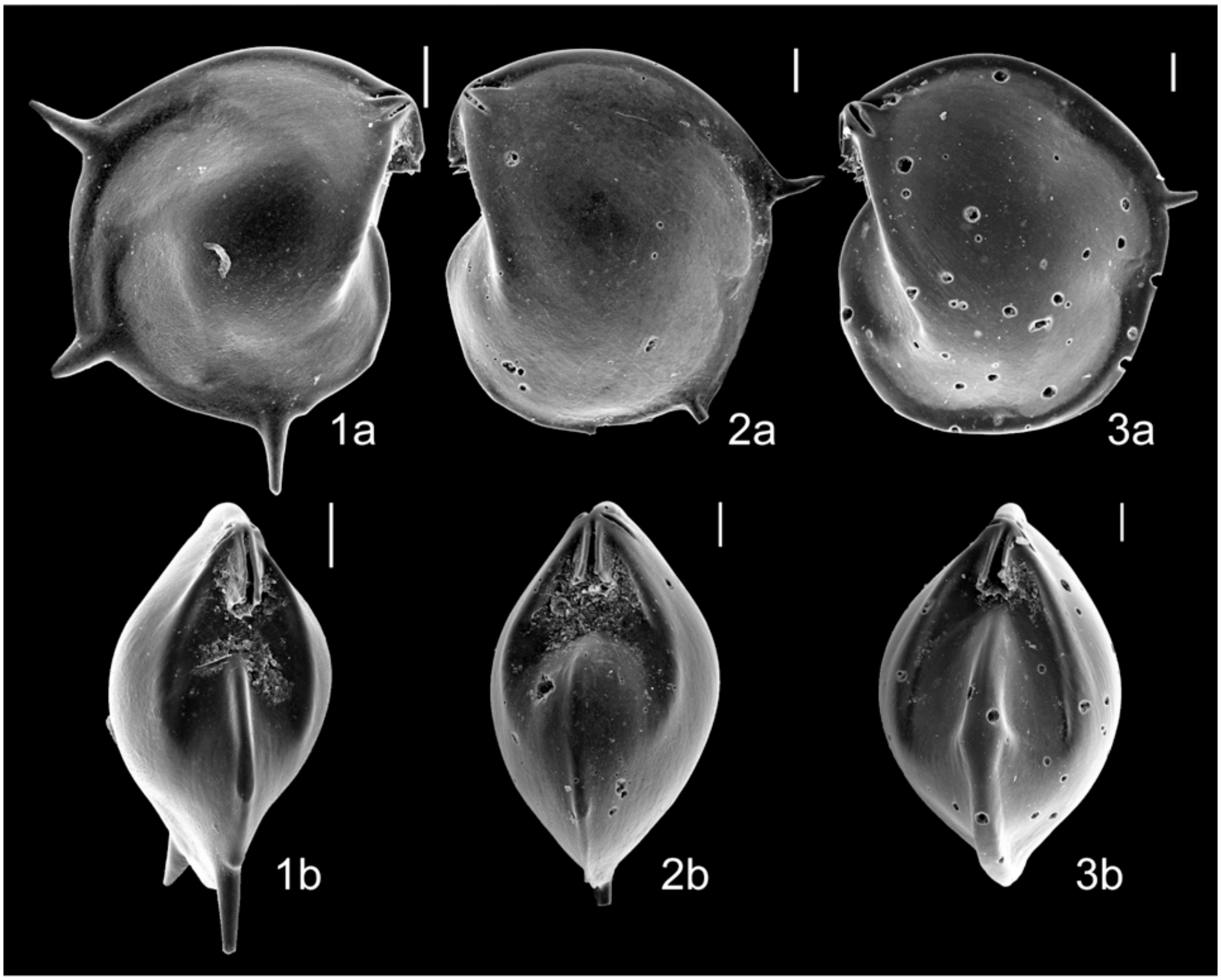

Plate 97

Scale bars = 50 μm

Lenticulina gibba (d'Orbigny)

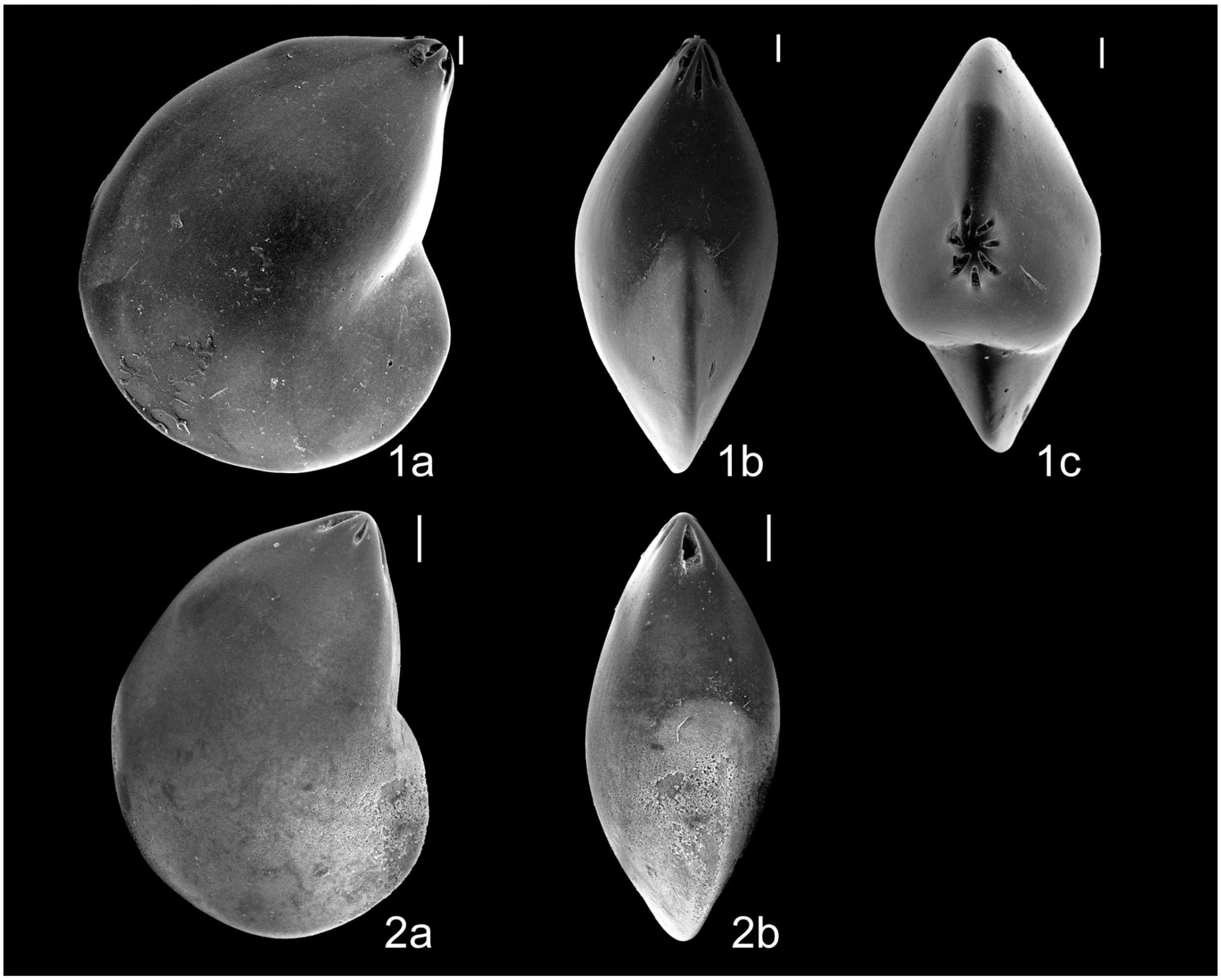

Plate 98 Scale bars = 50 μm

Lenticulina pliocaena (Silvestri)

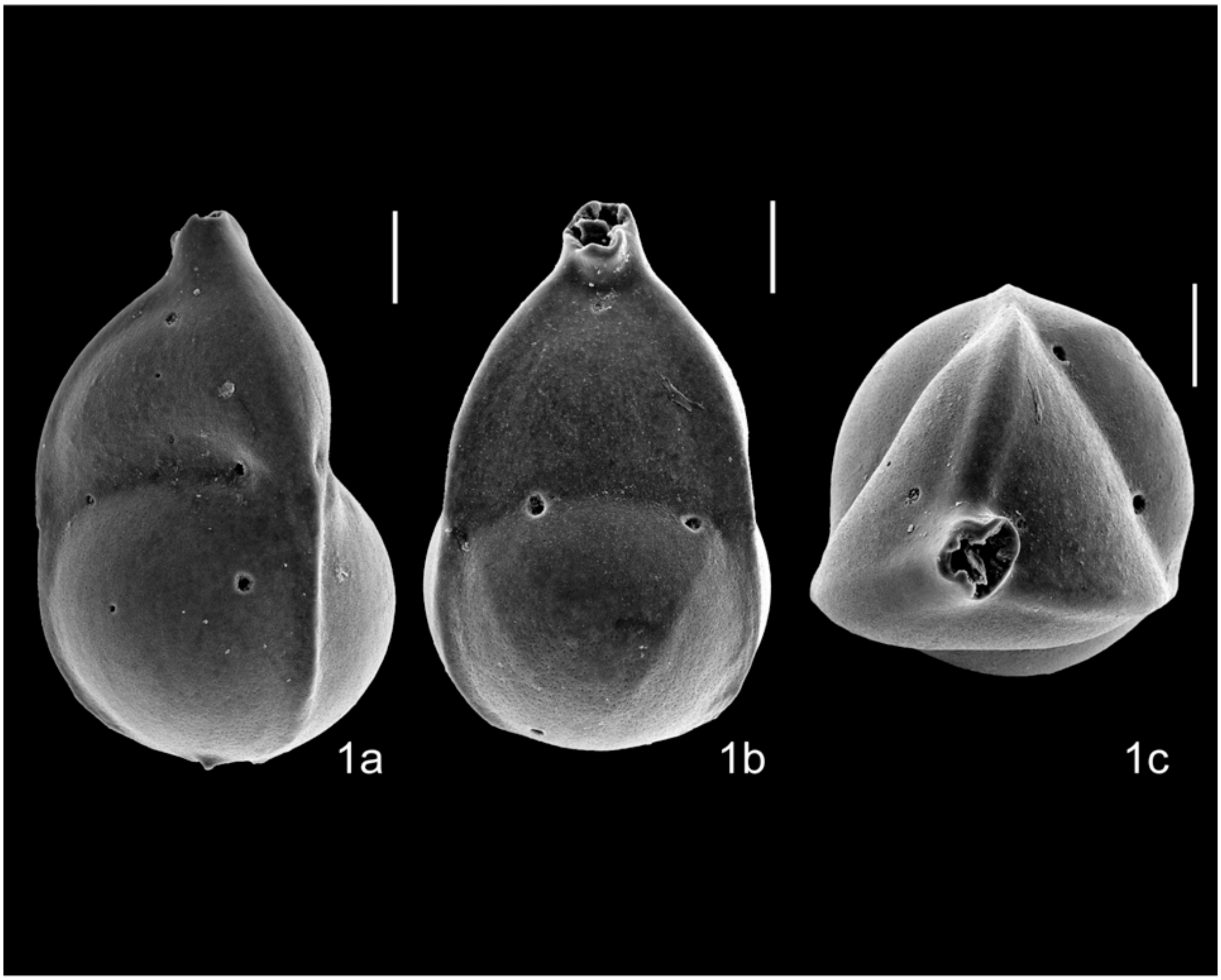

Plate 99

Scale bars = 50 μm

Lenticulina thalmanni (Hessland)

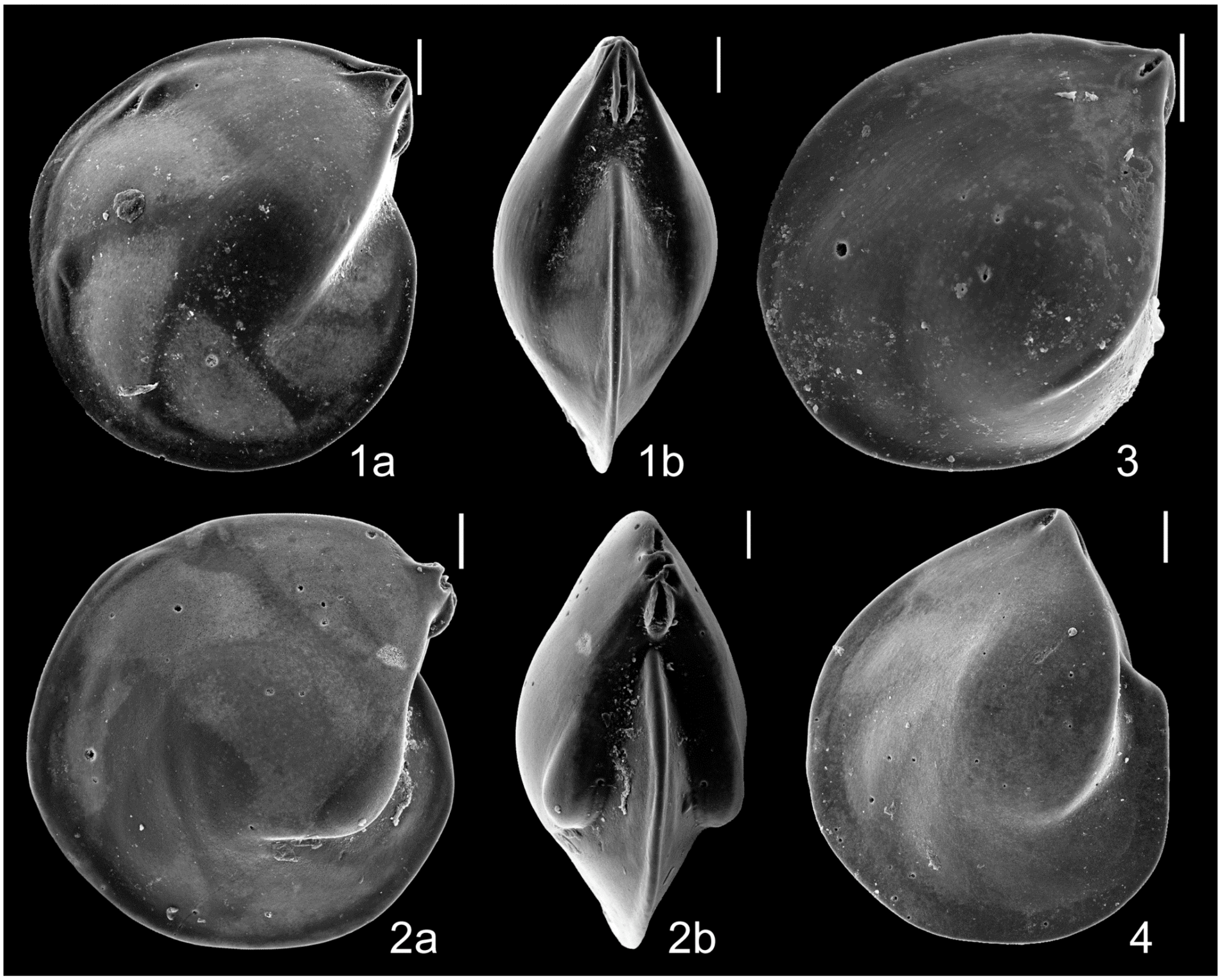

Plate 100 Scale bars = 50 μm

Lituotuba lituiformis (Brady)

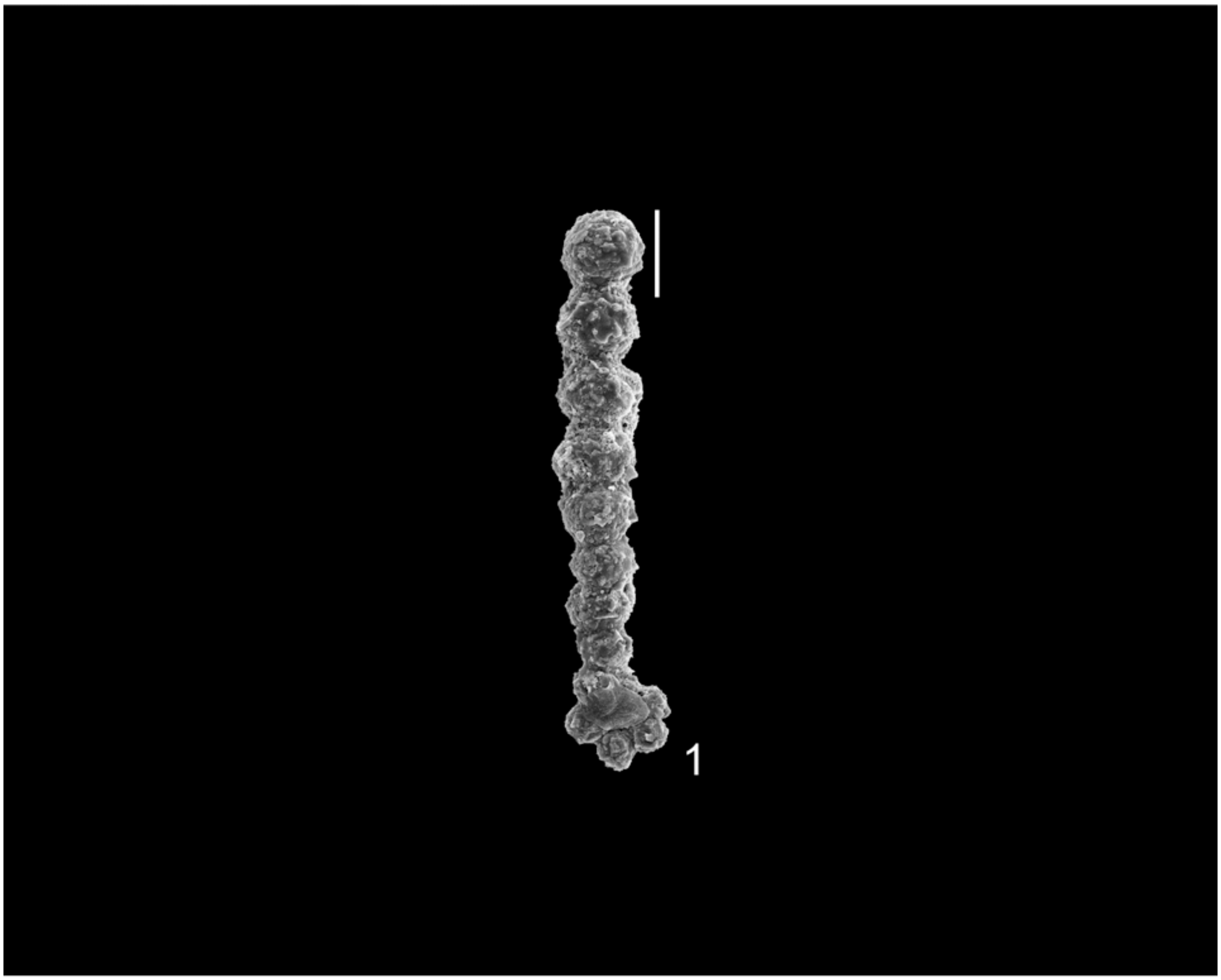

Plate 101

Scale bars = 50 μm

Martinottiella communis (d'Orbigny)

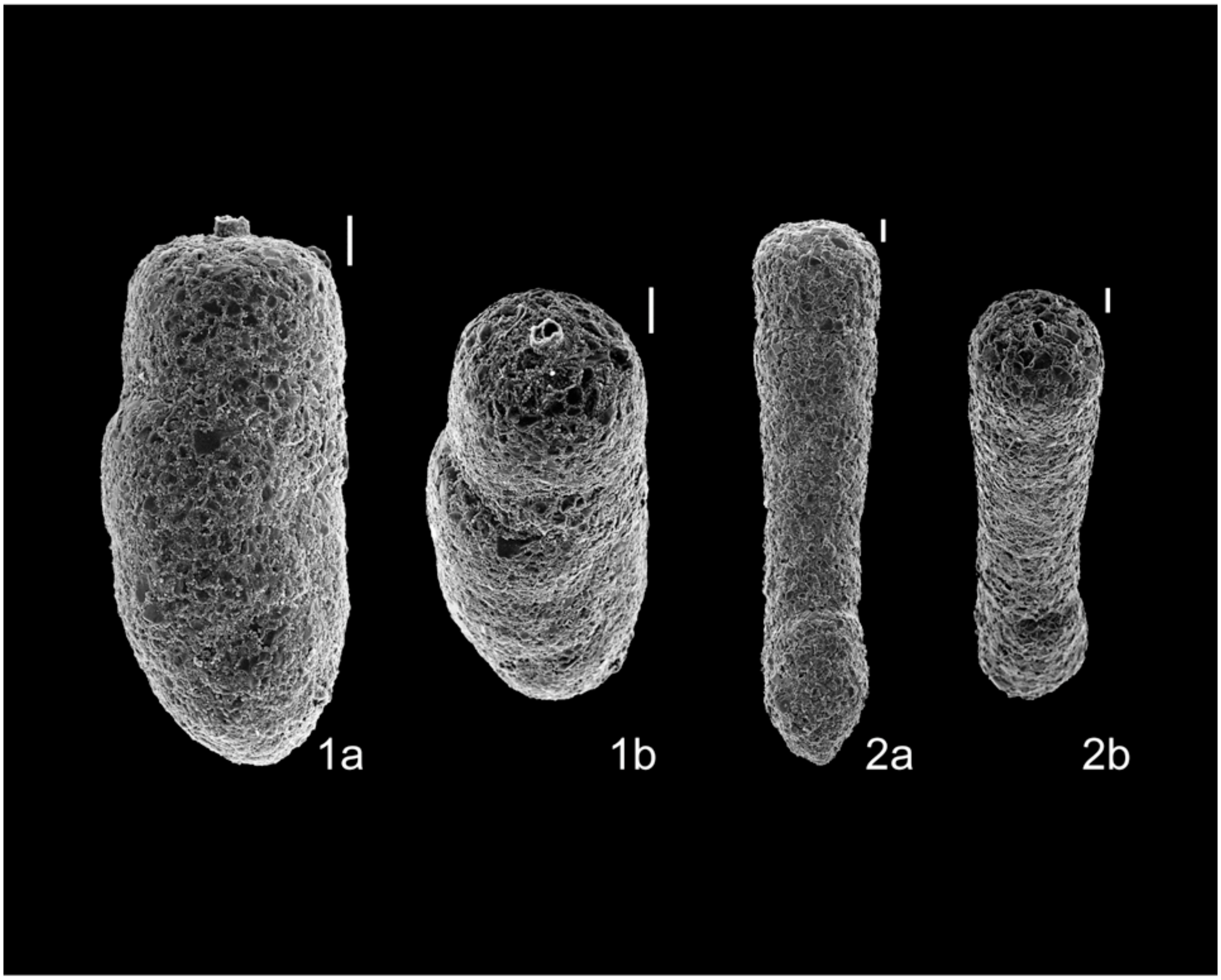

Plate 102

Scale bars = 50 μm

Melonis affinis (Reuss)

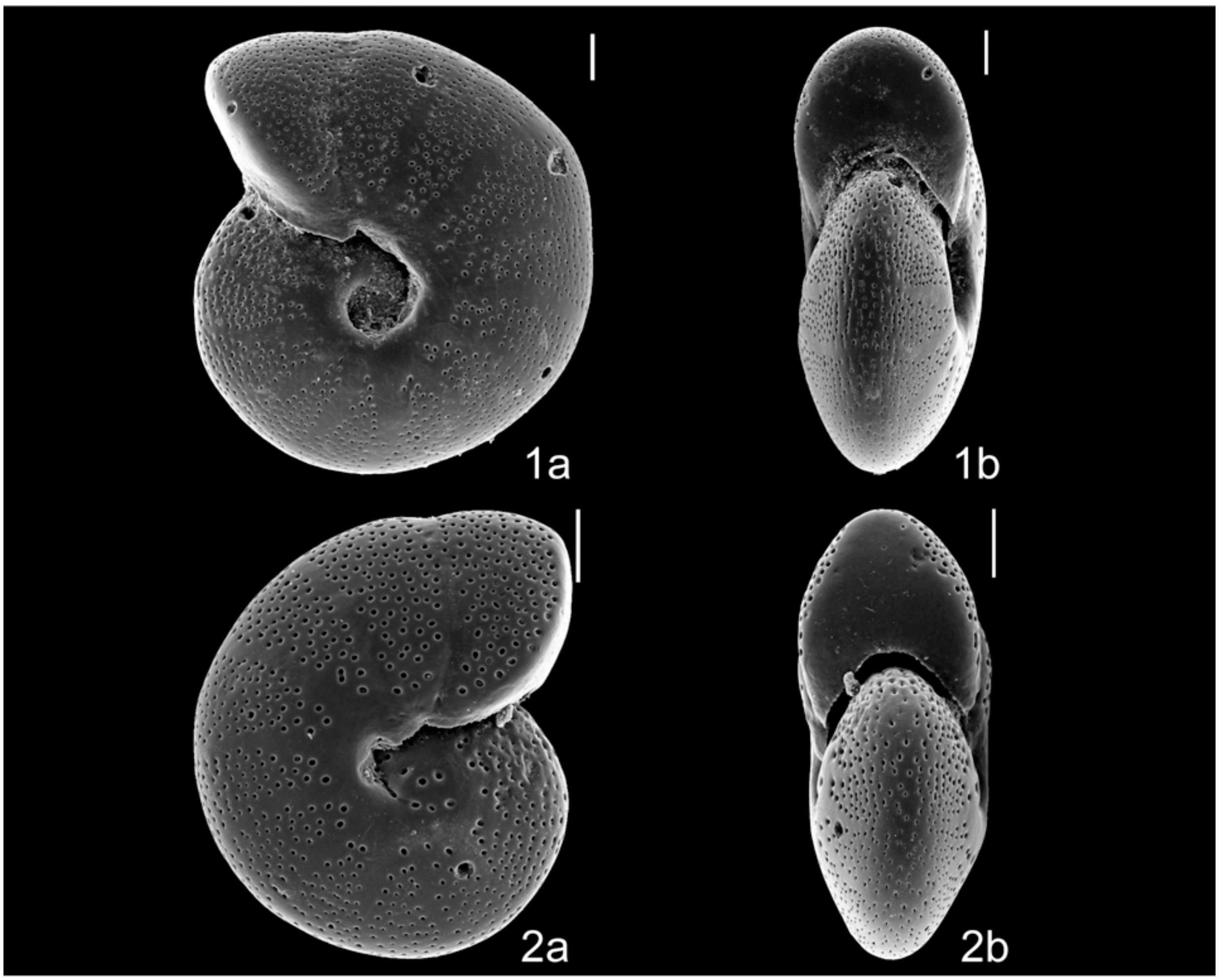

Plate 103

Scale bars = 50 μm

Melonis pompilioides (Fichtel and Moll)

Plate 104

Scale bars = 50 μm

Miliolinella warreni Andersen

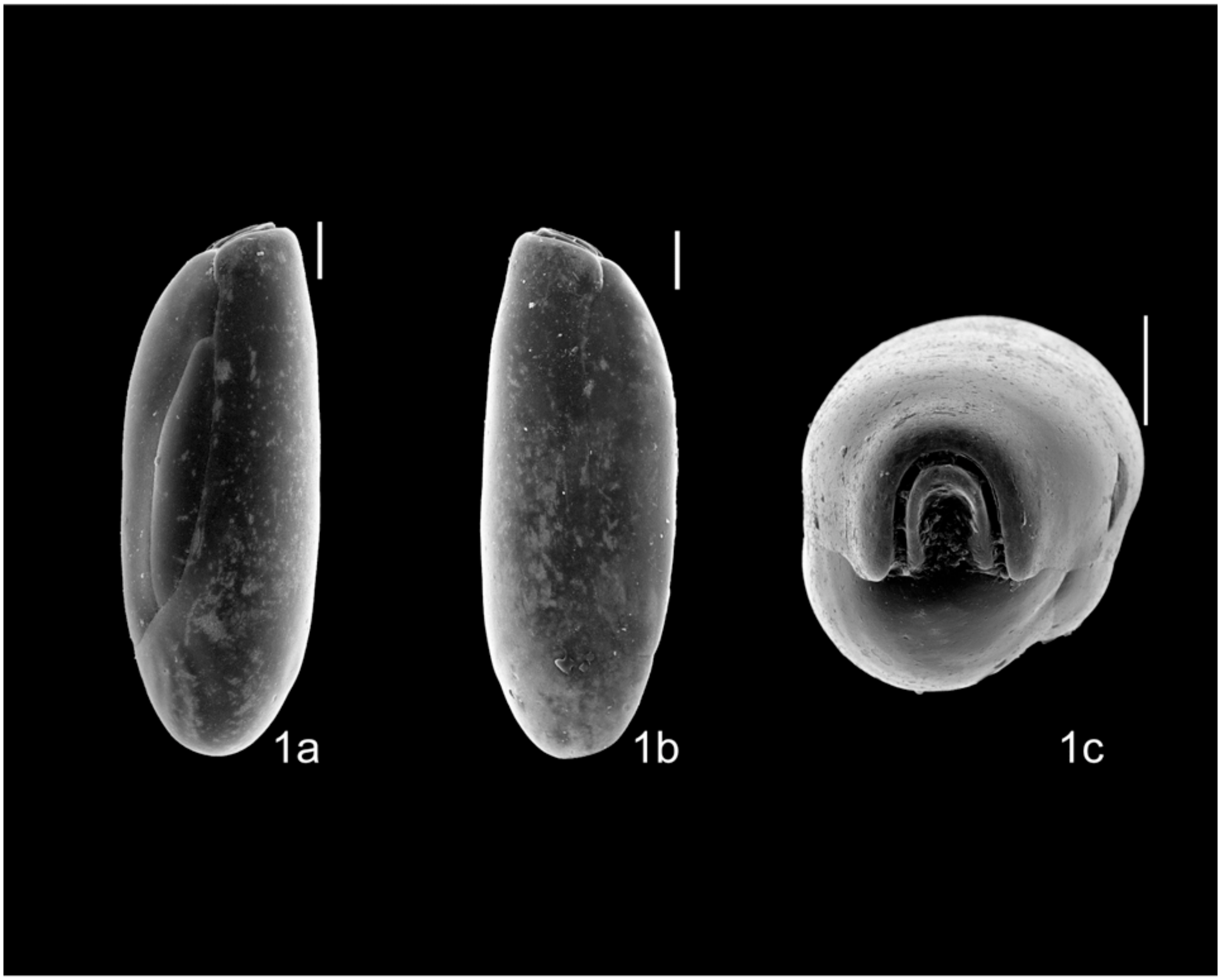

Plate 105 Scale bars = 50 μm

Miliolinella sp.

Plate 106

Multifidella nodulosa (Cushman)

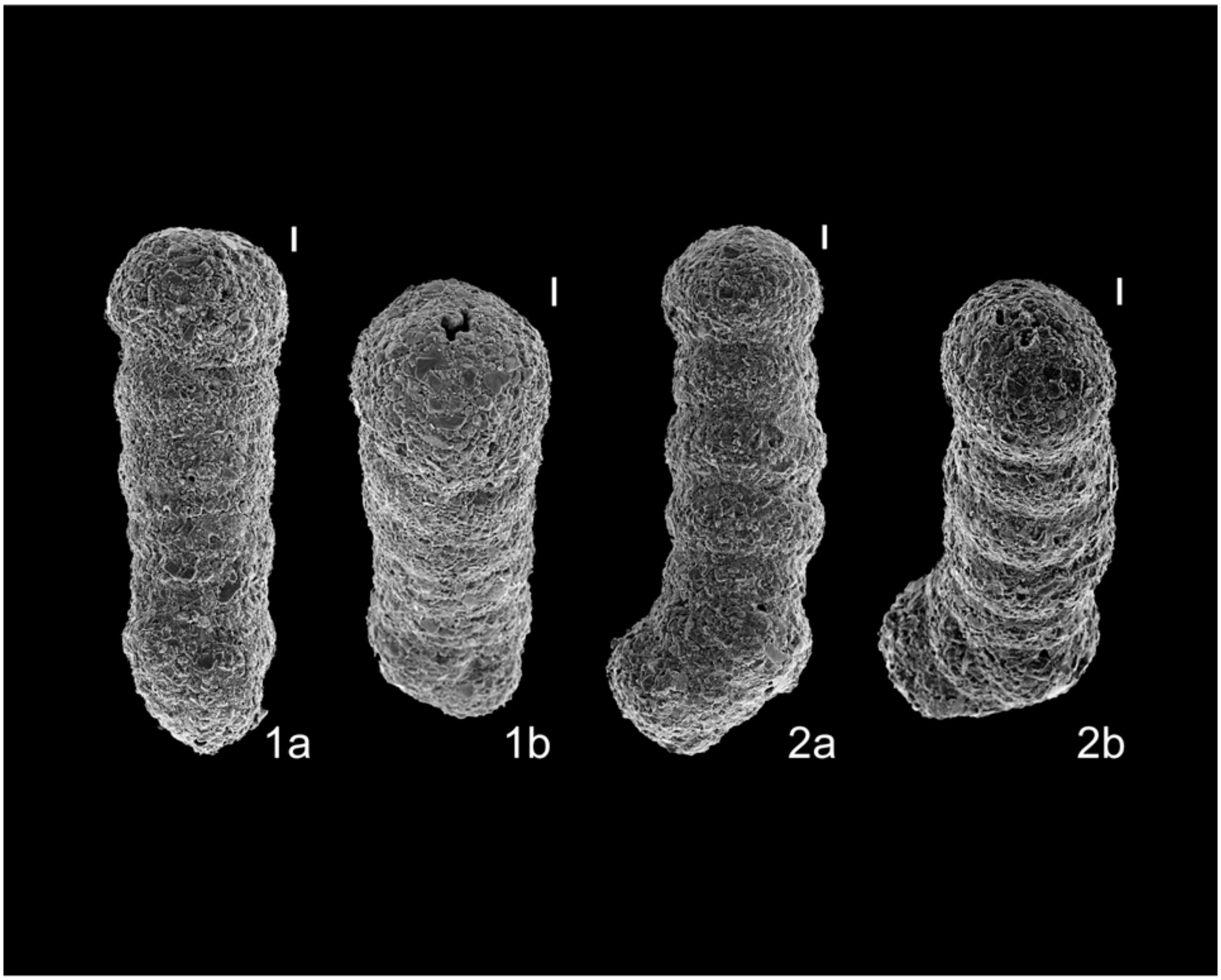

Plate 107

Scale bars = 50 μm

Neocrosbyia minuta (Parker)

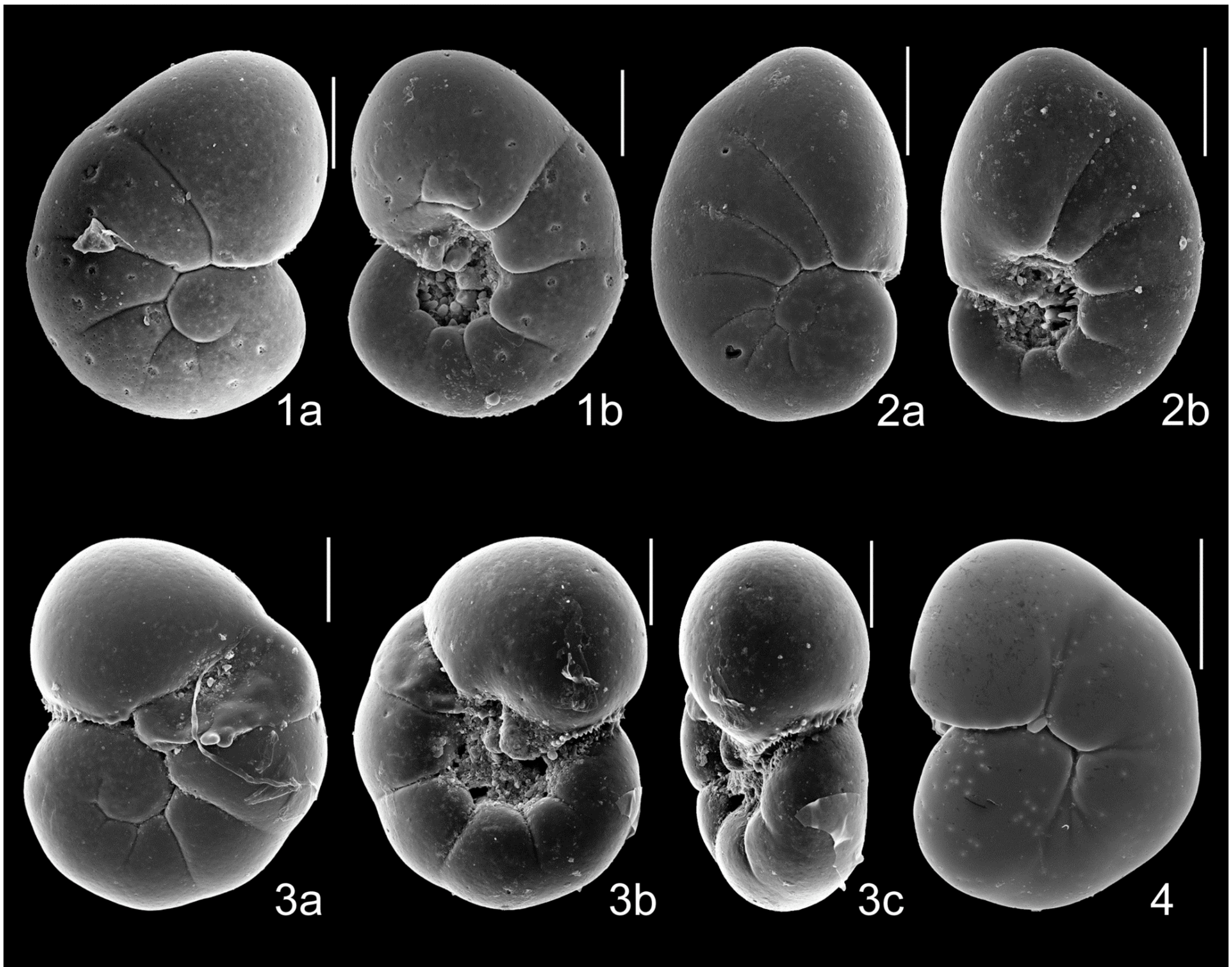

Plate 108

Scale bars = 50 μm

Nonionella iridea Heron-Allen and Earland

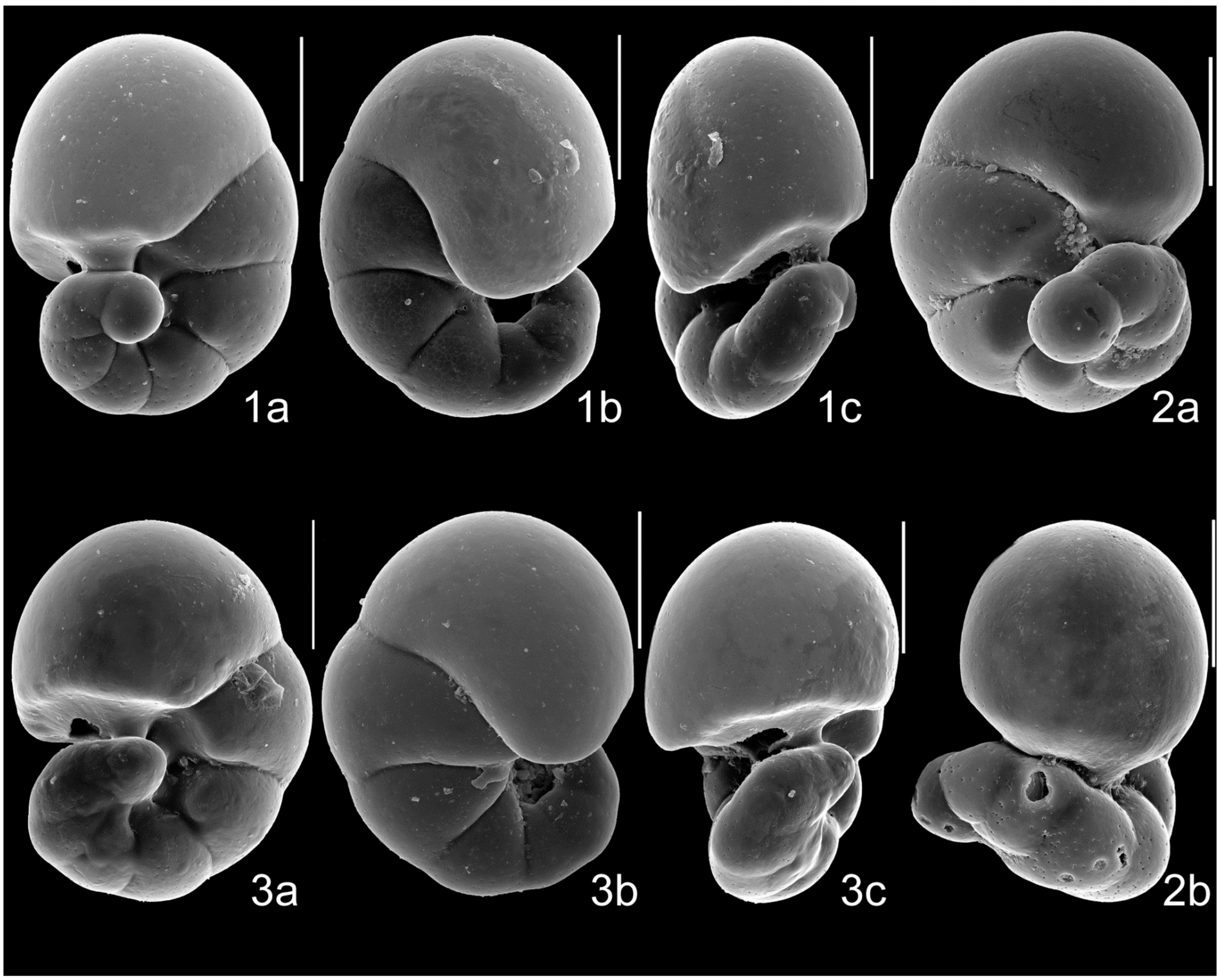

Plate 109 Scale bars = 50 μm

Nuttallides decorata (Phleger and Parker)

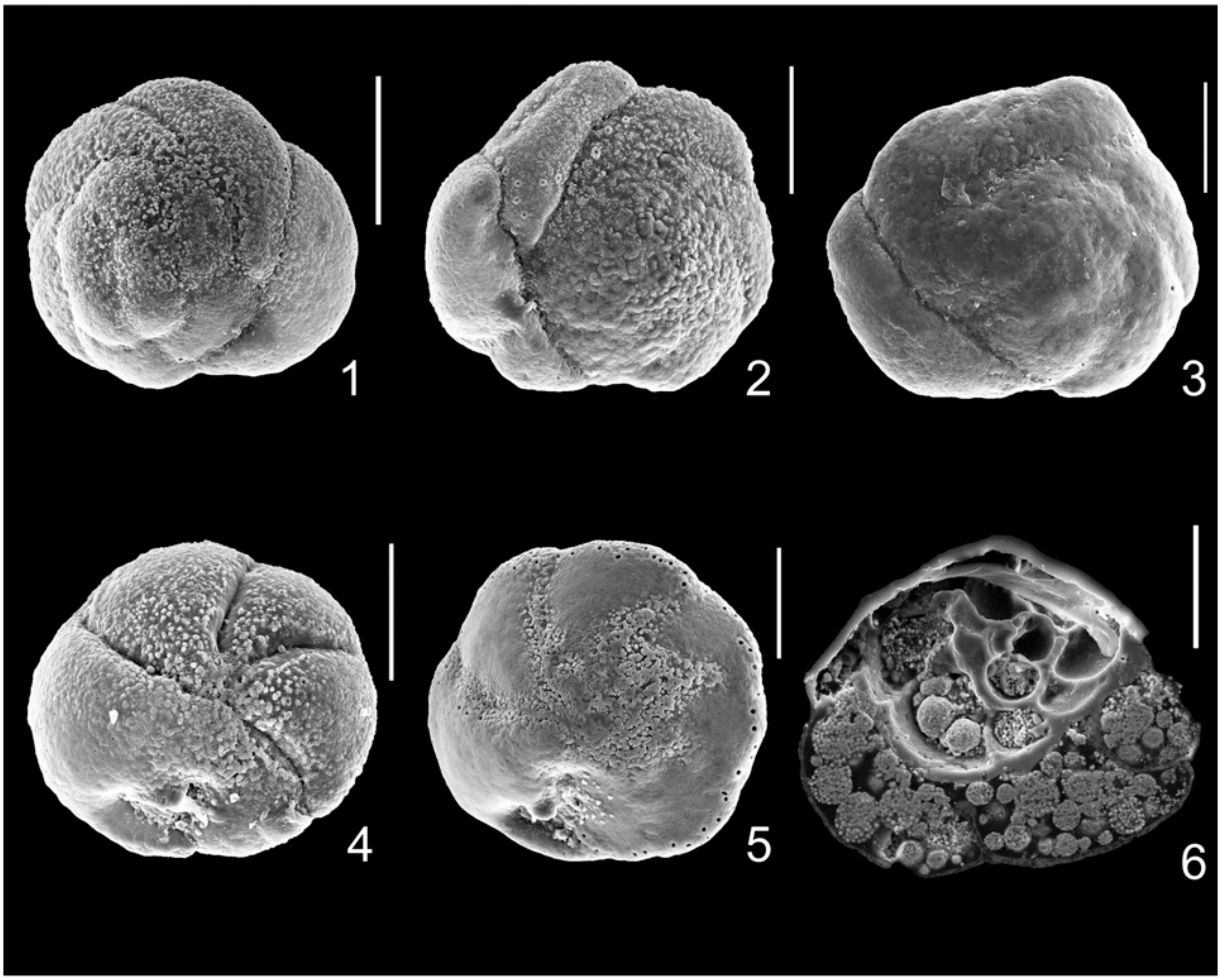

Plate 110

Scale bars = 50 μm

Oolina apiopleura (Loeblich and Tappan)

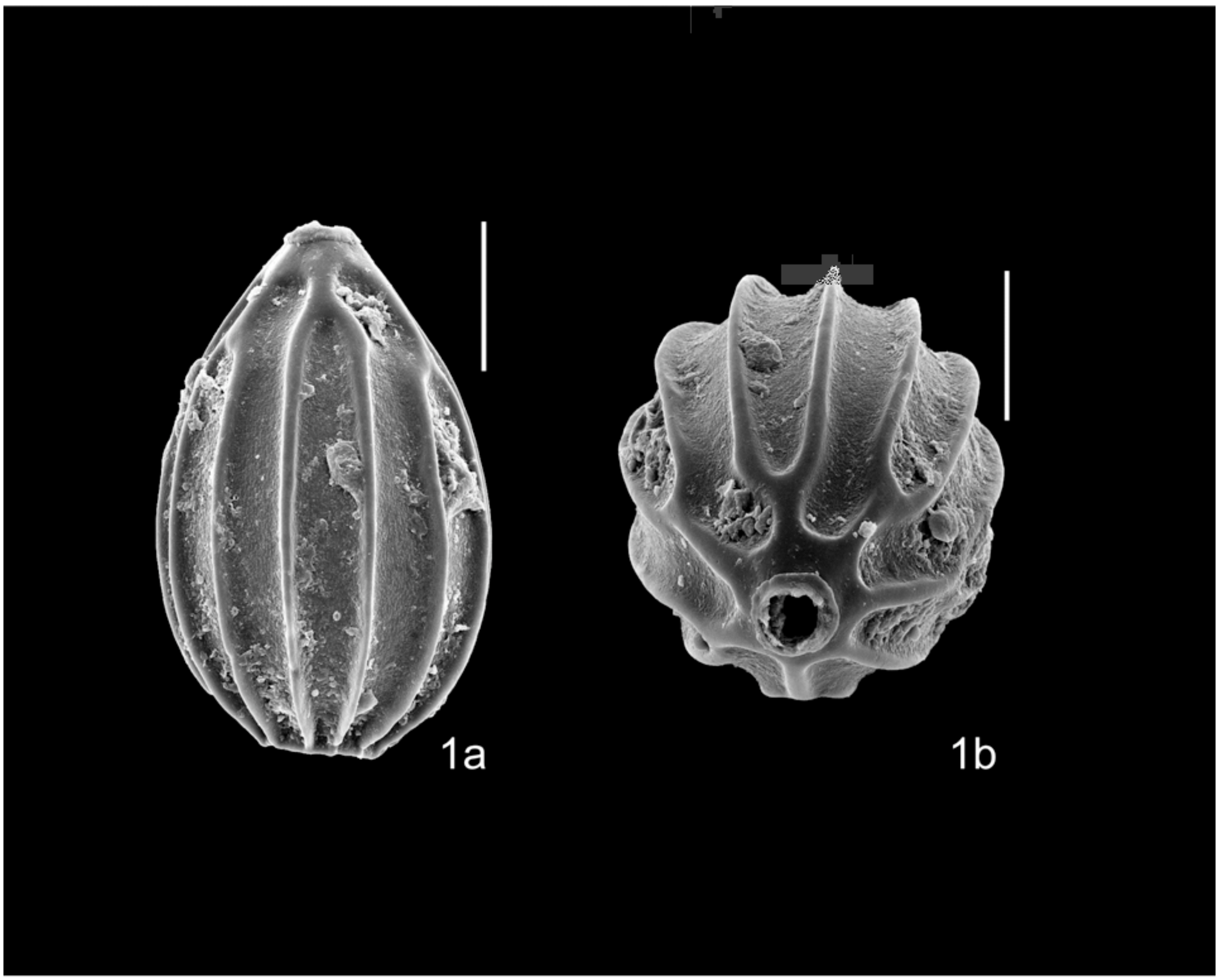

Plate 111

Scale bars = 50 μm

Oolina globosa (Montagu)

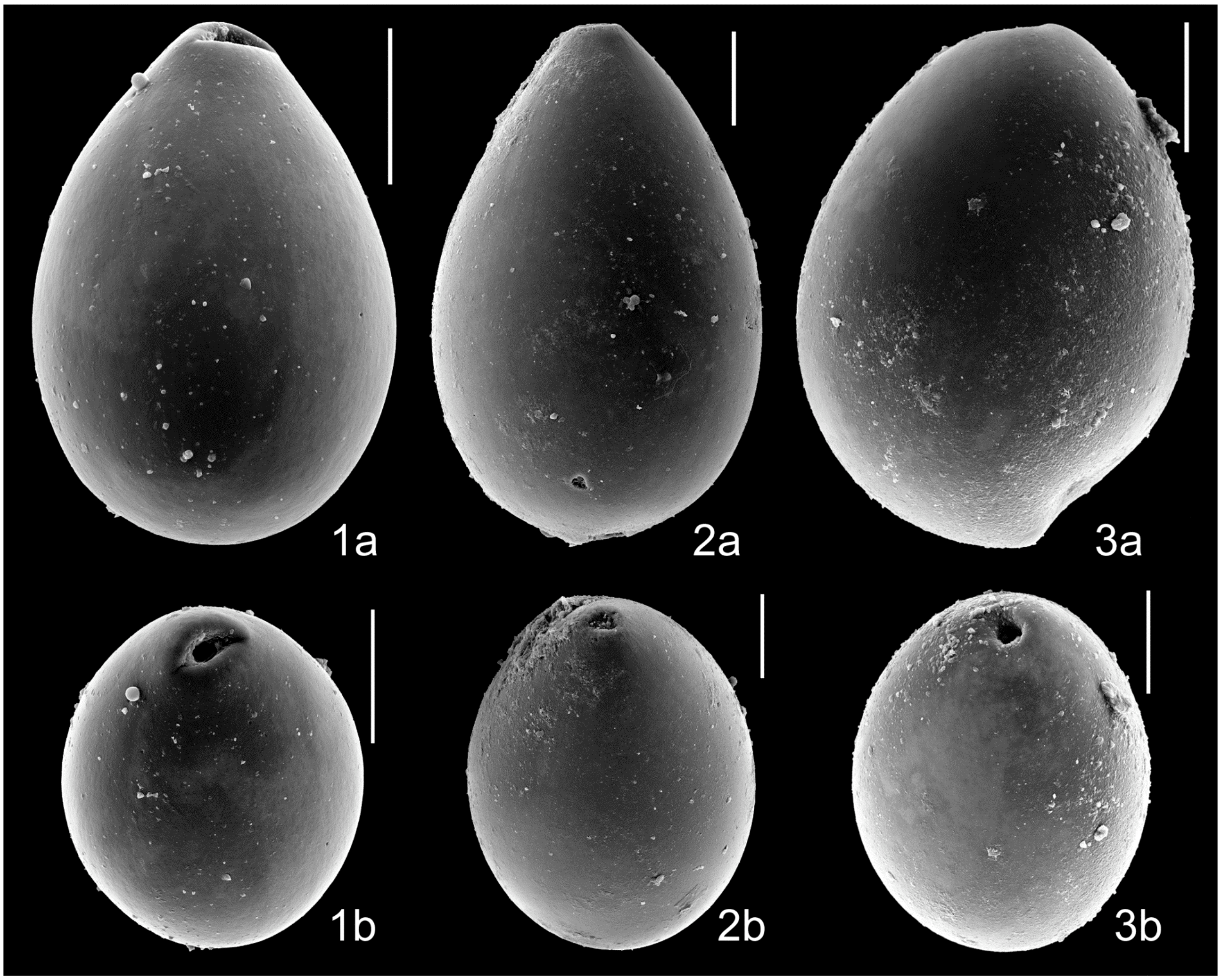

Plate 112 Scale bars = 50 μm

Oolina ovum (Ehrenberg)

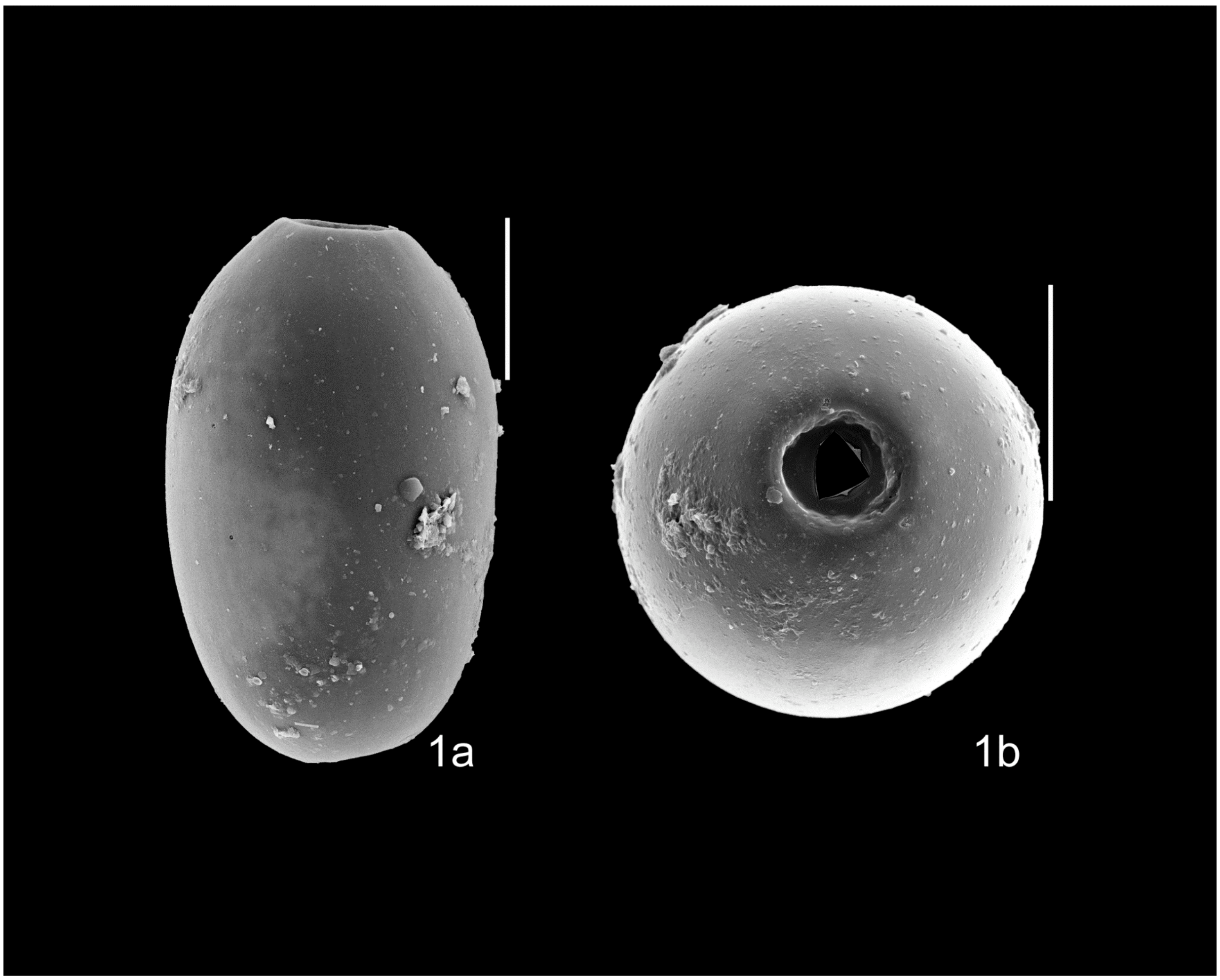

Plate 113

Scale bars = 50 μm

Oolina squamosa (Montagu)

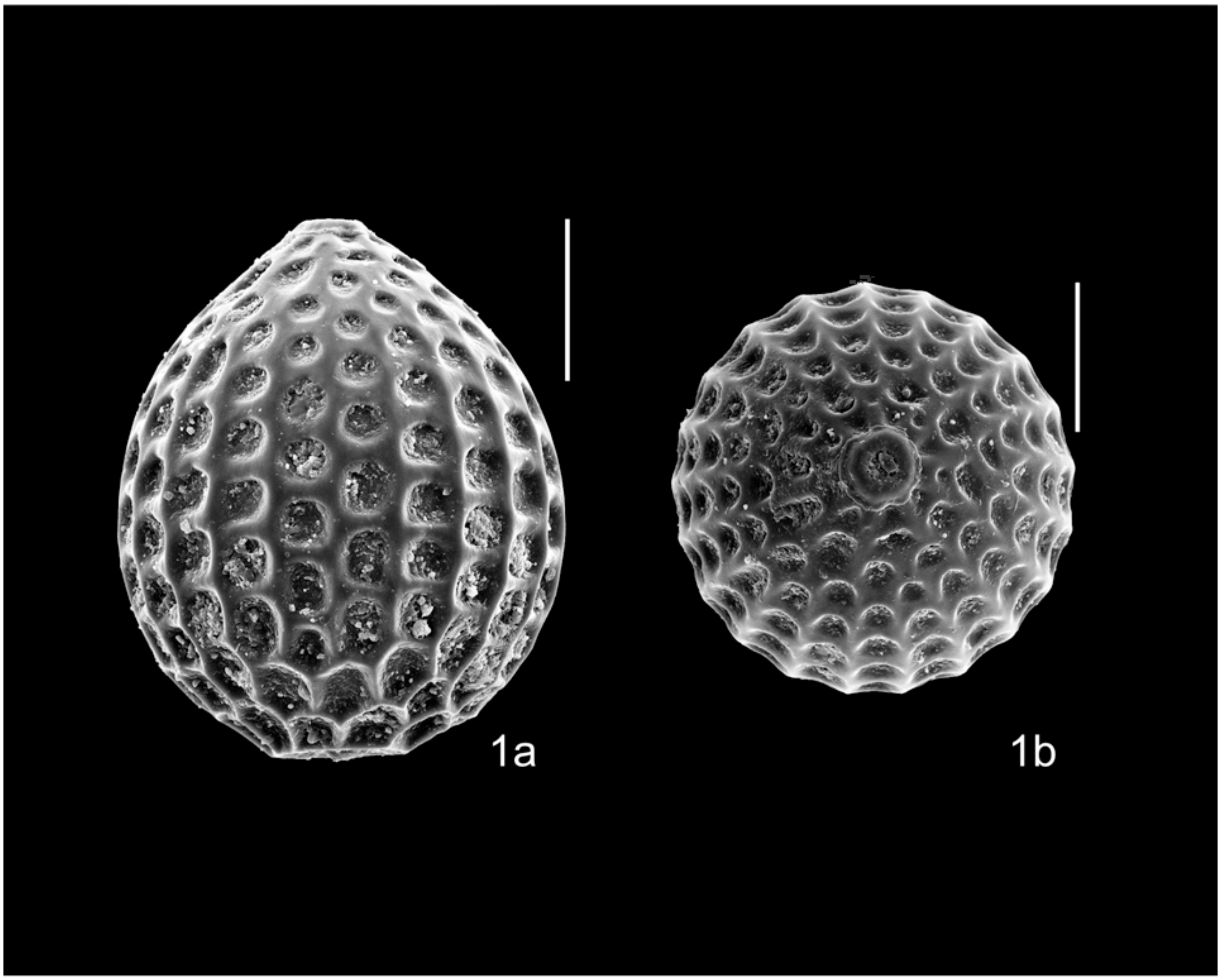

Plate 114 Scale bars = 50 μm

Orectostomina camposi (Brönniman and Beurlen)

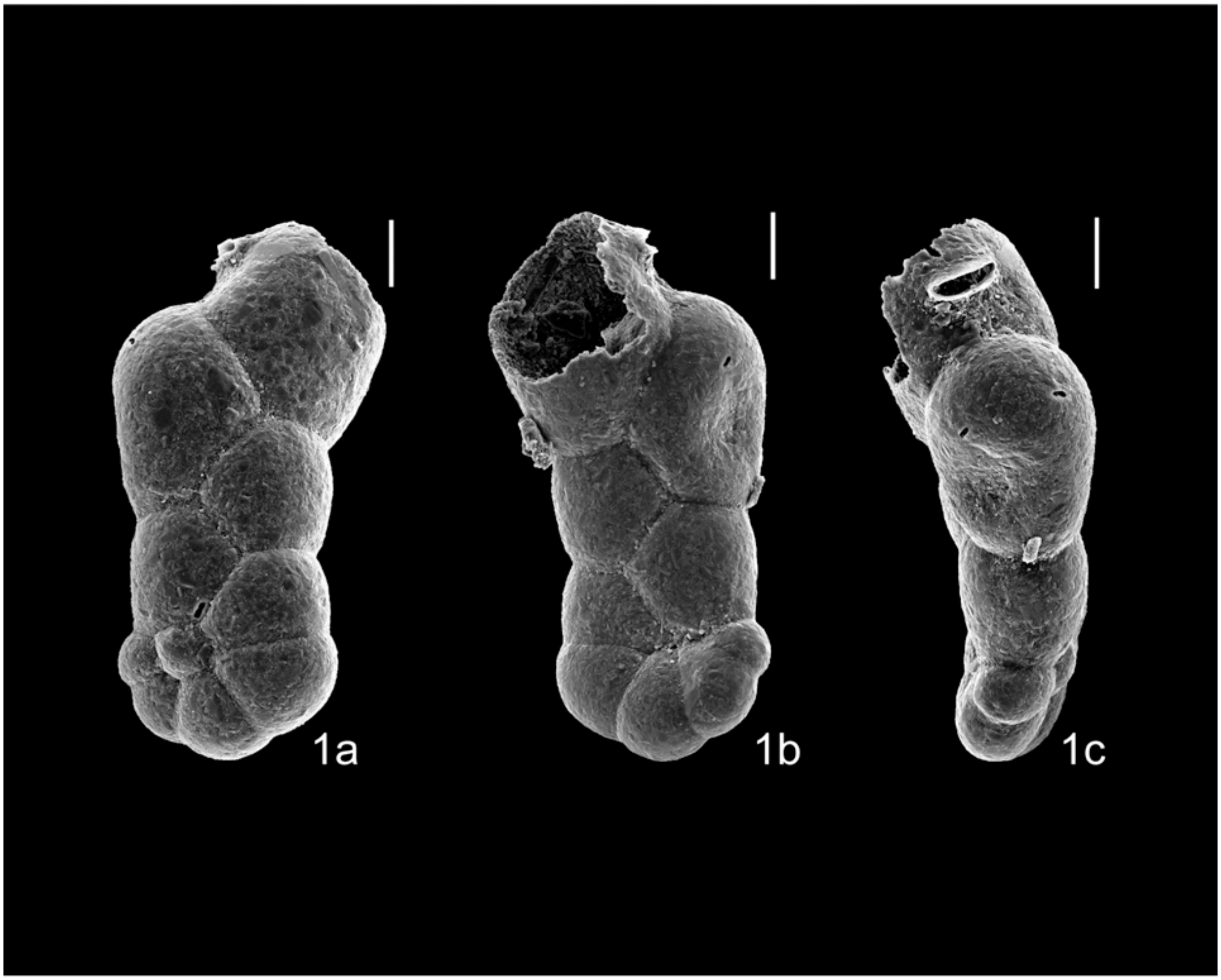

Plate 115

Scale bars = 50 μm

Oridorsalis umbonatus (Reuss)

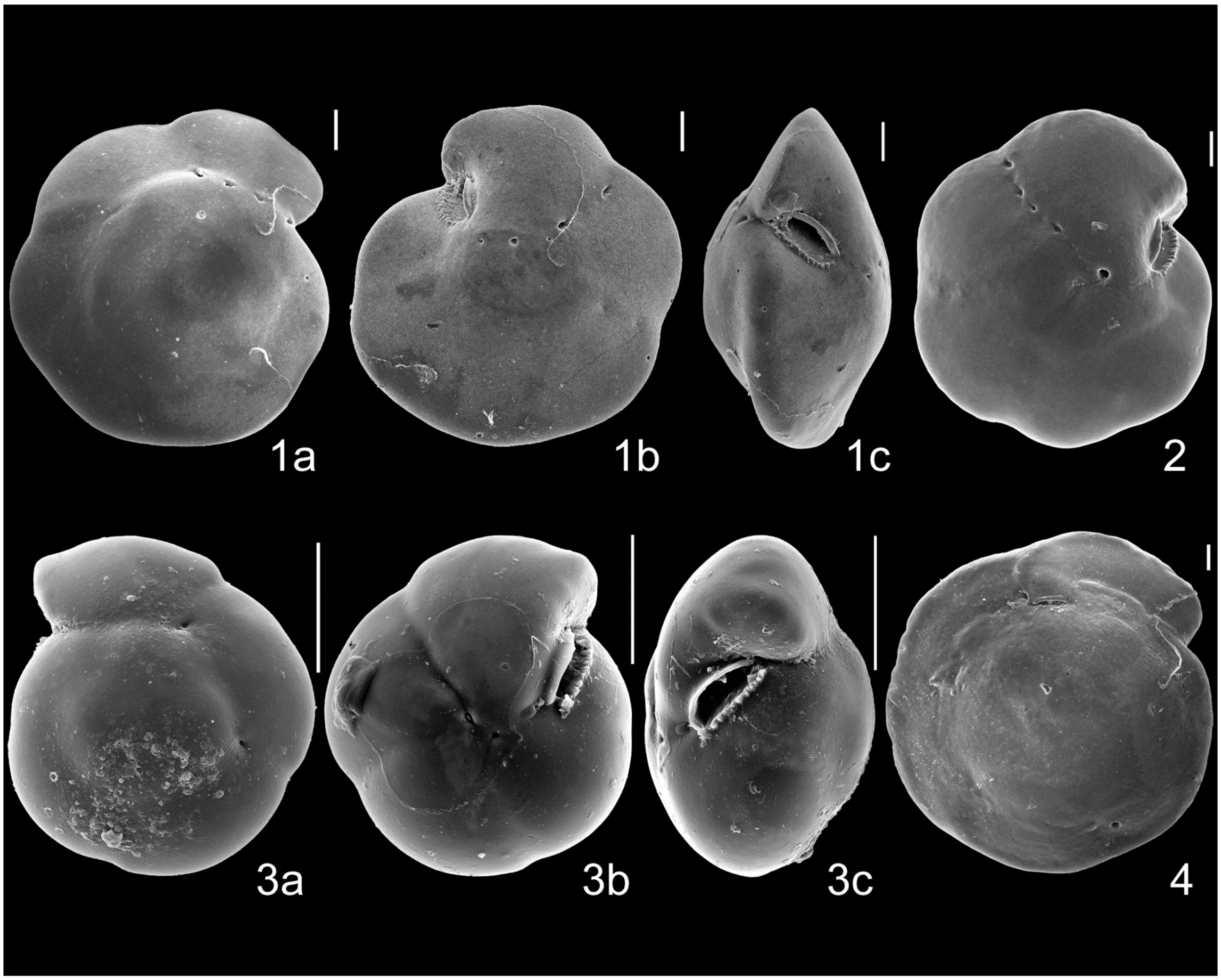

Plate 116

Scale bars = 50 μm

Osangularia culter (Parker and Jones)

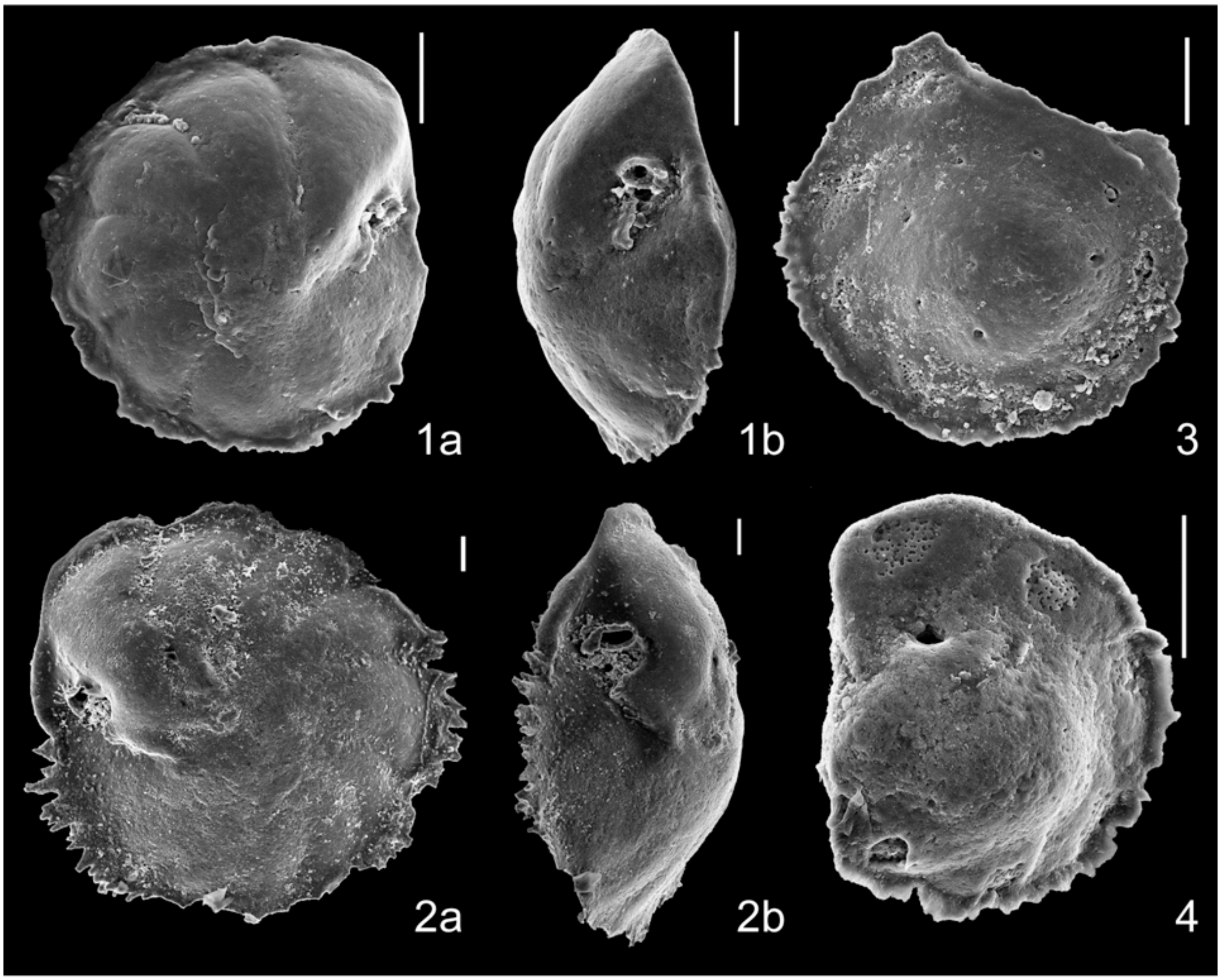

Plate 117 Scale bars = 50 μm

Osangularia rugosa (Phleger and Parker)

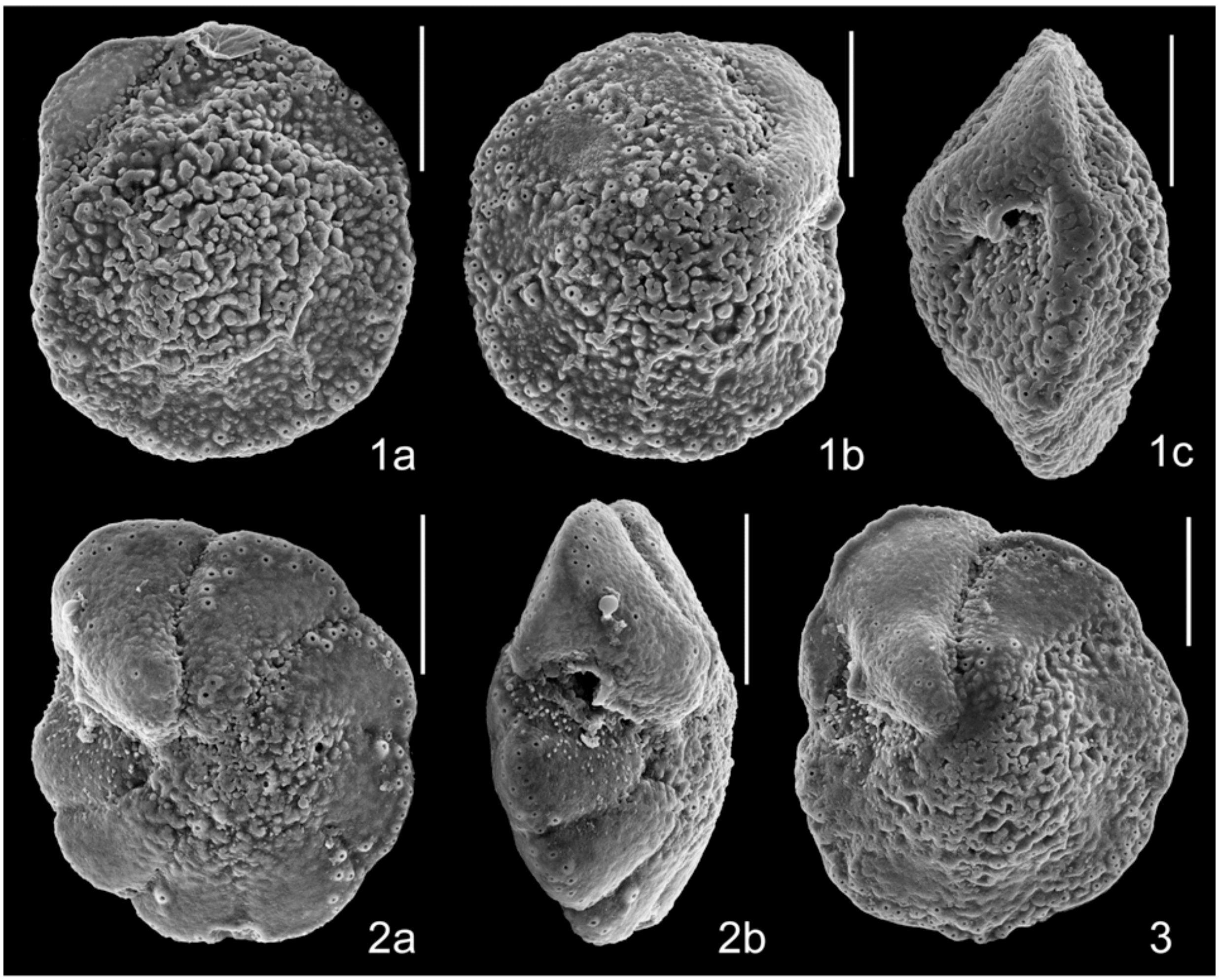

Plate 118

Scale bars = 50 μm

Parafissurina botelliformis (Brady)

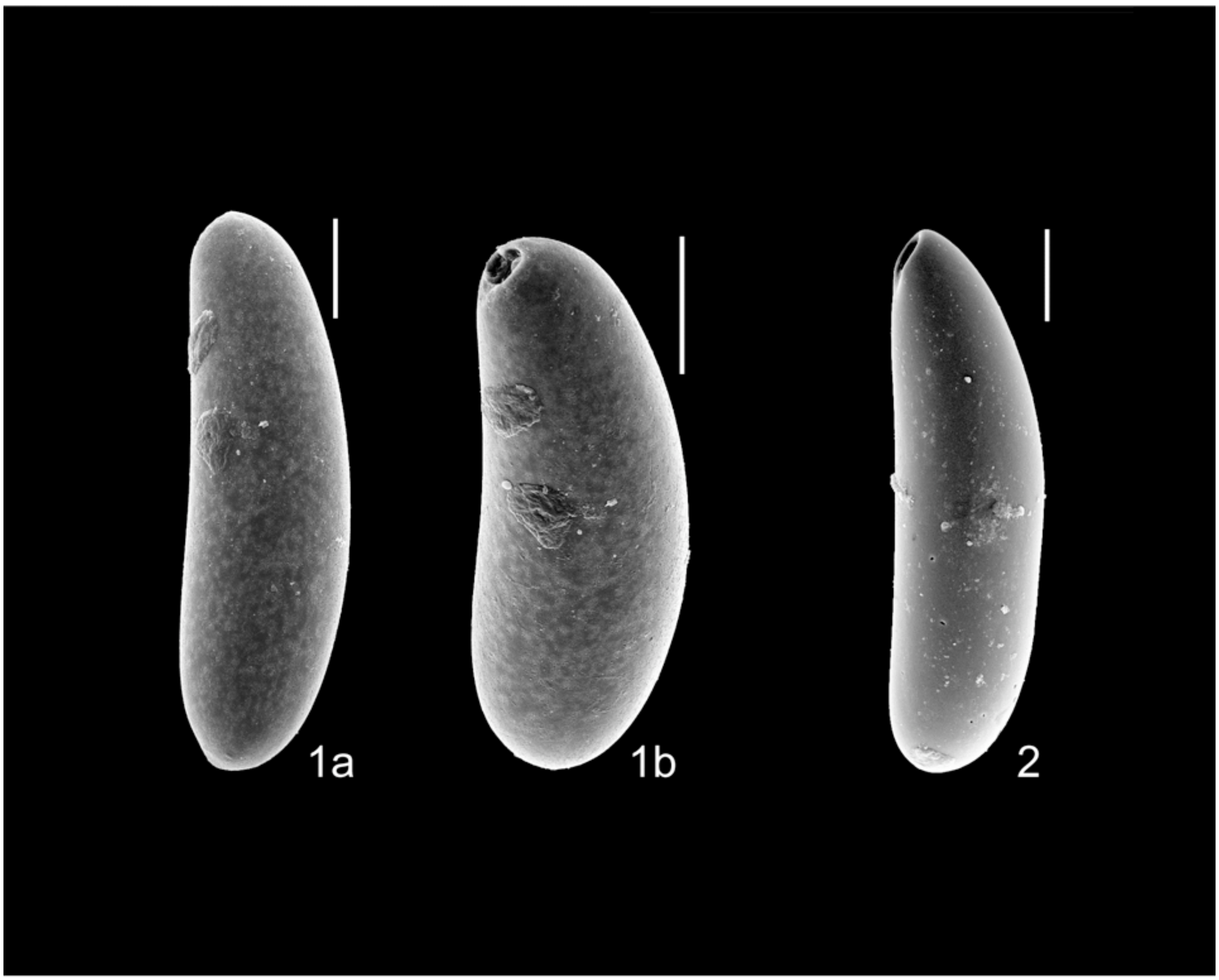

Plate 119 Scale bars = 50 µm

Parafissurina kerguelenensis (Parr)

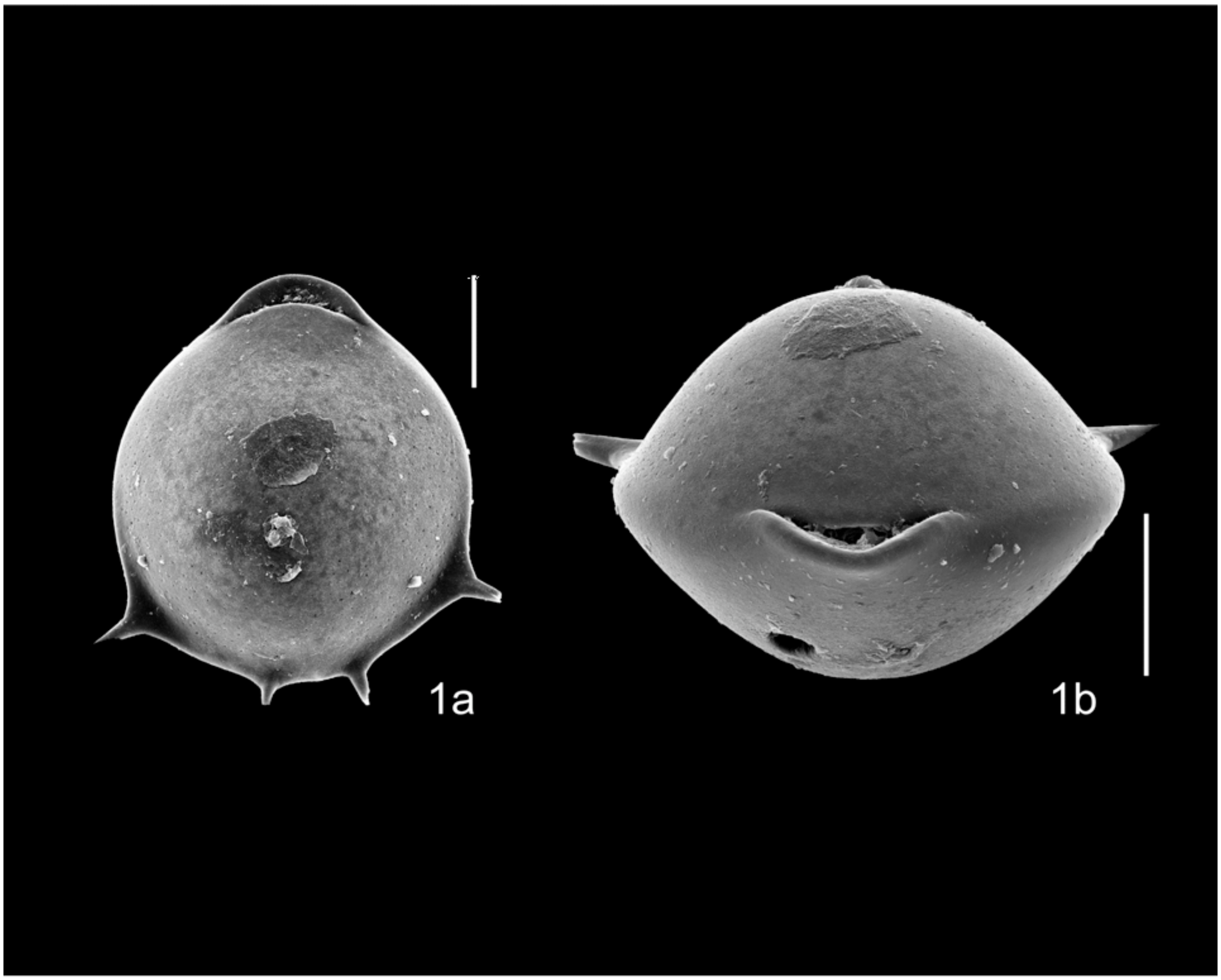

Plate 120

Scale bars = 50 μm

Parafissurina lateralis (Cushman)

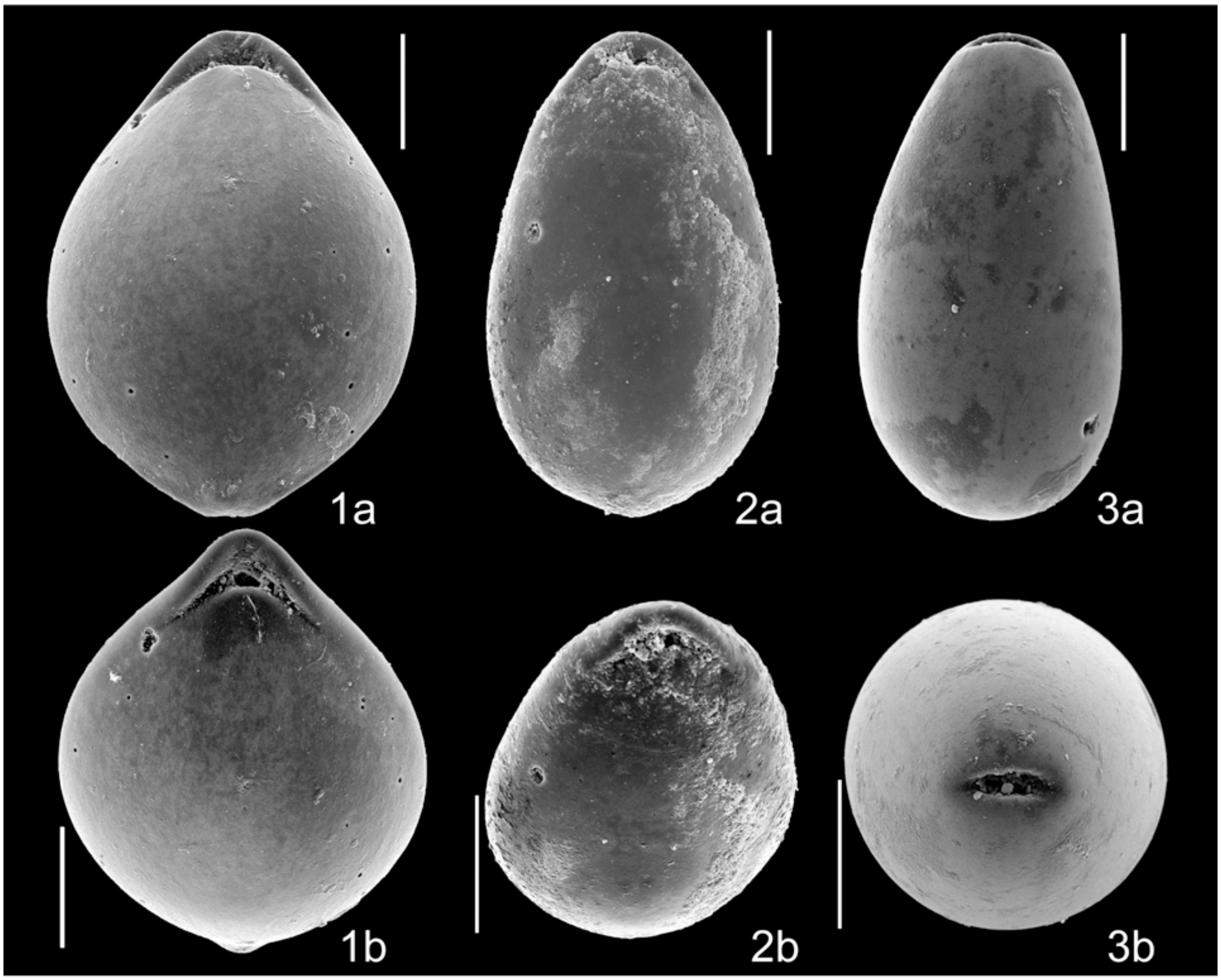

Plate 121

Scale bars = 50 μm

Paratrochammina challengeri Brönnimann and Whittaker

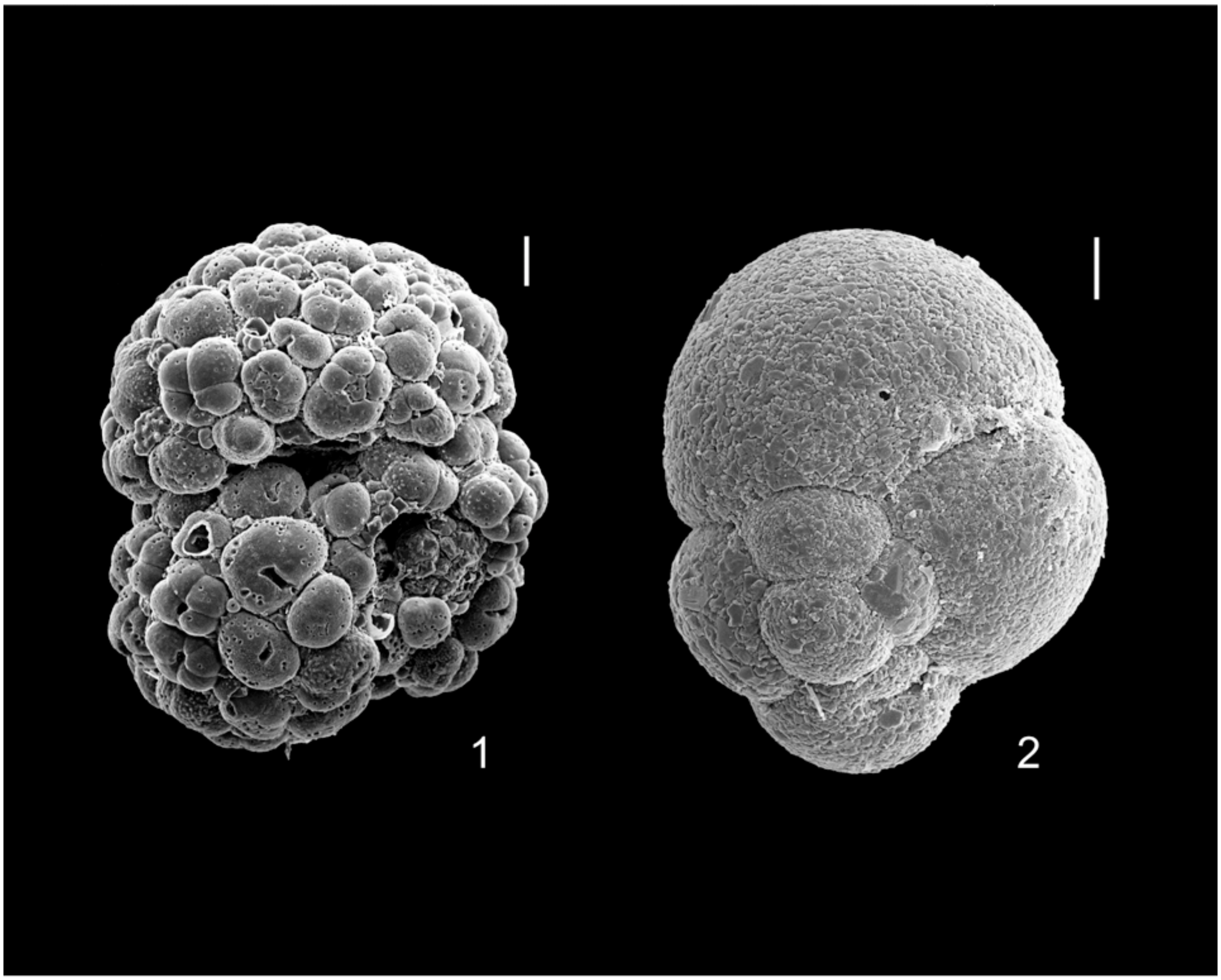

Plate 122 Scale bars = 50 μm

Parvigenerina arenacea (Heron-Allen and Earland)

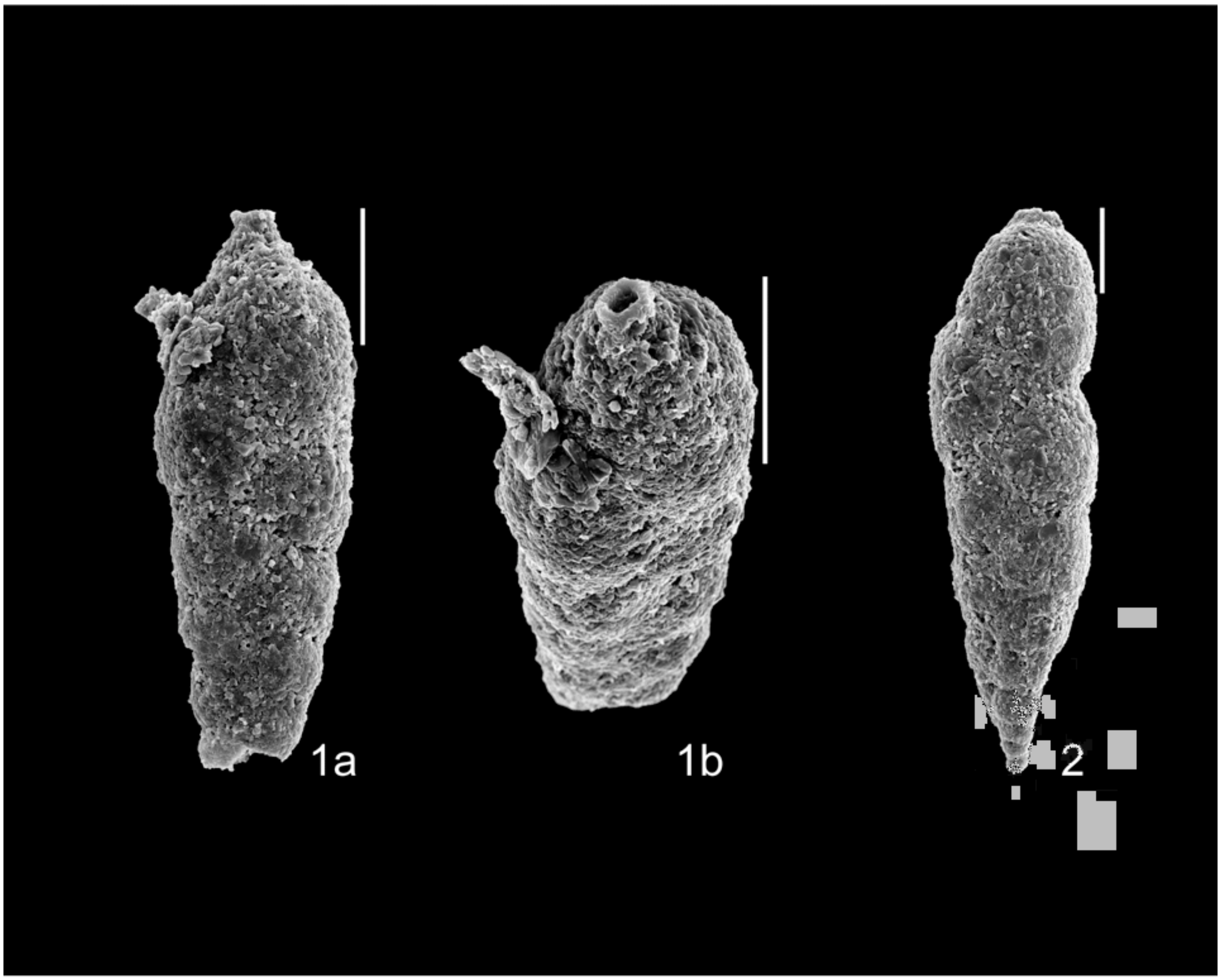

Plate 123 Scale bars = 50 μm

Patellina corrugata Williamson

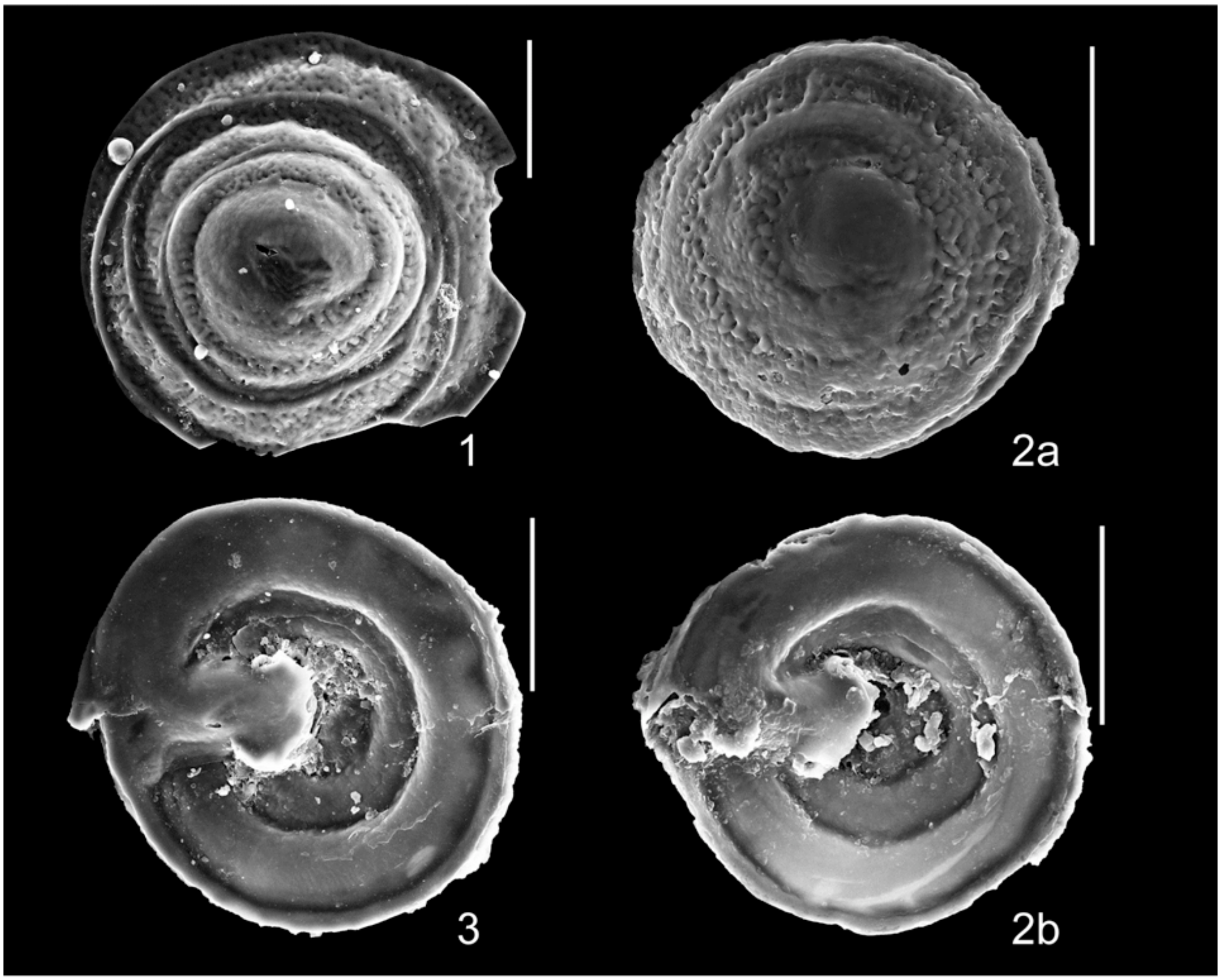

Plate 124 Scale bars = 50 µm

Patellina corrugata Williamson

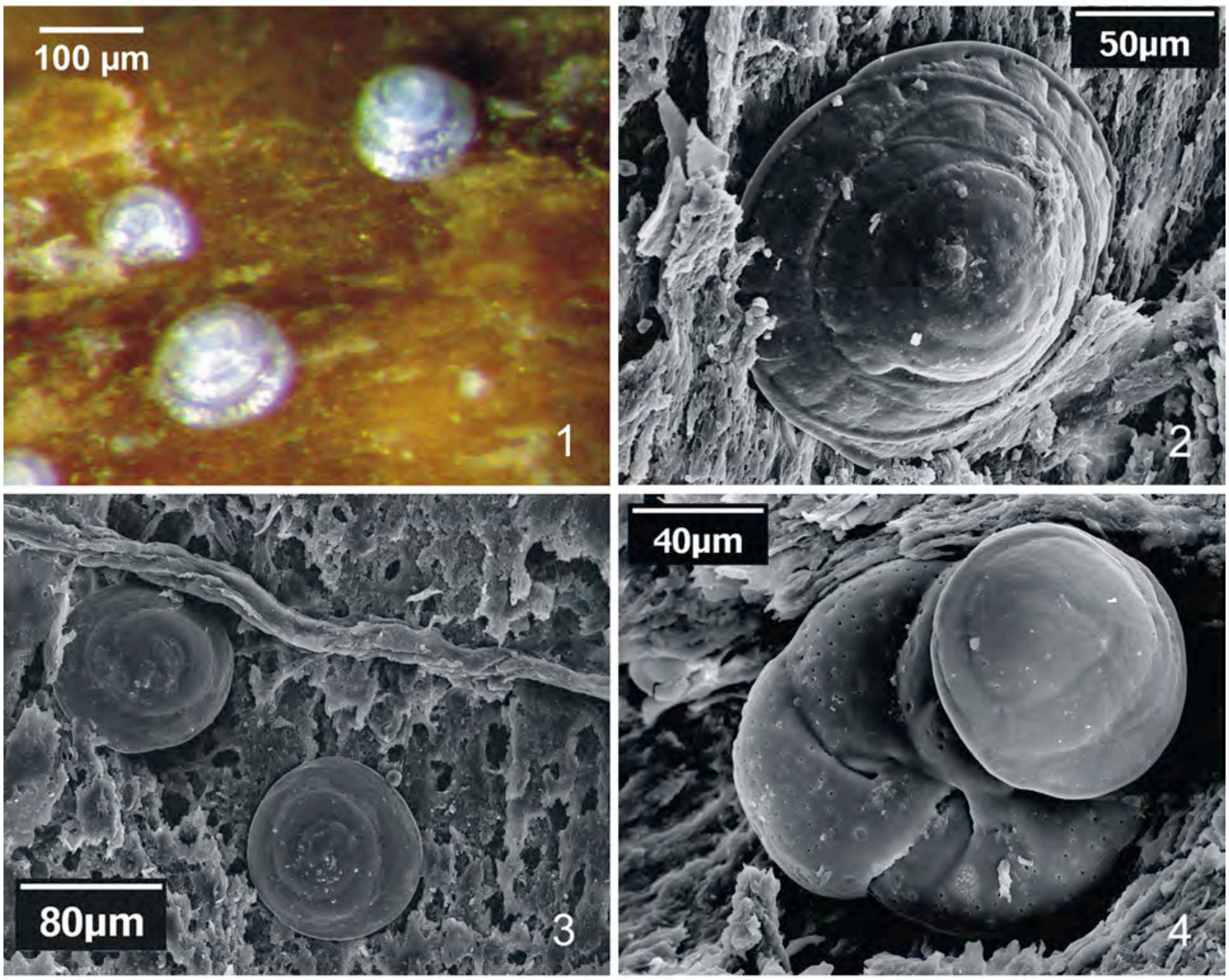

Plate 125

Planispirinoides bucculentus var. *placentiformis* (Brady)

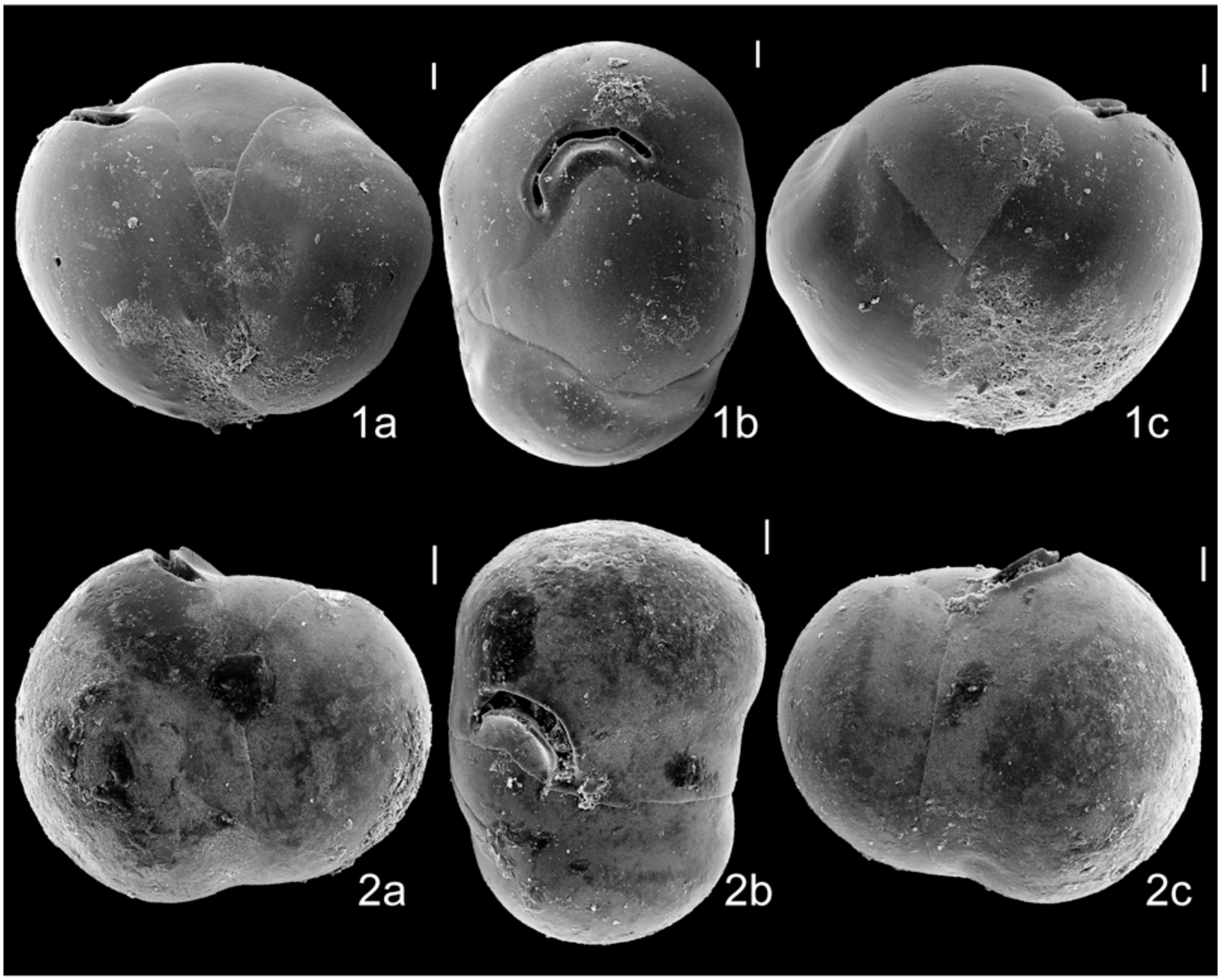

Plate 126 Scale bars = 50 μm

Planulina ariminensis d'Orbigny

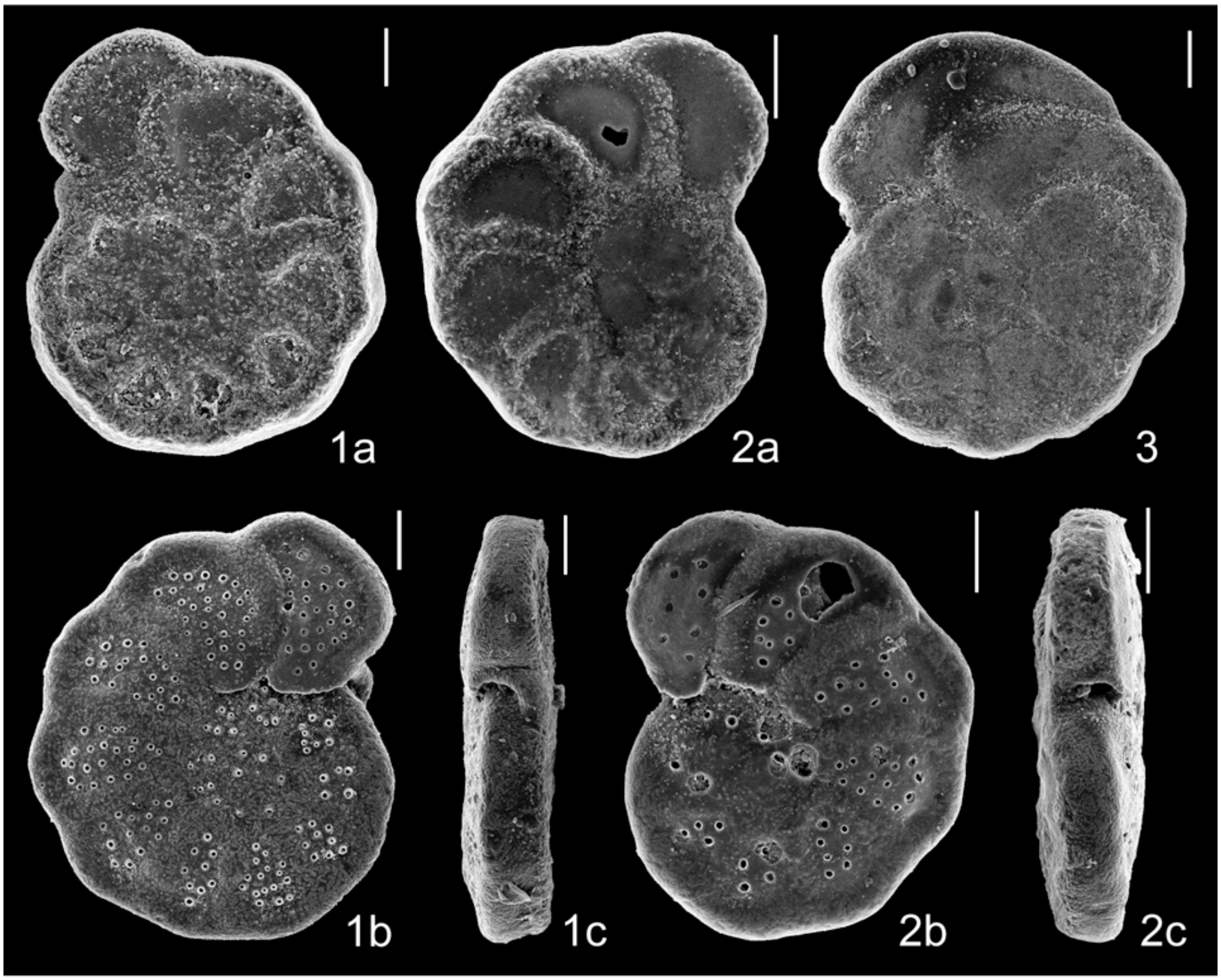

Plate 127

Scale bars = 50 μm

Planulina ariminensis d'Orbigny

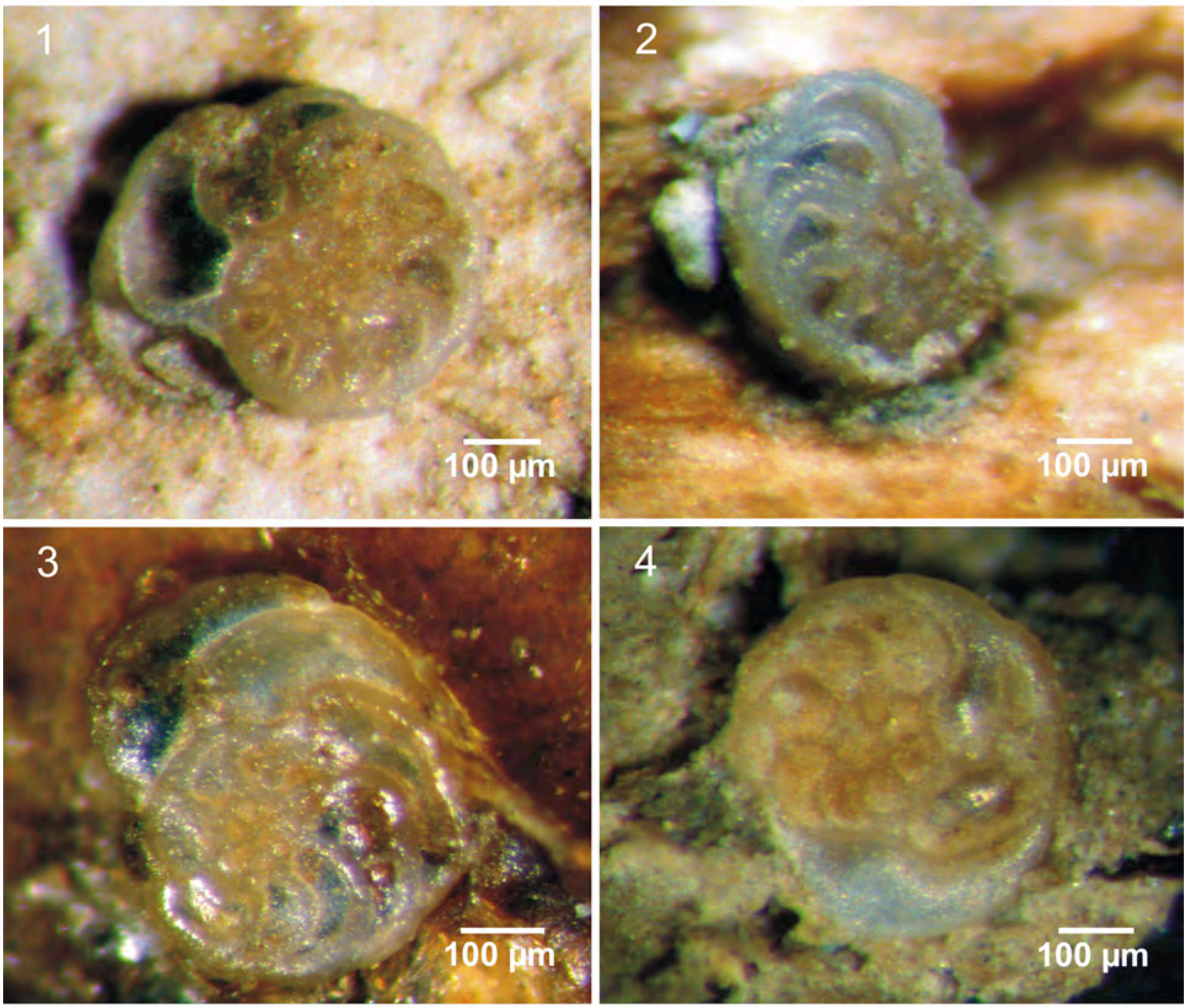

Plate 128

Planulina ariminensis d'Orbigny

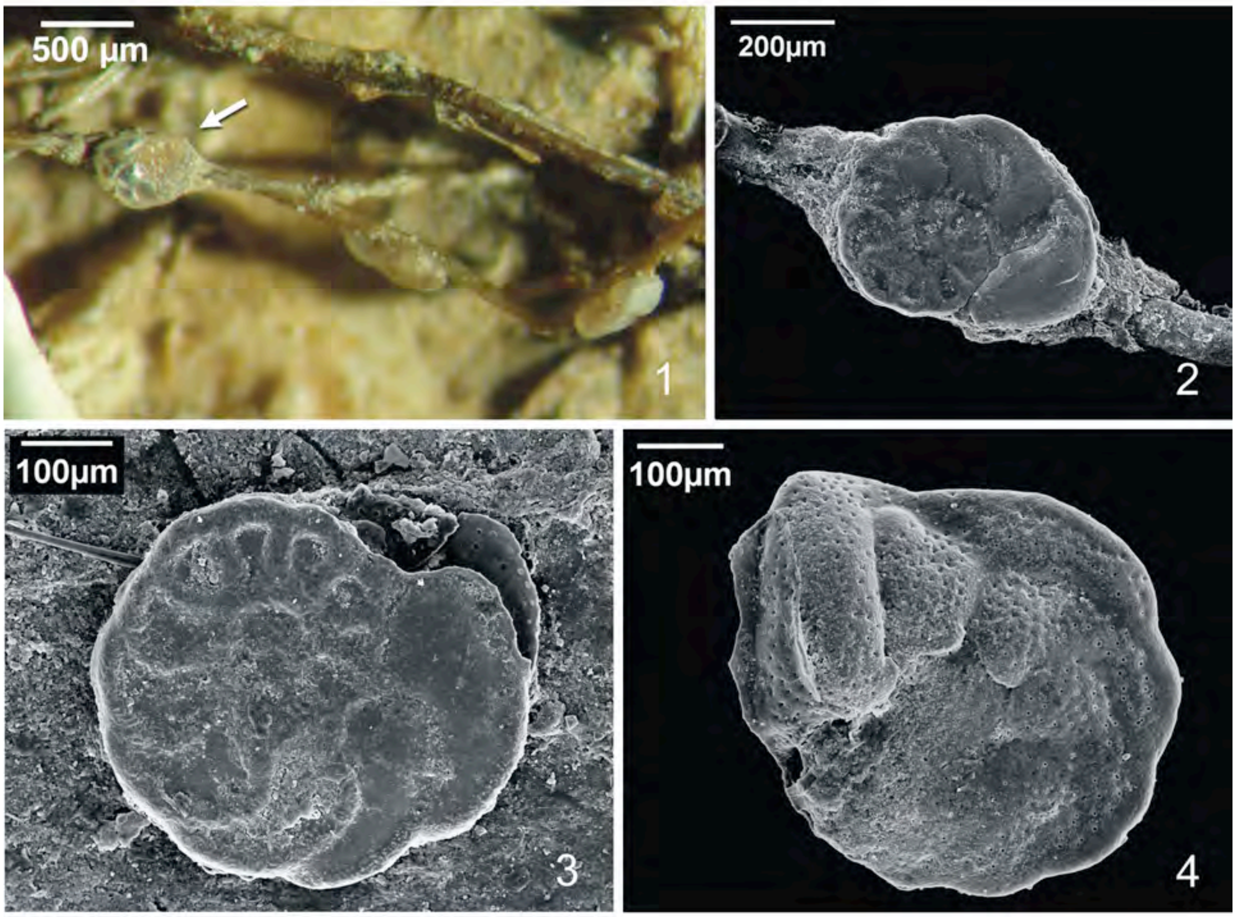

Plate 129

Planulina foveolata (Brady)

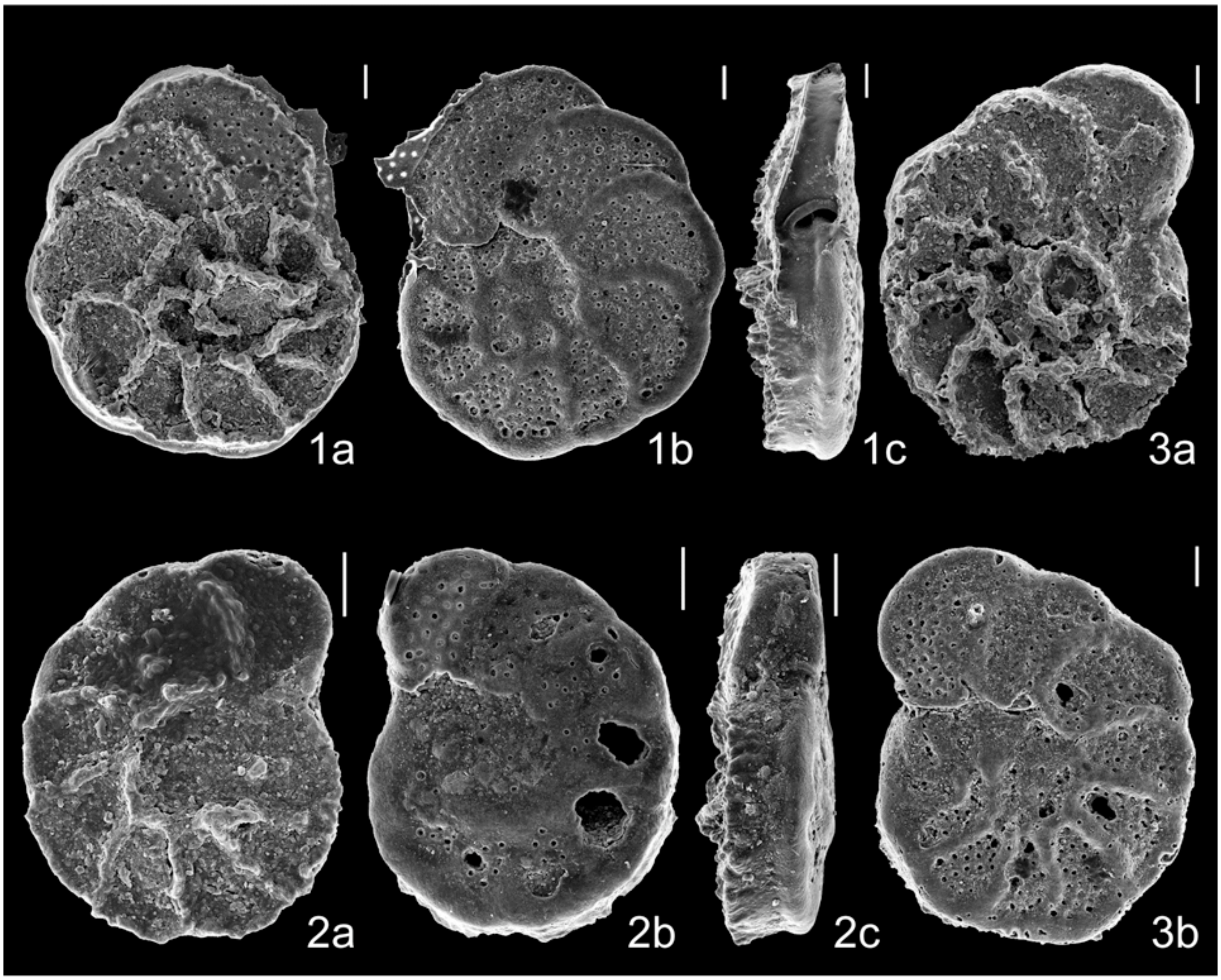

Plate 130

Scale bars = 50 μm

Plectofrondicularia advena (Cushman)

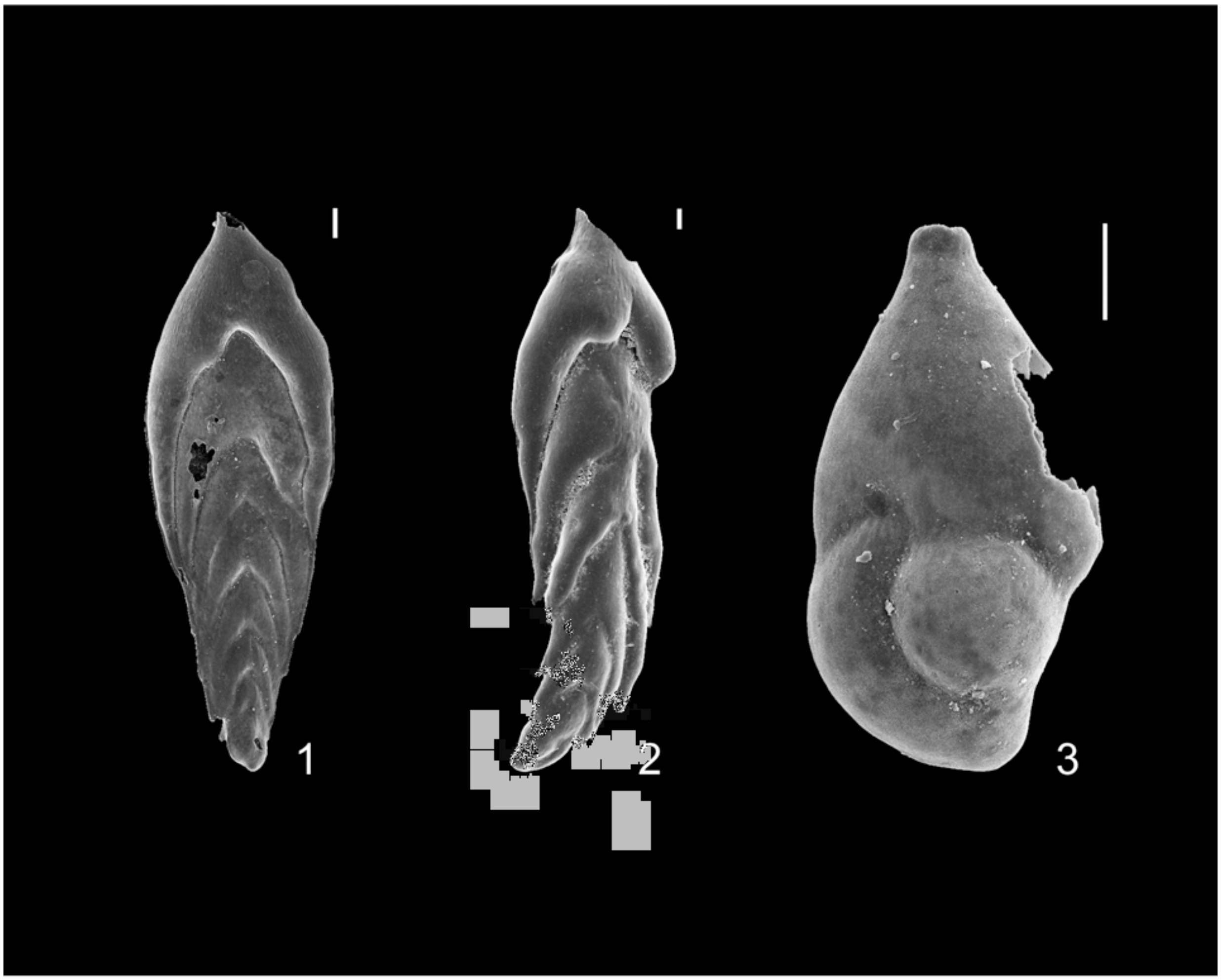

Plate 131

Scale bars = 50 μm except in fig.1 (100 μm)

Portatrochammina antarctica (Parr)

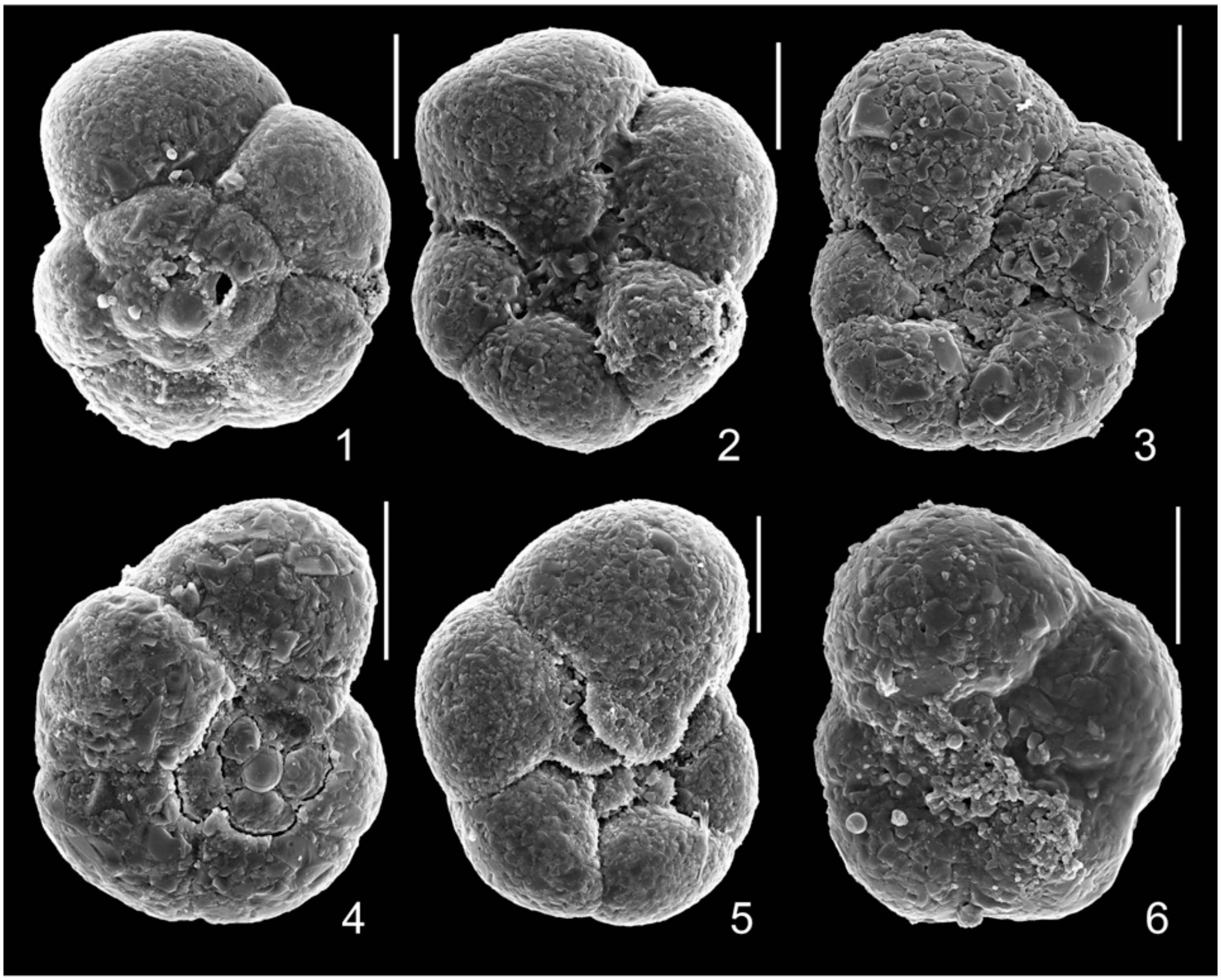

Plate 132 Scale bars = 50 μm

Praeglobobulimina ovata (d'Orbigny)

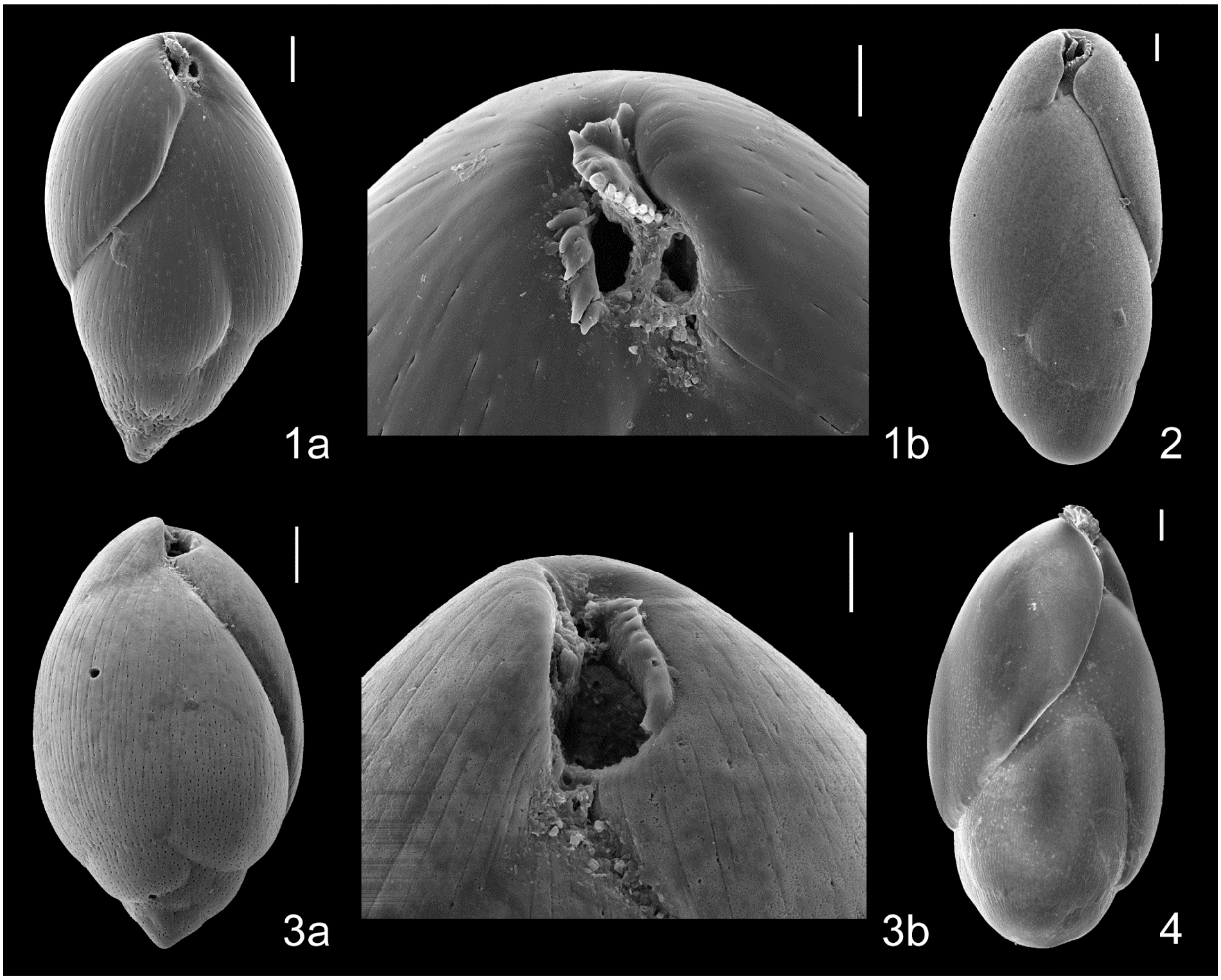

Plate 133

Scale bars = 50 μm
except in 1b & 3b (20 μm)

Praeglobobulimina ovula (d'Orbigny)

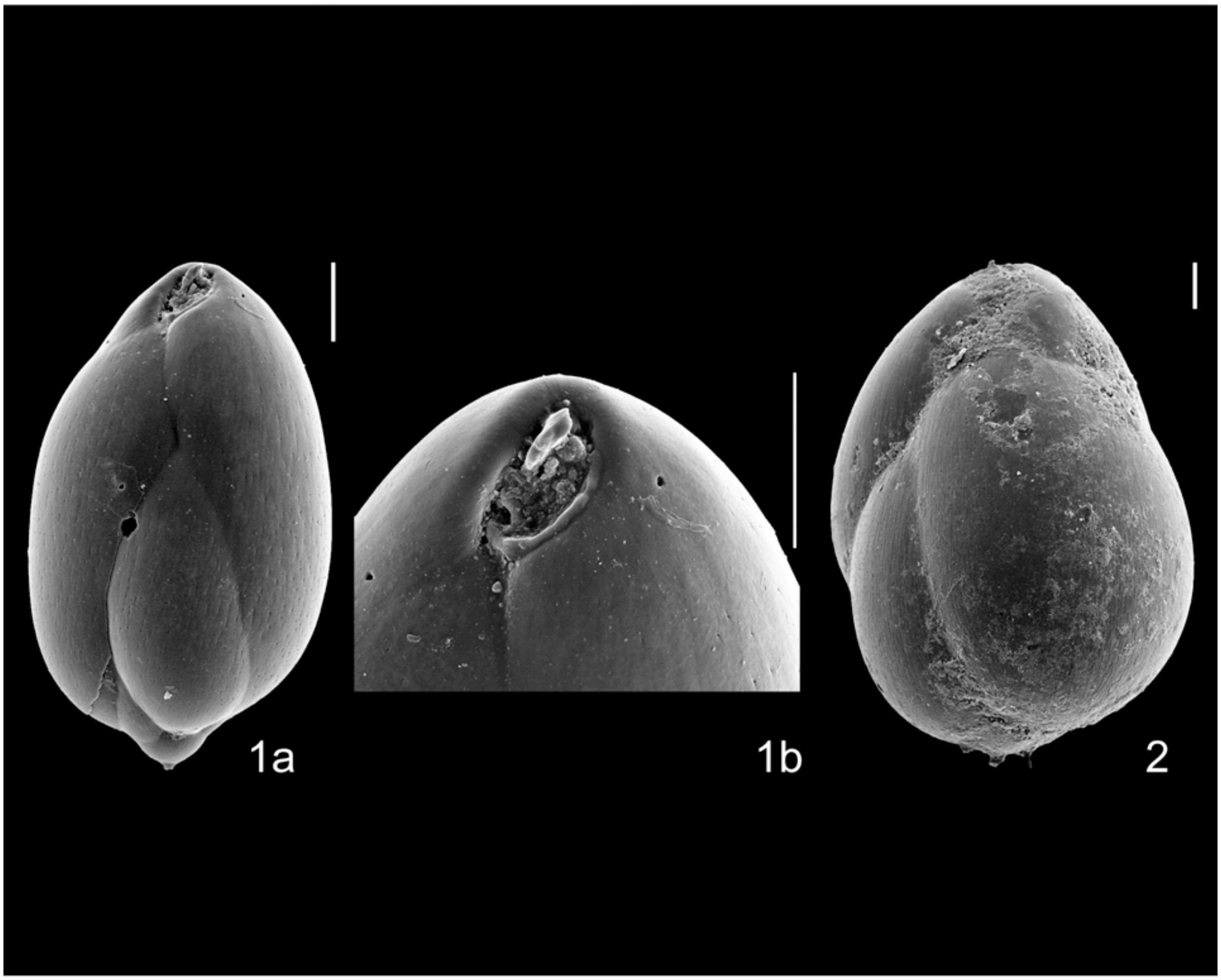

Plate 134 Scale bars = 50 μm

Procerolagena gracilis (Williamson)

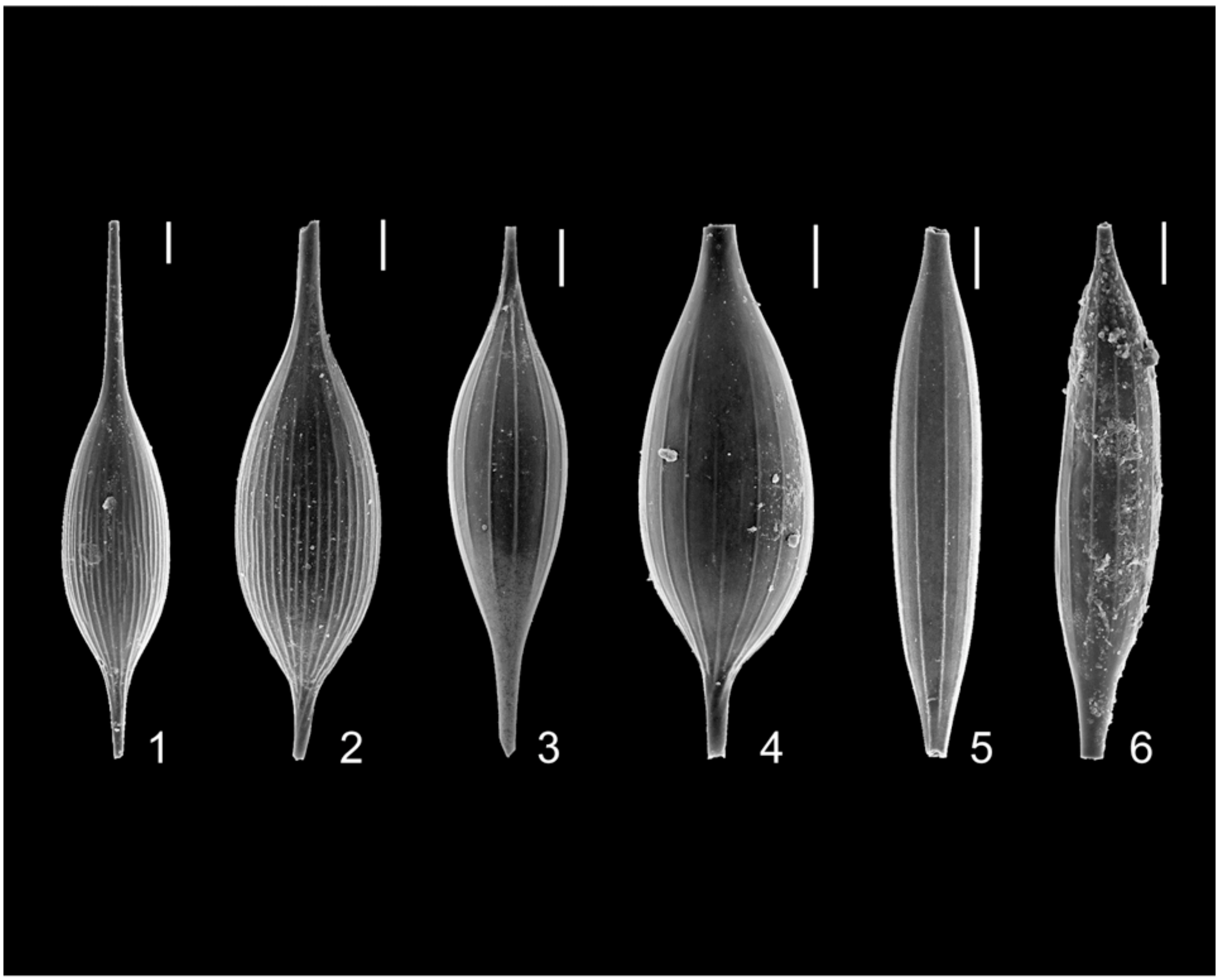

Plate 135

Scale bars = 50 μm

Prolixoplecta parvula (Cushman)

Plate 136

Scale bars = 50 µm

Psammosphaera fusca Schulze

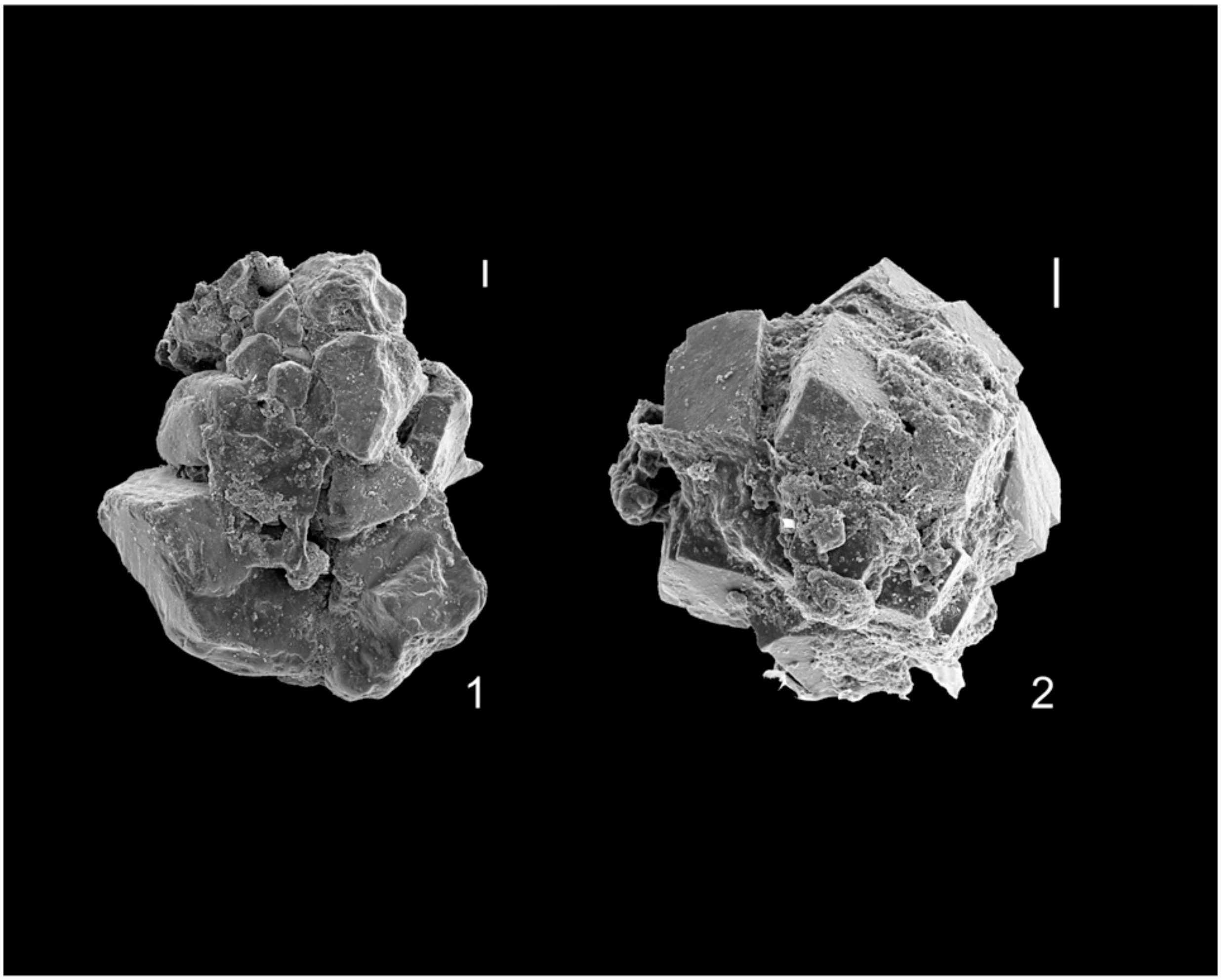

Plate 137 Scale bars = 50 μm

Pseudoclavulina mexicana (Cushman)

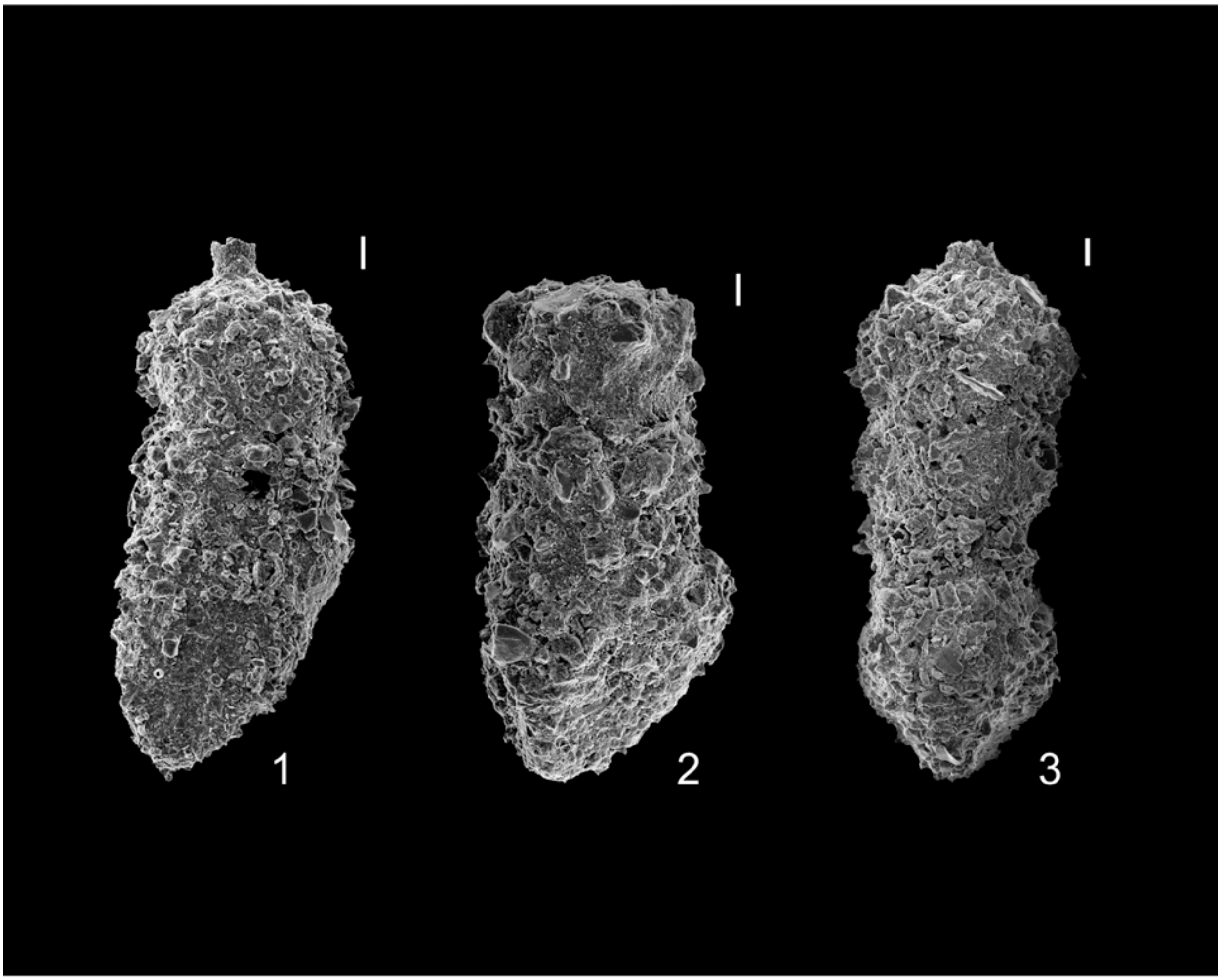

Plate 138

Scale bars = 50 µm

Pseudoclavulina serventyi (Chapman and Parr)

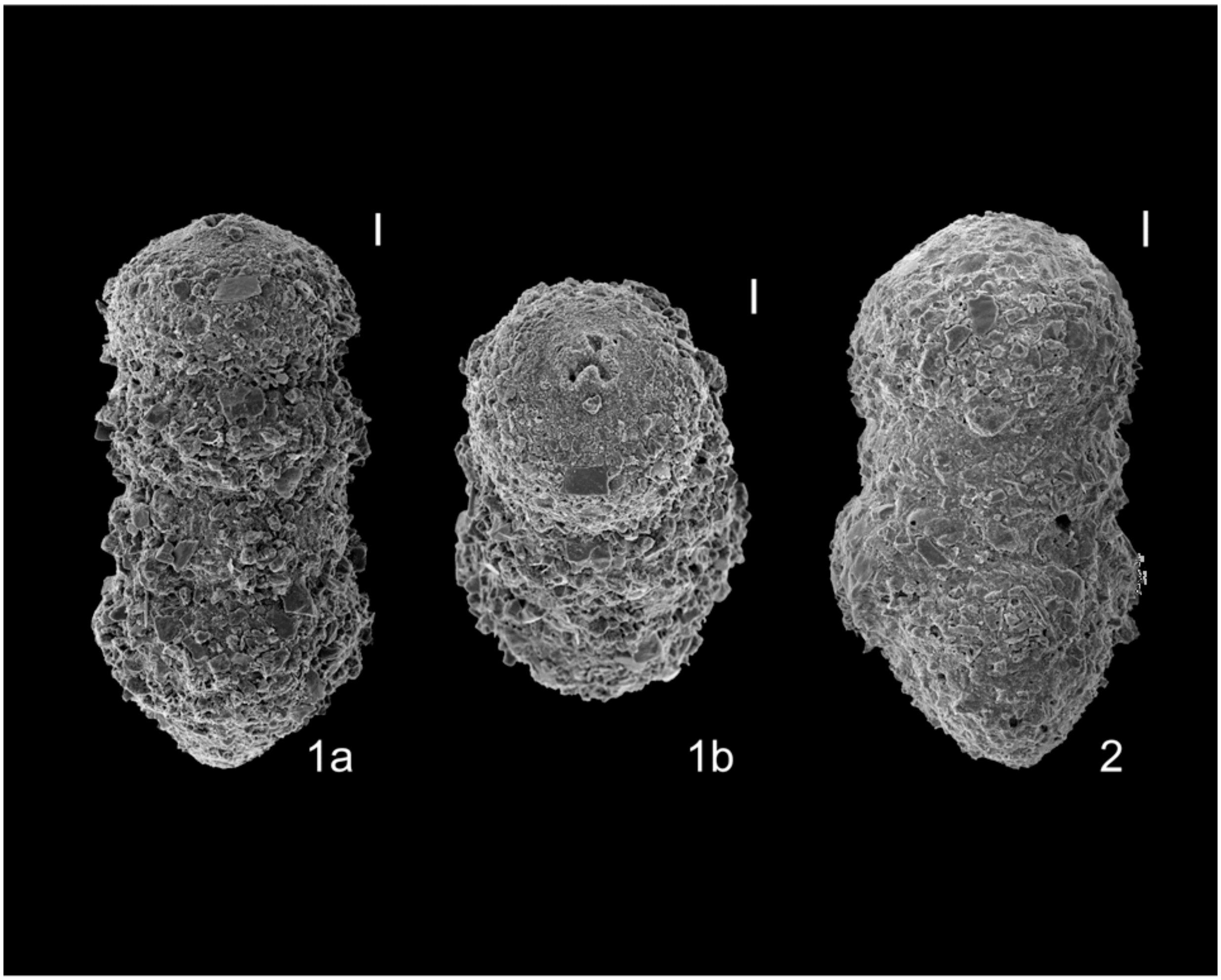

Plate 139

Scale bars = 50 μm

Pseudogaudryina atlantica (Bailey)

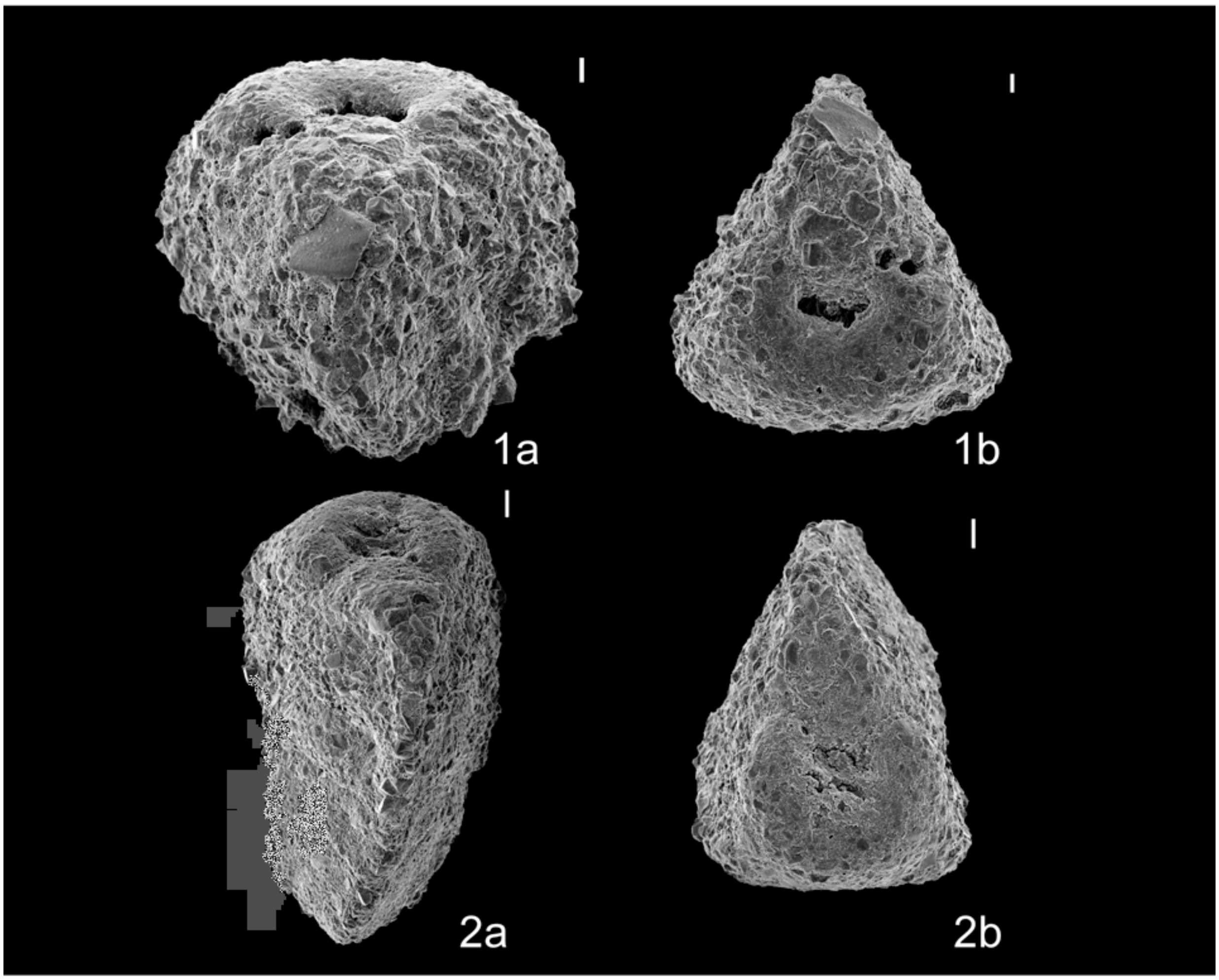

Plate 140

Scale bars = 50 μm
except in 2a & 2b (100 μm)

Pseudoglandulina comatula (Cushman)

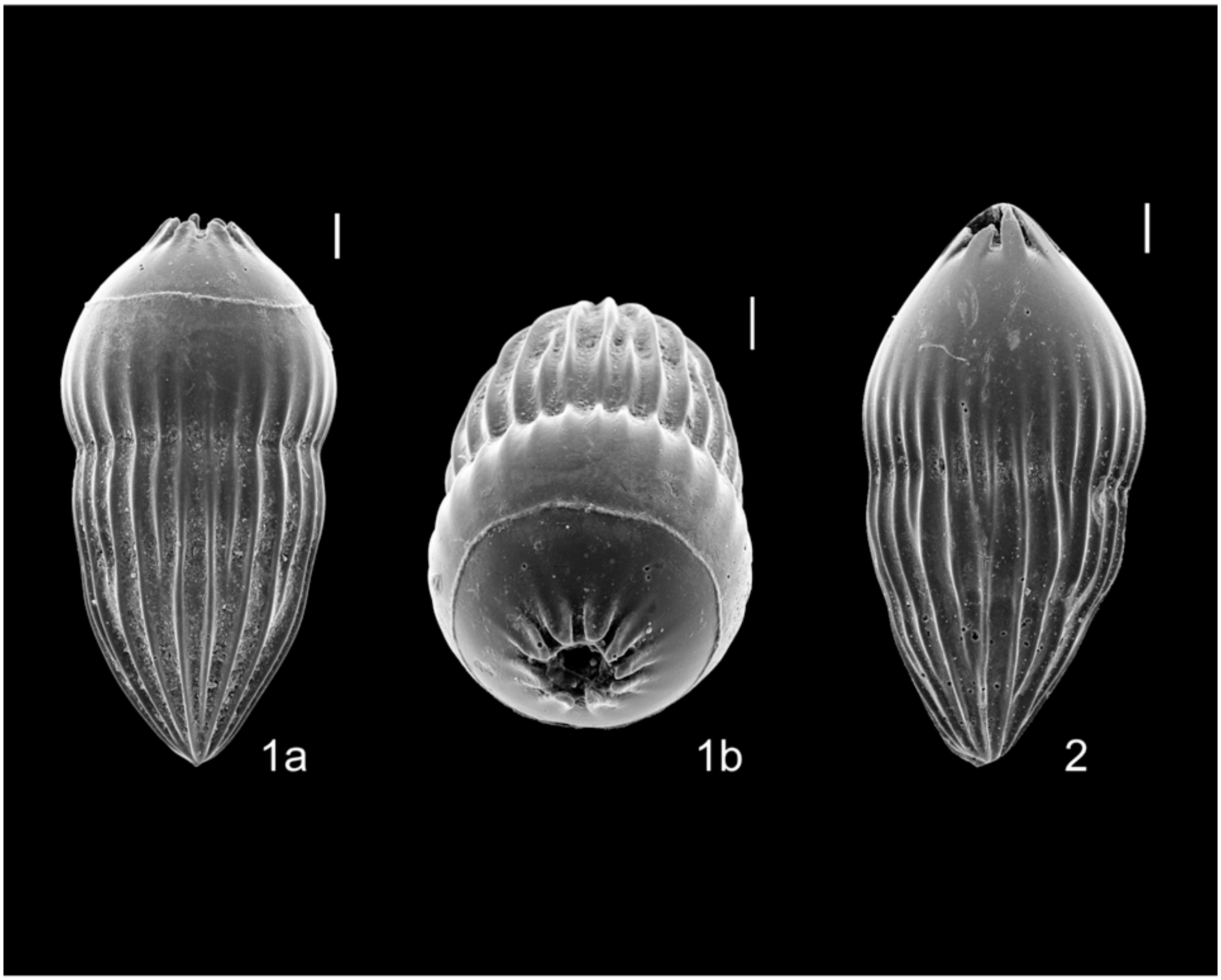

Plate 141 Scale bars = 50 μm

Pseudotrochammina sp.

Plate 142

Scale bars = 50 μm

Pullenia bulloides (d'Orbigny)

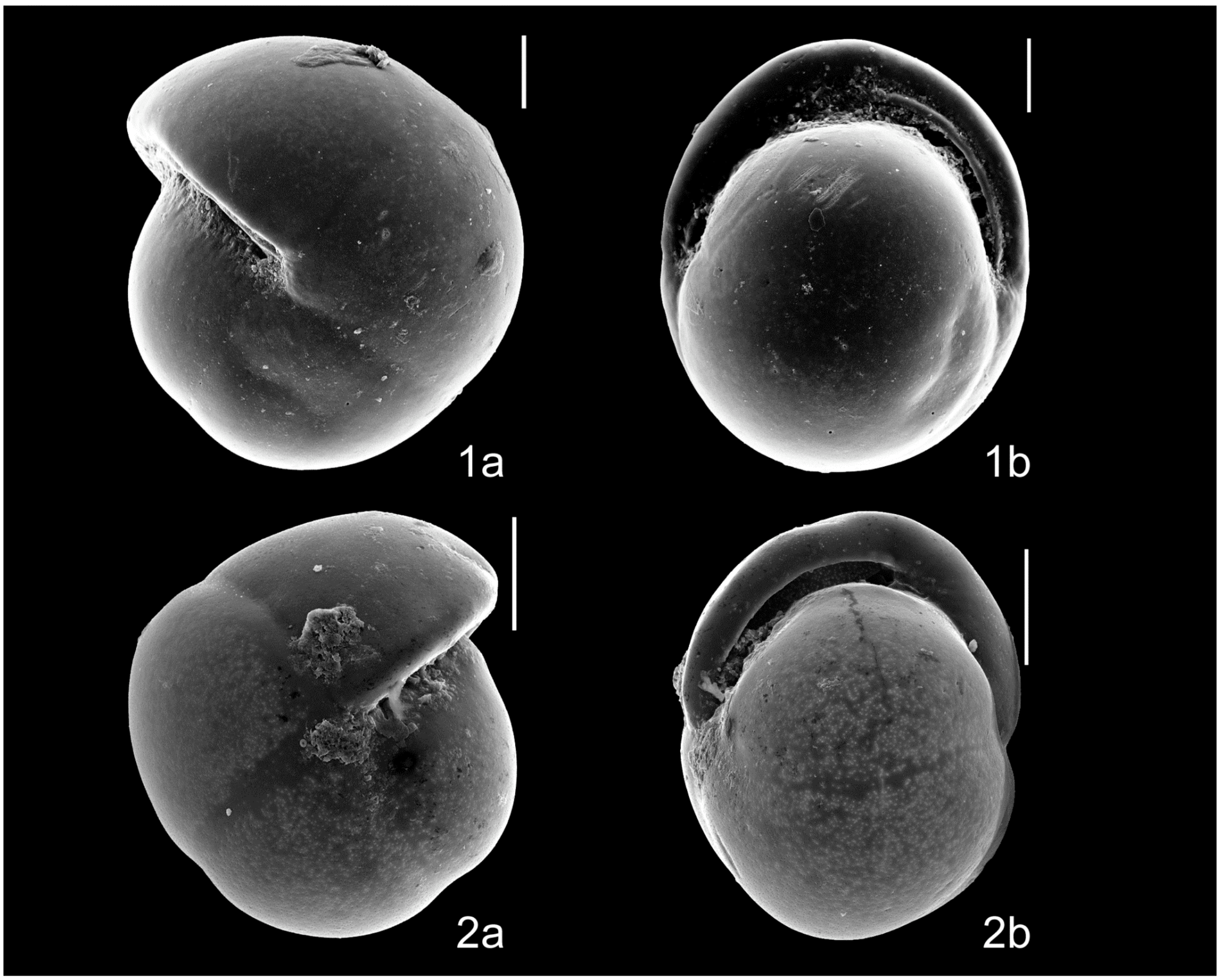

Plate 143

Scale bars = 50 μm

Pullenia quinqueloba (Reuss)

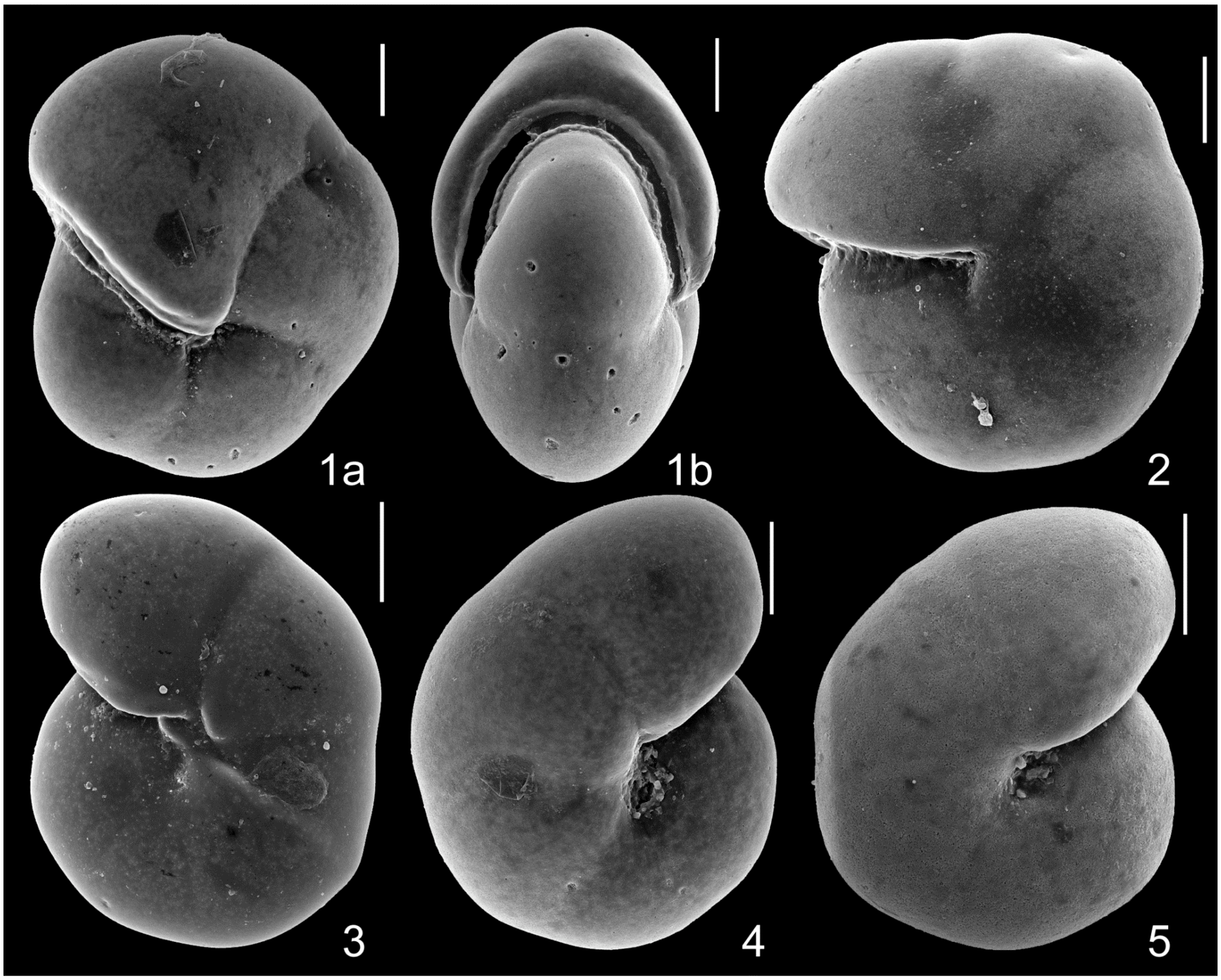

Plate 144 Scale bars = 50 μm

Pyrgo lucernula (Schwager)

Plate 145

Scale bars = 50 μm

Pyrgo murrhina (Schwager)

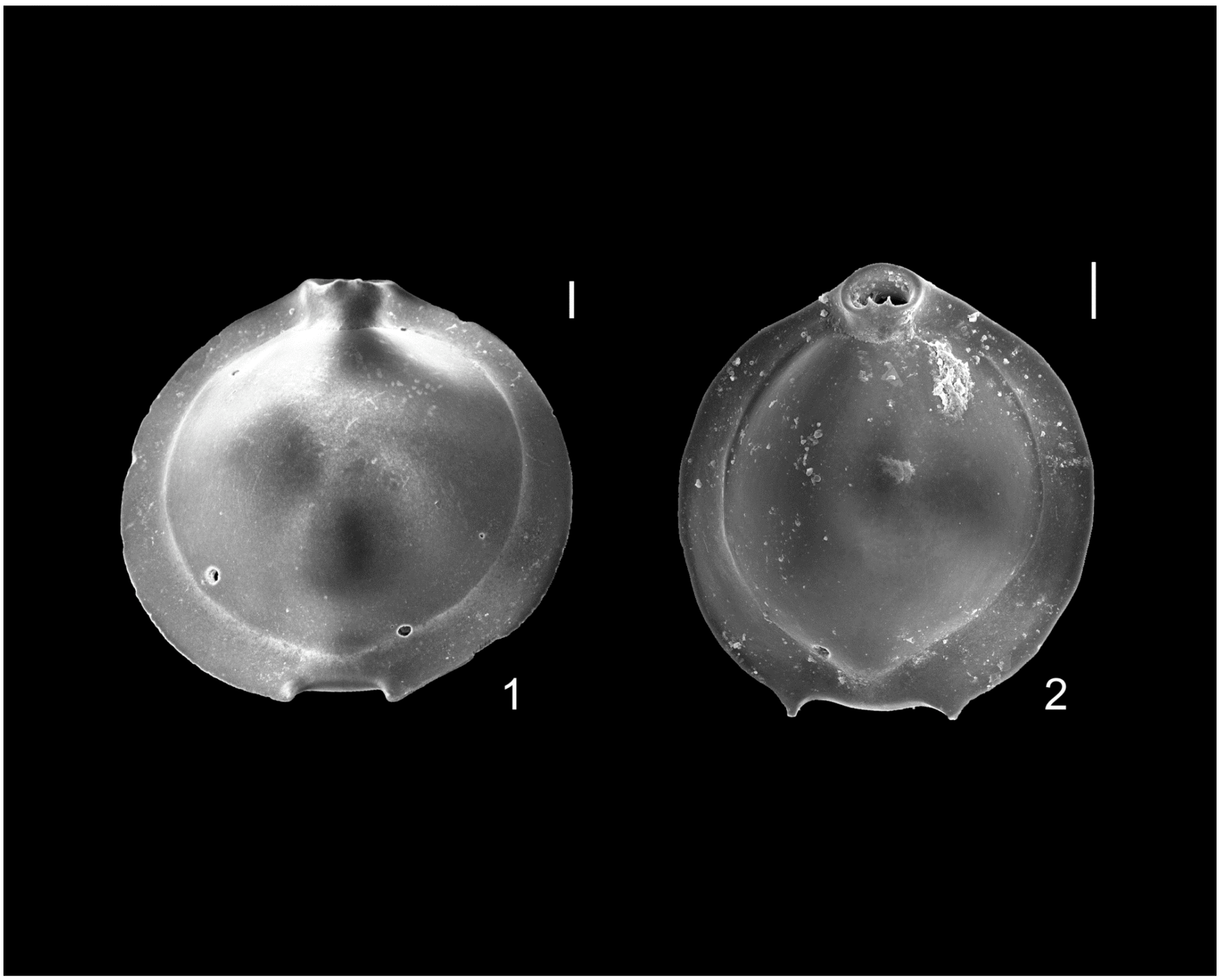

Plate 146

Scale bars = 50 μm

Pyrgo nasuta Cushman

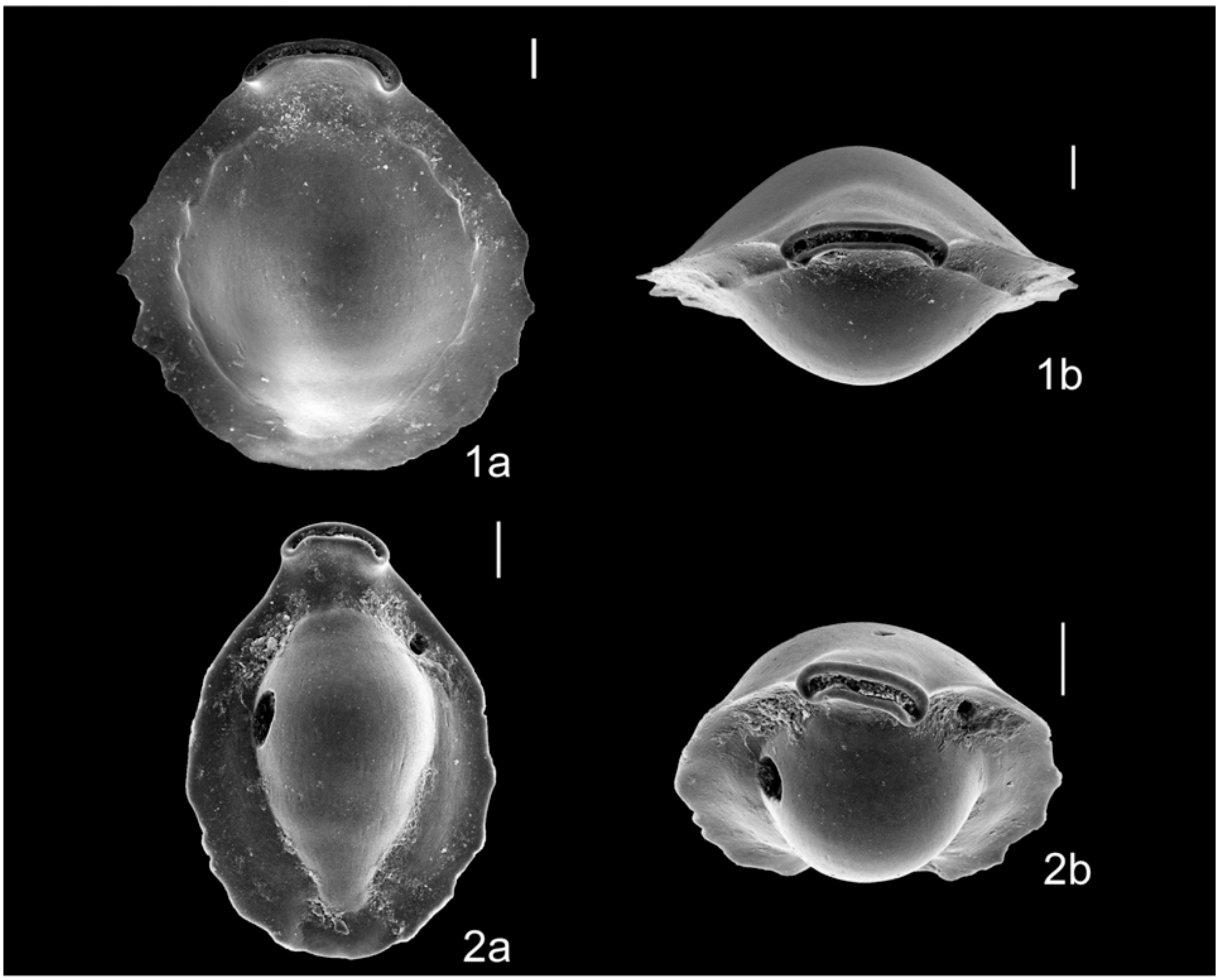

Plate 147

Scale bars = 50 μm

?Pyrgo sp.

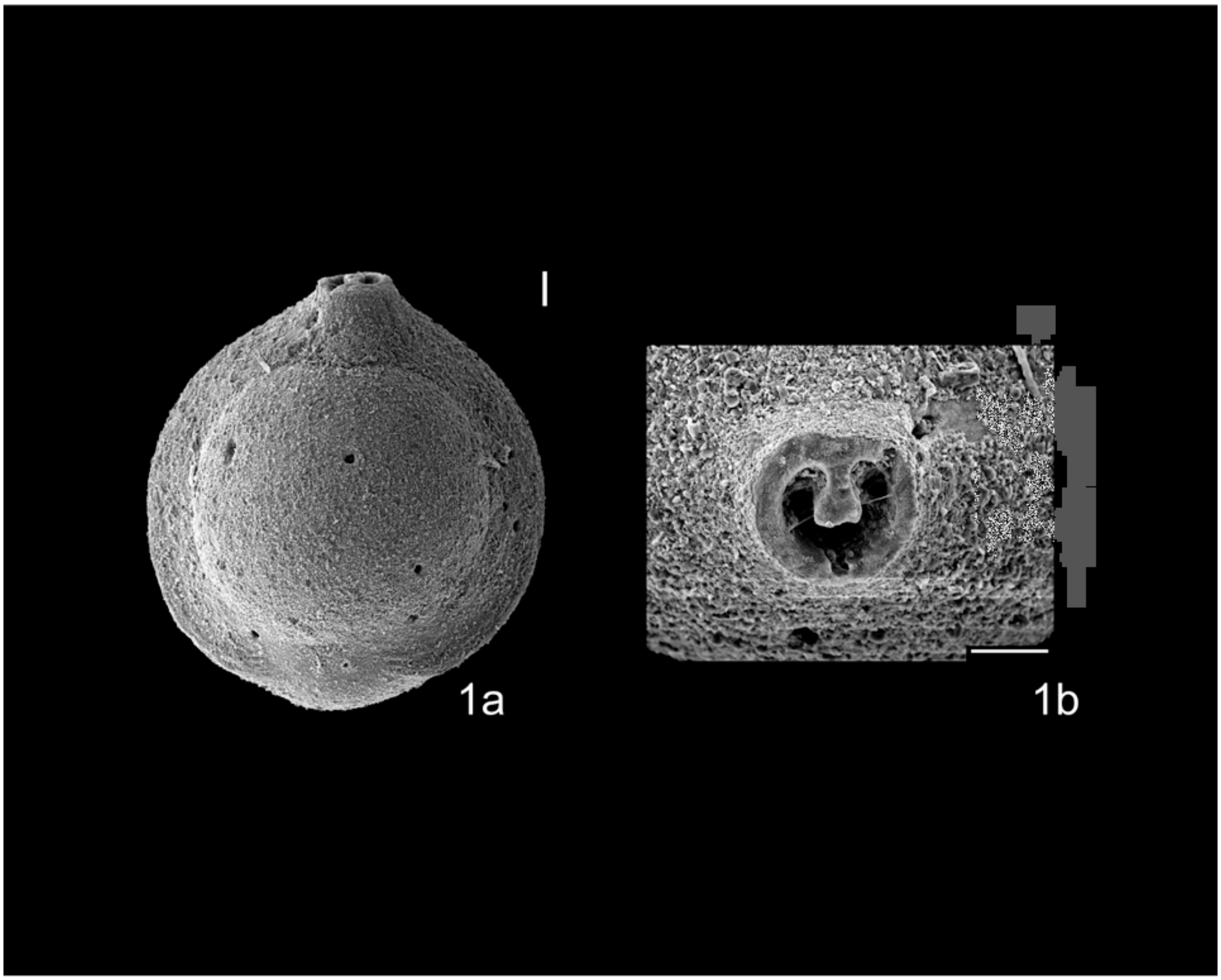

Plate 148

Scale bars = 50 μm

Quinqueloculina bosciana d'Orbigny

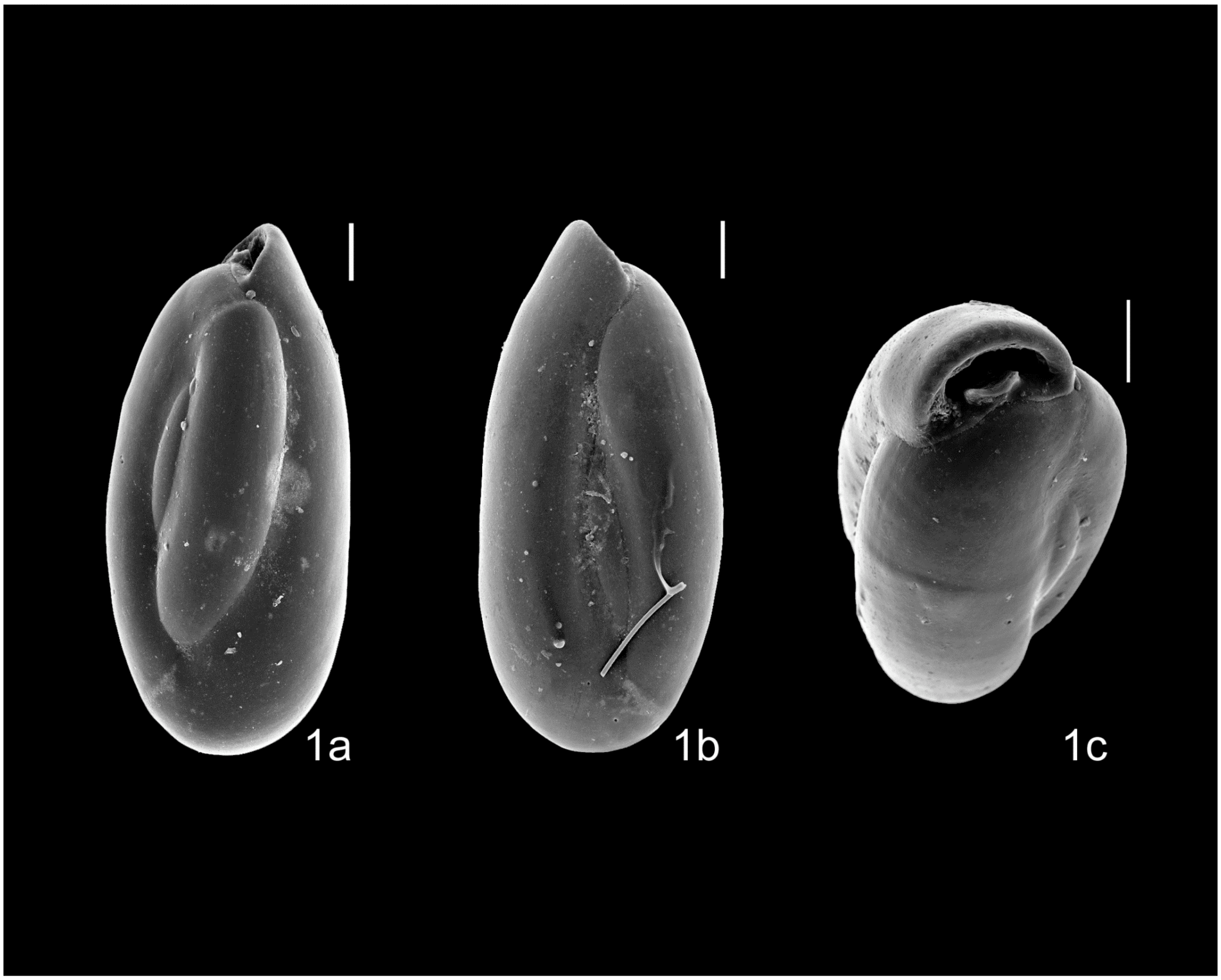

Plate 149

Scale bars = 50 μm

Reophax agglutinatus Cushman

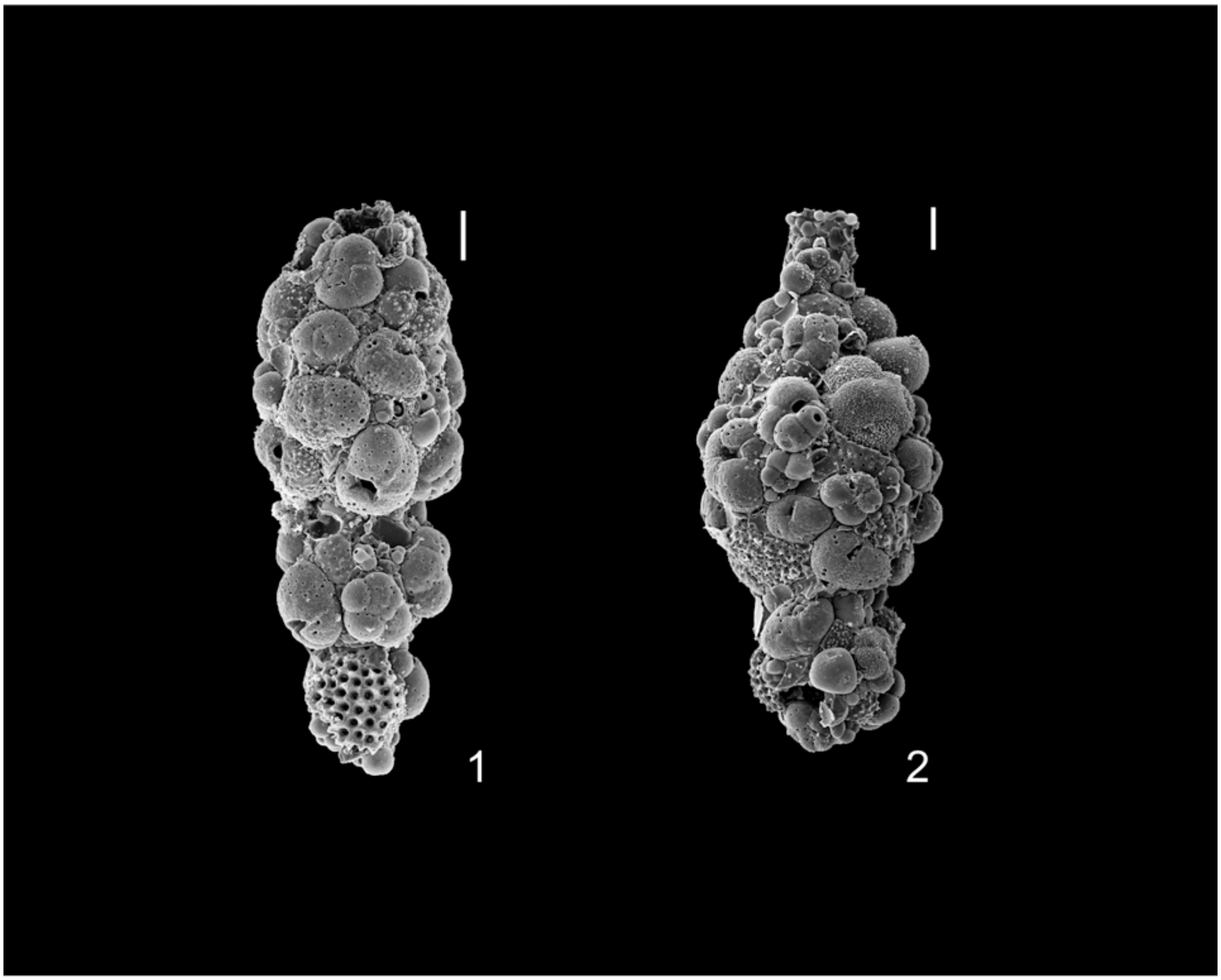

Plate 150

Scale bars = 50 μm

Reophax scorpiurus Dénys de Montfort

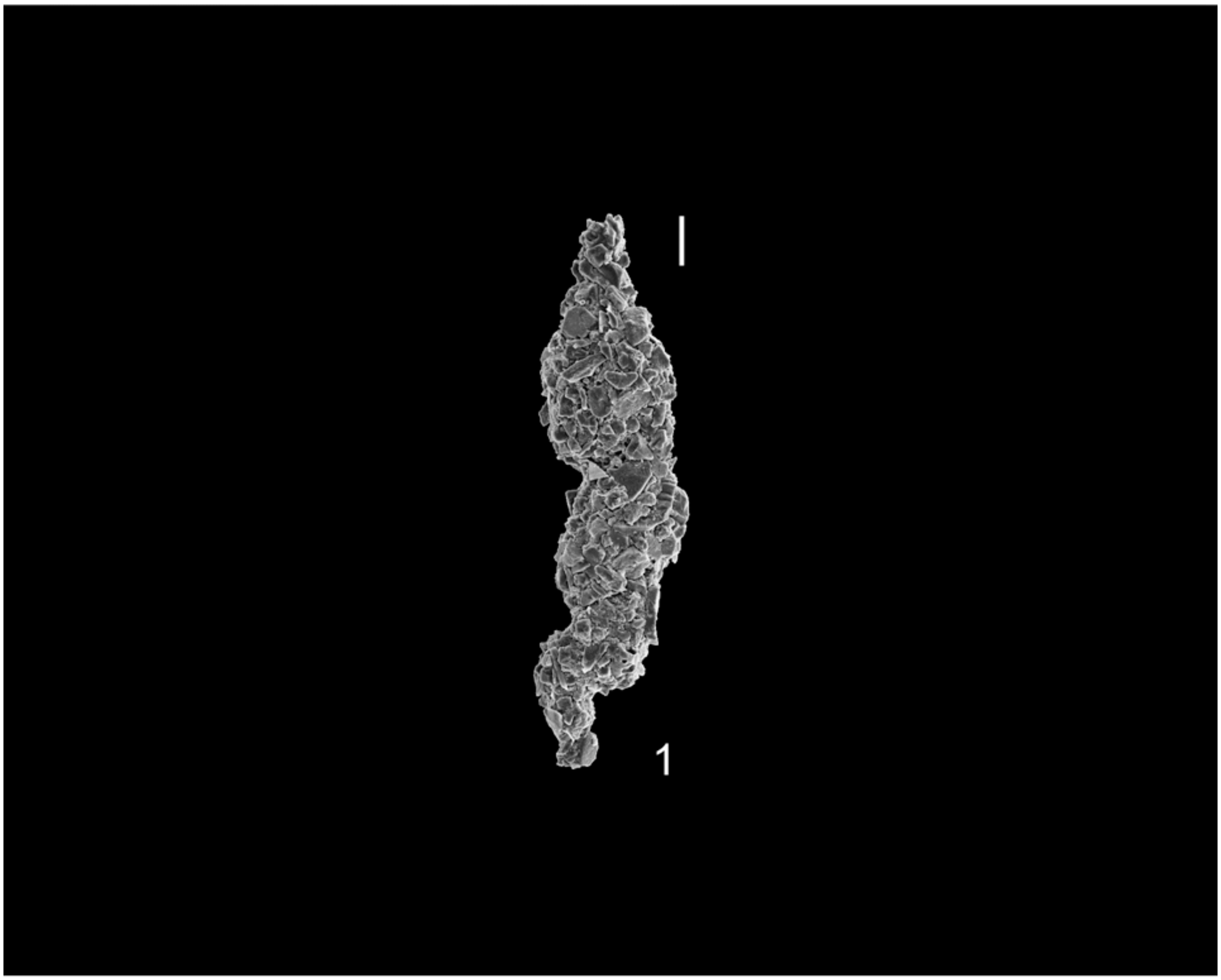

Plate 151

Scale bar = 50 μm

Rhabdammina abyssorum Sars

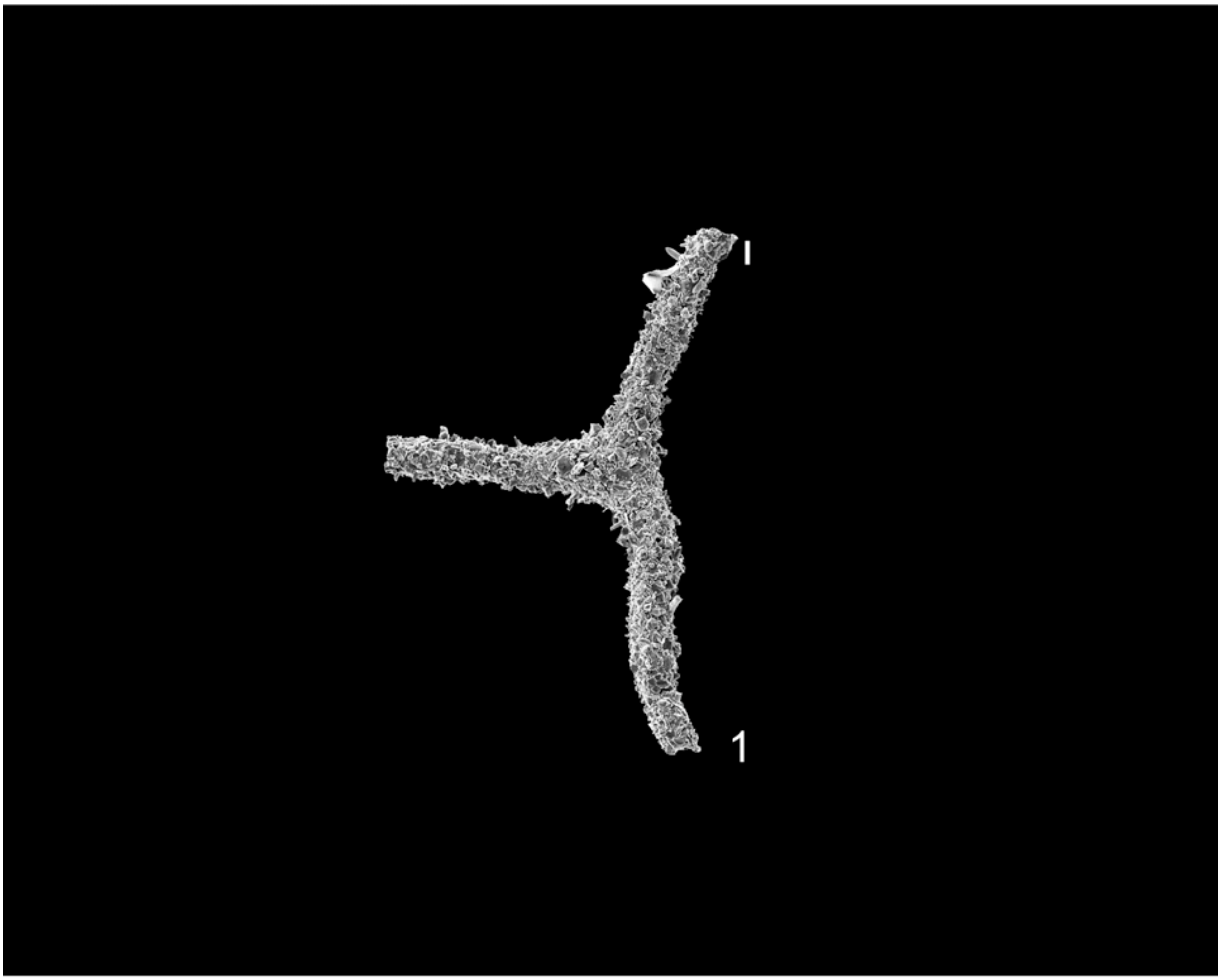

Plate 152 Scale bar = 50 µm

Rhabdammina discreta Brady

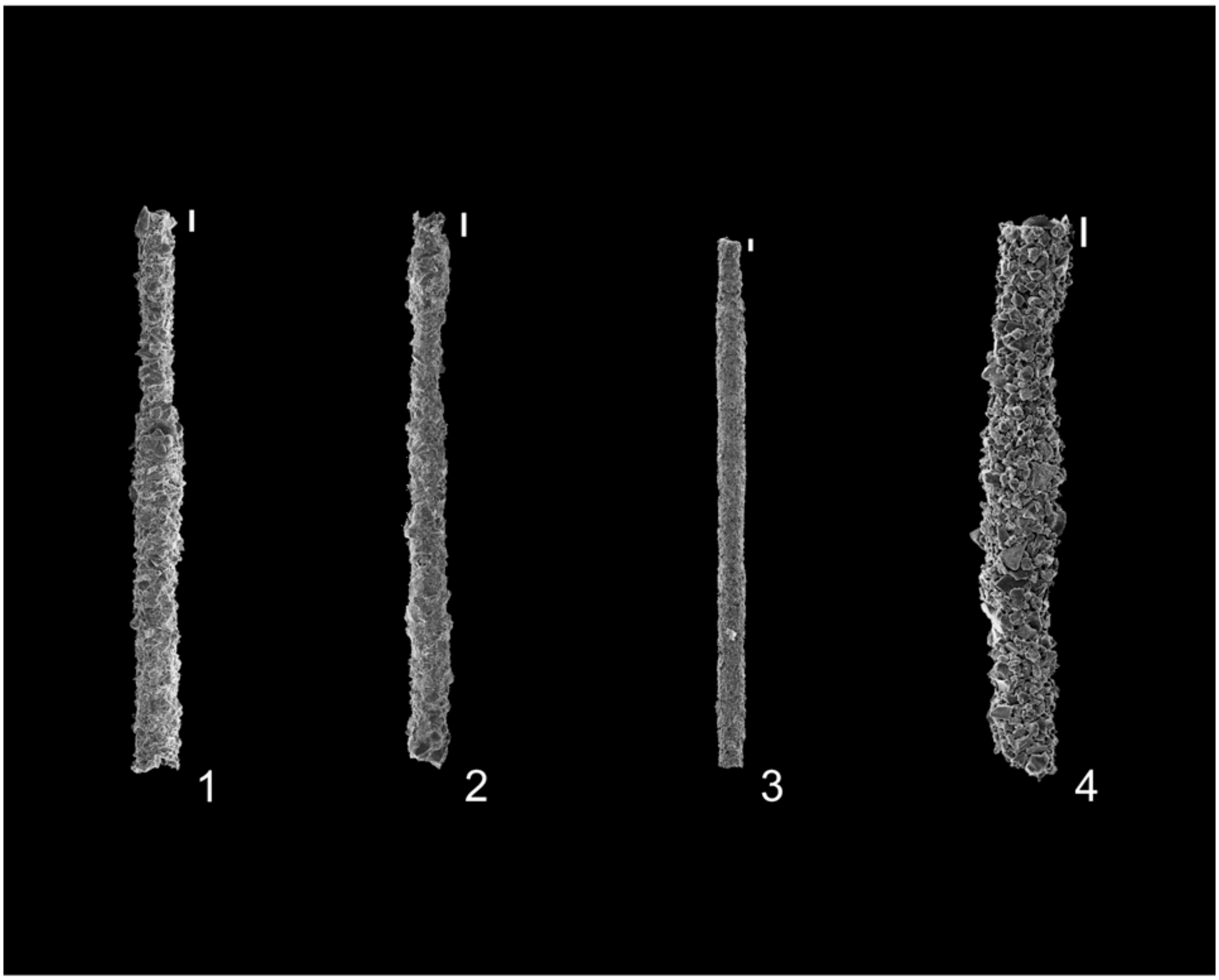

Plate 153

Scale bars = 50 μm

Rhizammina algaeformis Brady

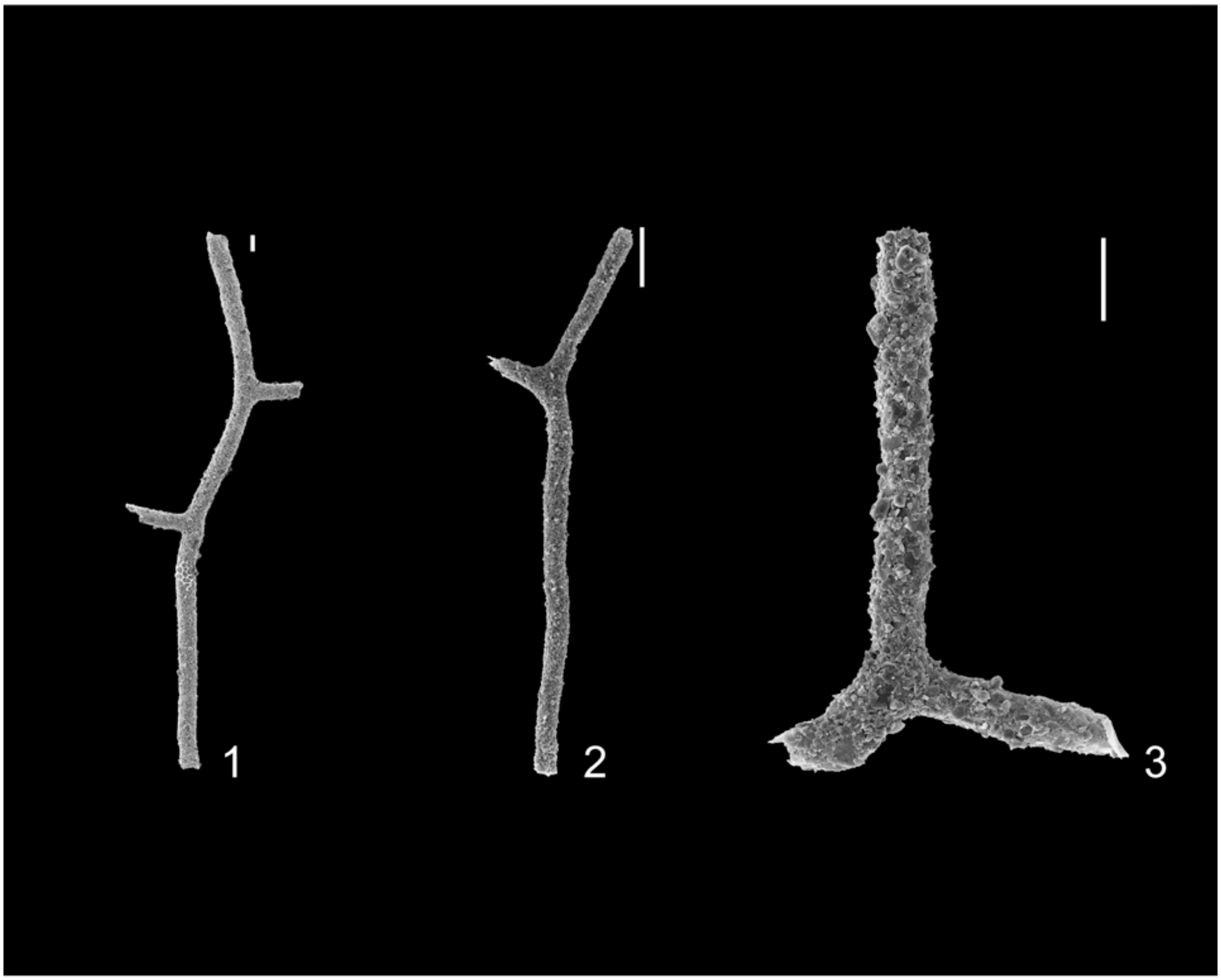

Plate 154

Scale bars = 50 μm

Rhizammina indivisa Brady

Plate 155

Scale bars = 50 μm

Robertina subcylindrica (Brady)

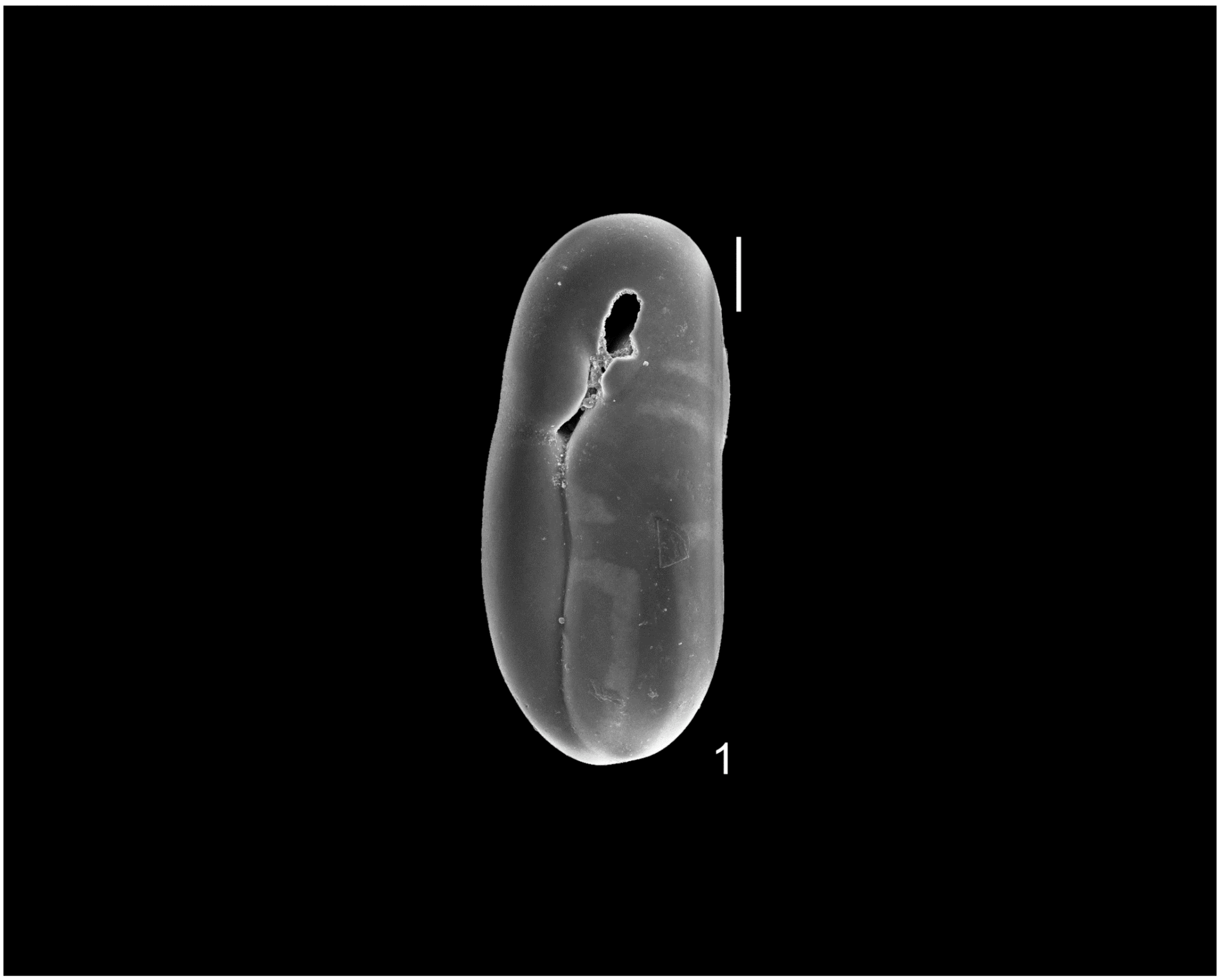

Plate 156 Scale bar = 50 μm

Robertinoides bradyi (Cushman and Parker)

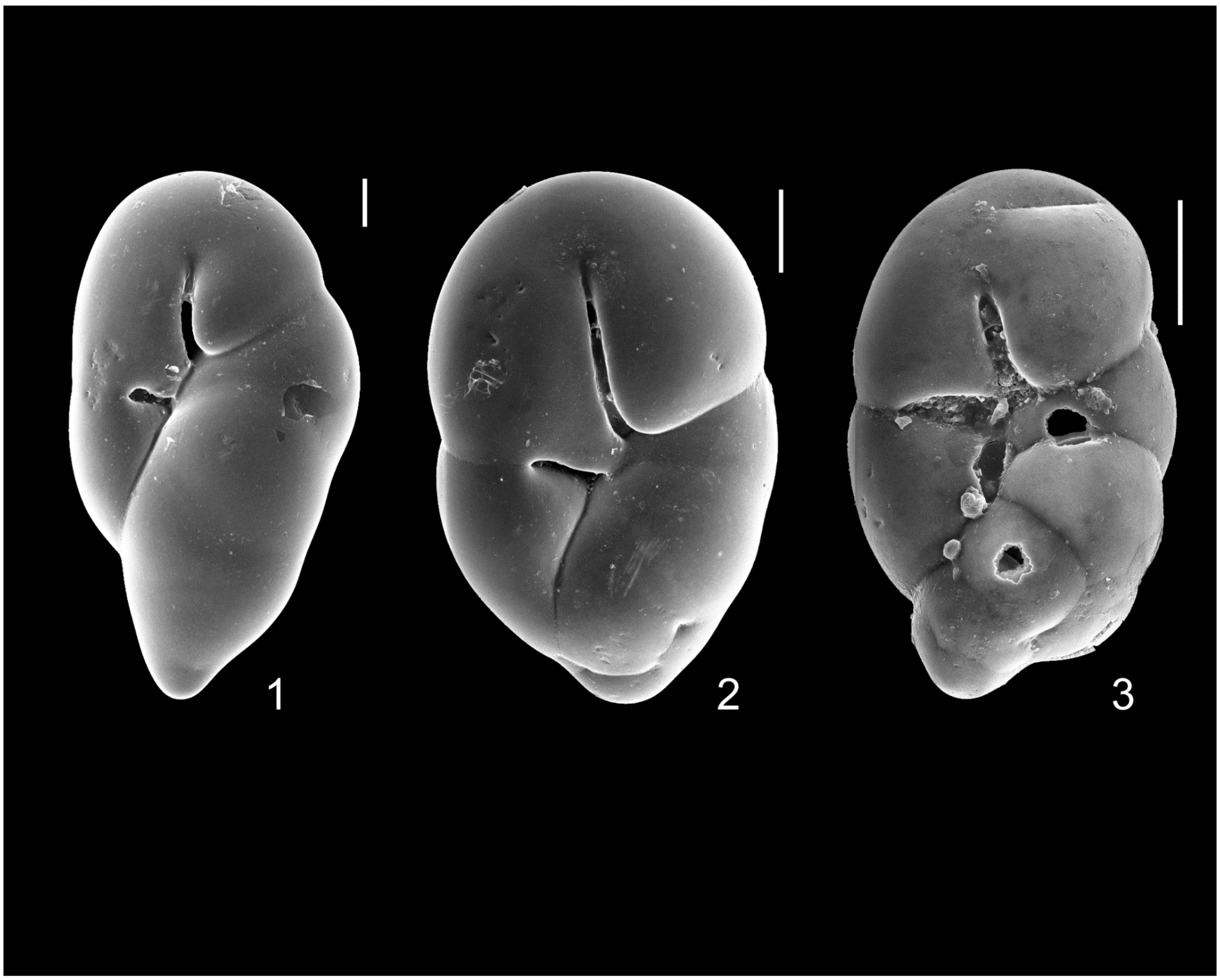

Plate 157

Scale bars = 50 μm

Rutherfordoides mexicanus (Cushman)

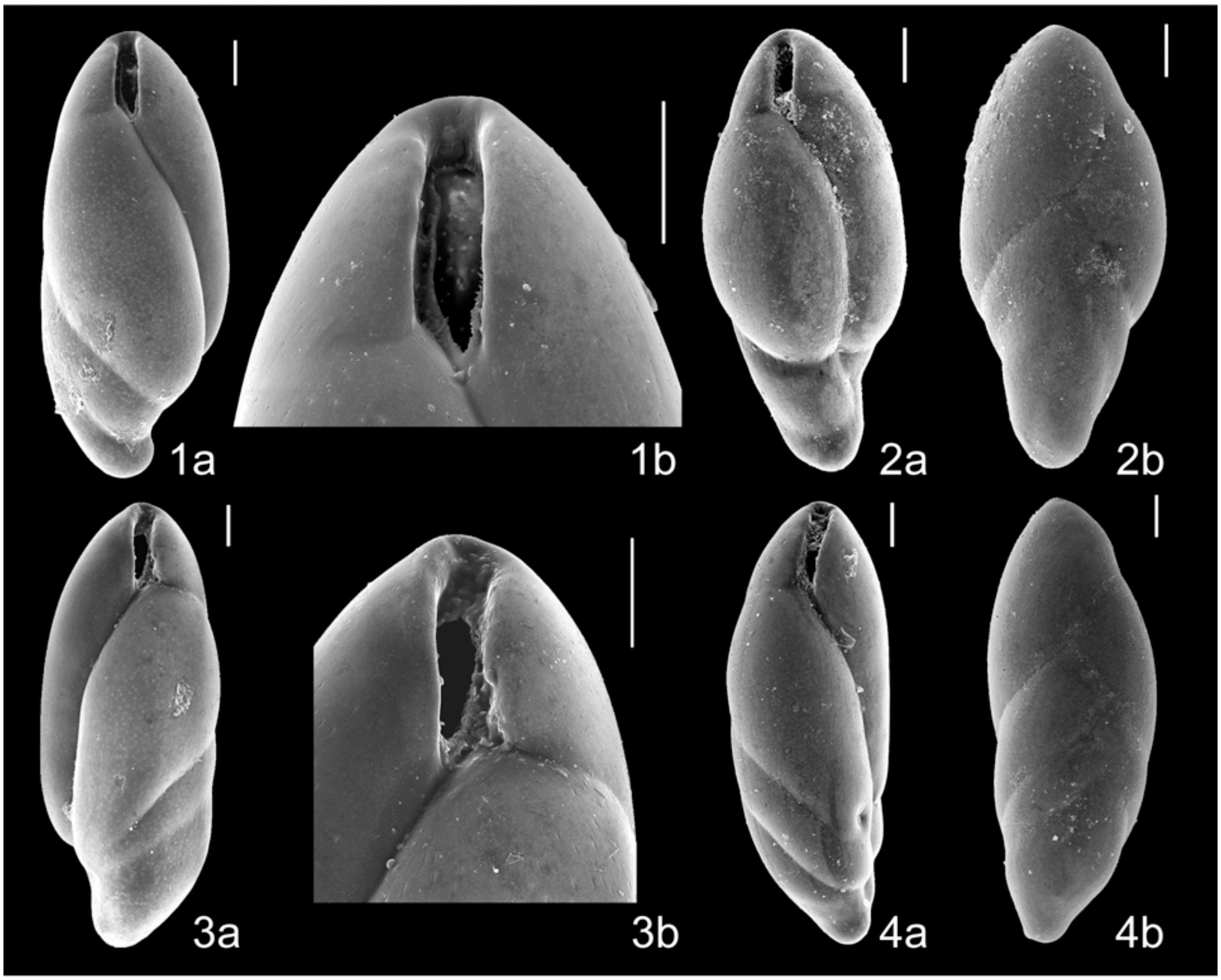

Plate 158

Scale bars = 50 µm

Saccammina helenae (Rhumbler)

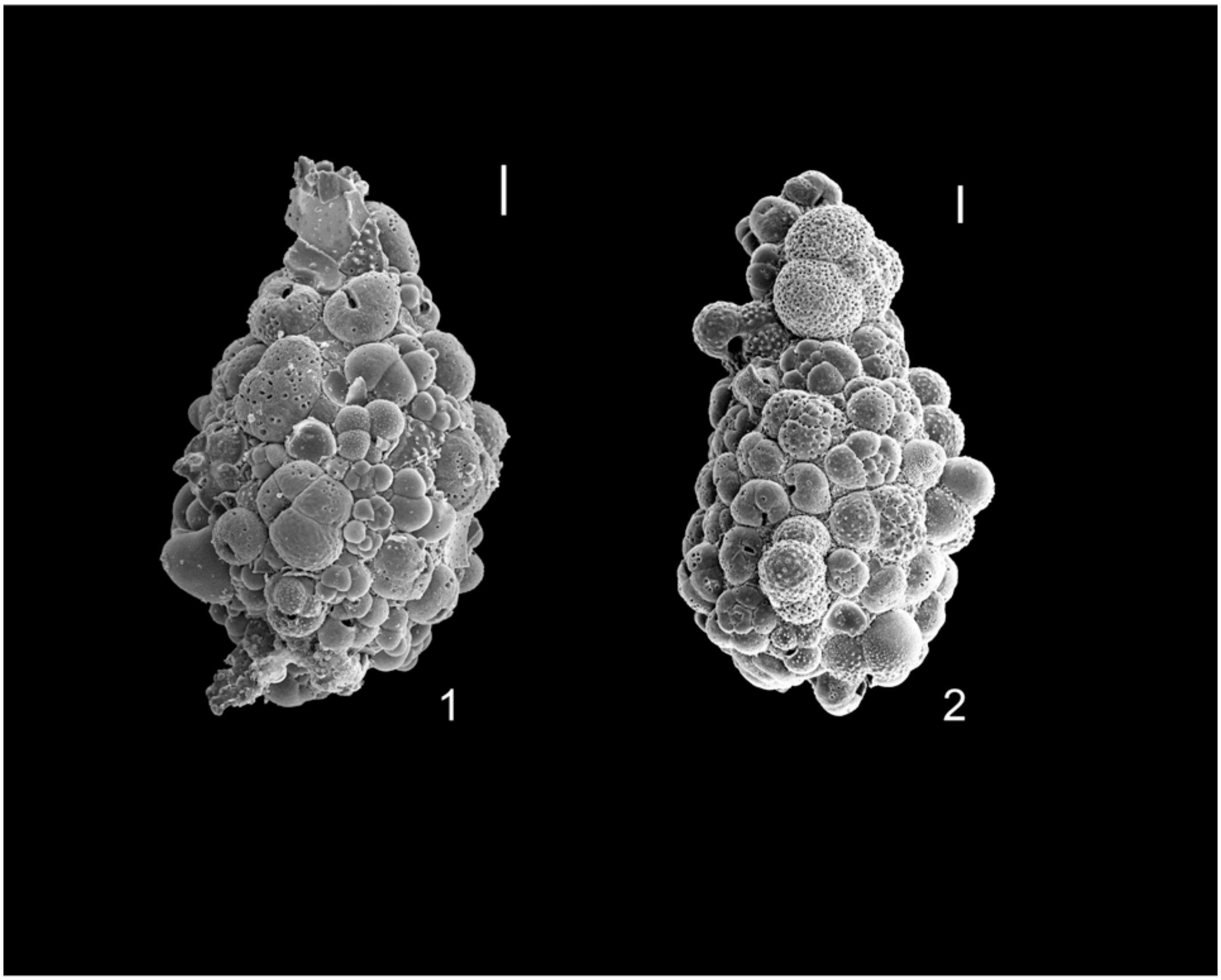

Plate 159

Scale bars = 50 μm

Saccorhiza ramosa (Brady)

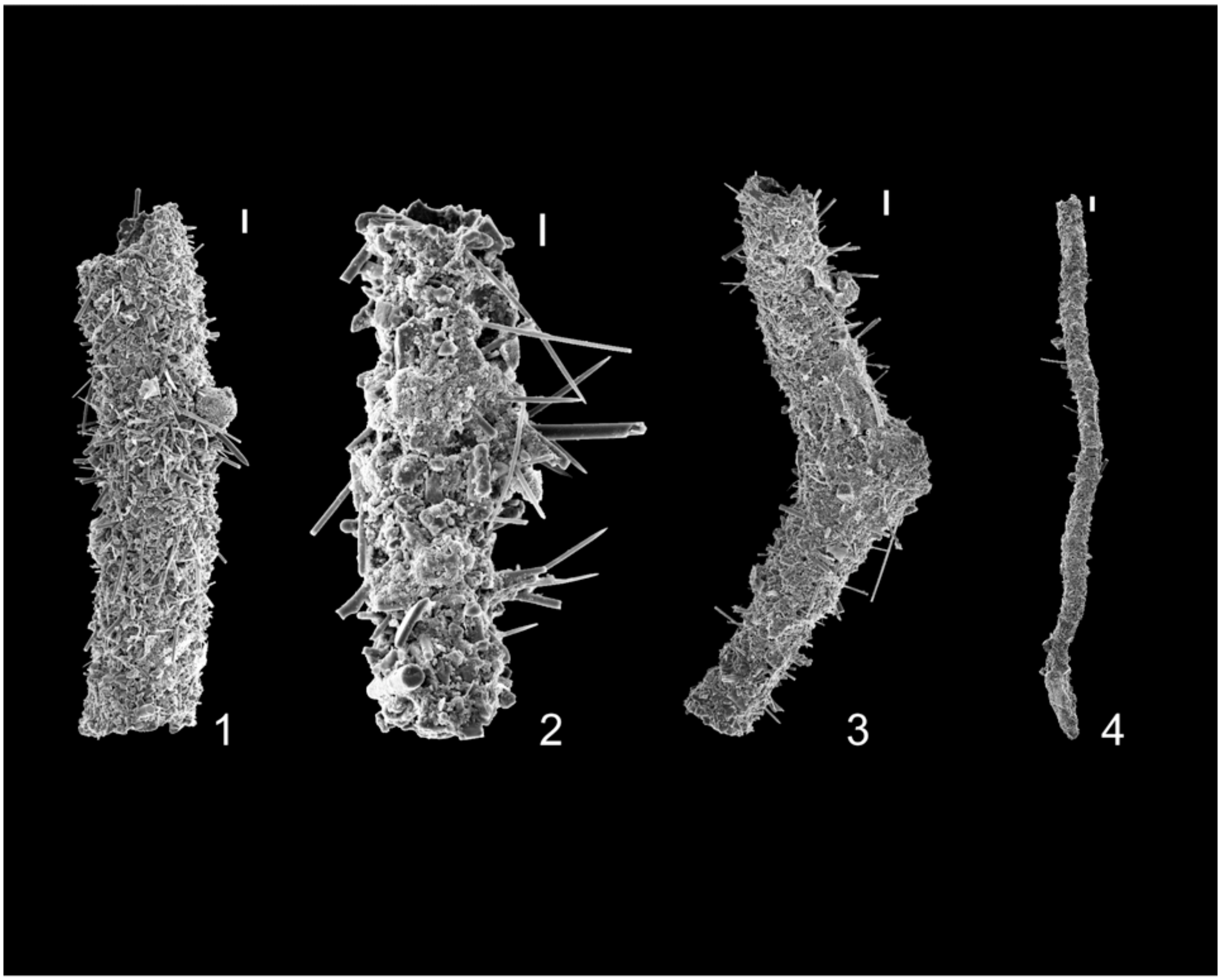

Plate 160

Scale bars = 50 µm

Saracenaria altifrons (Parr)

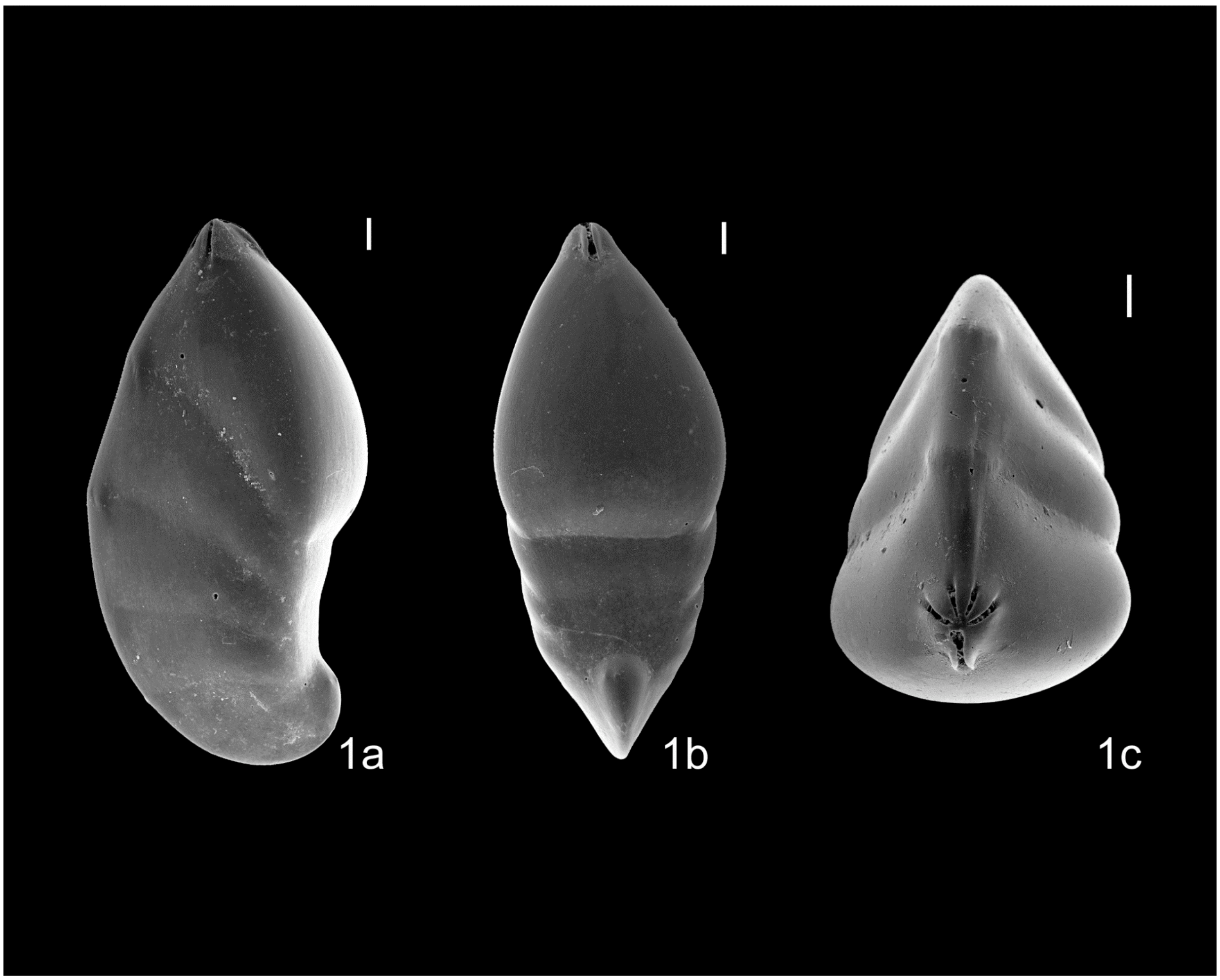

Plate 161

Scale bars = 50 µm

Seabrookia earlandi Wright

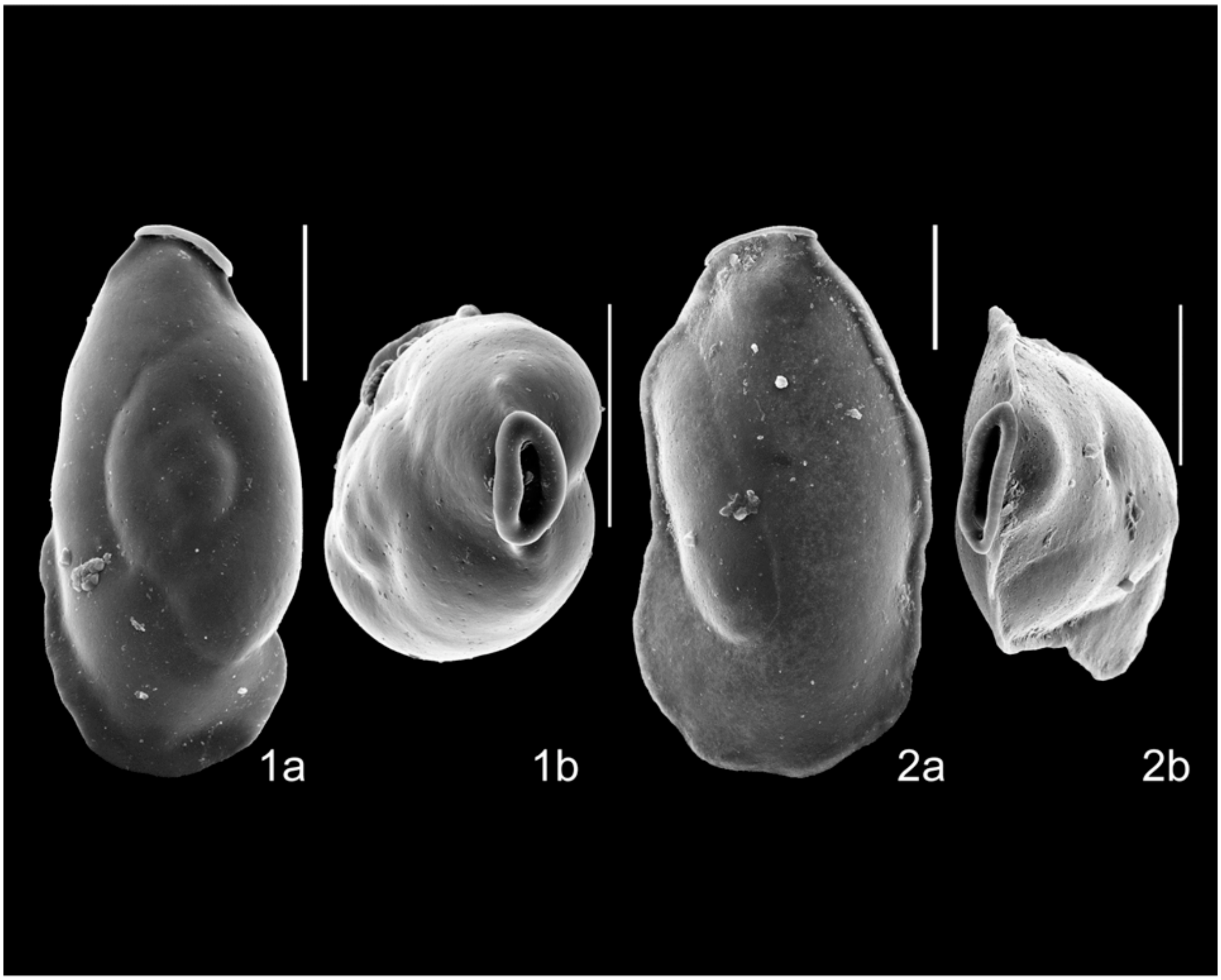

Plate 162 Scale bars = 50 μm

Sigmoilinita elliptica (Galloway and Wissler)

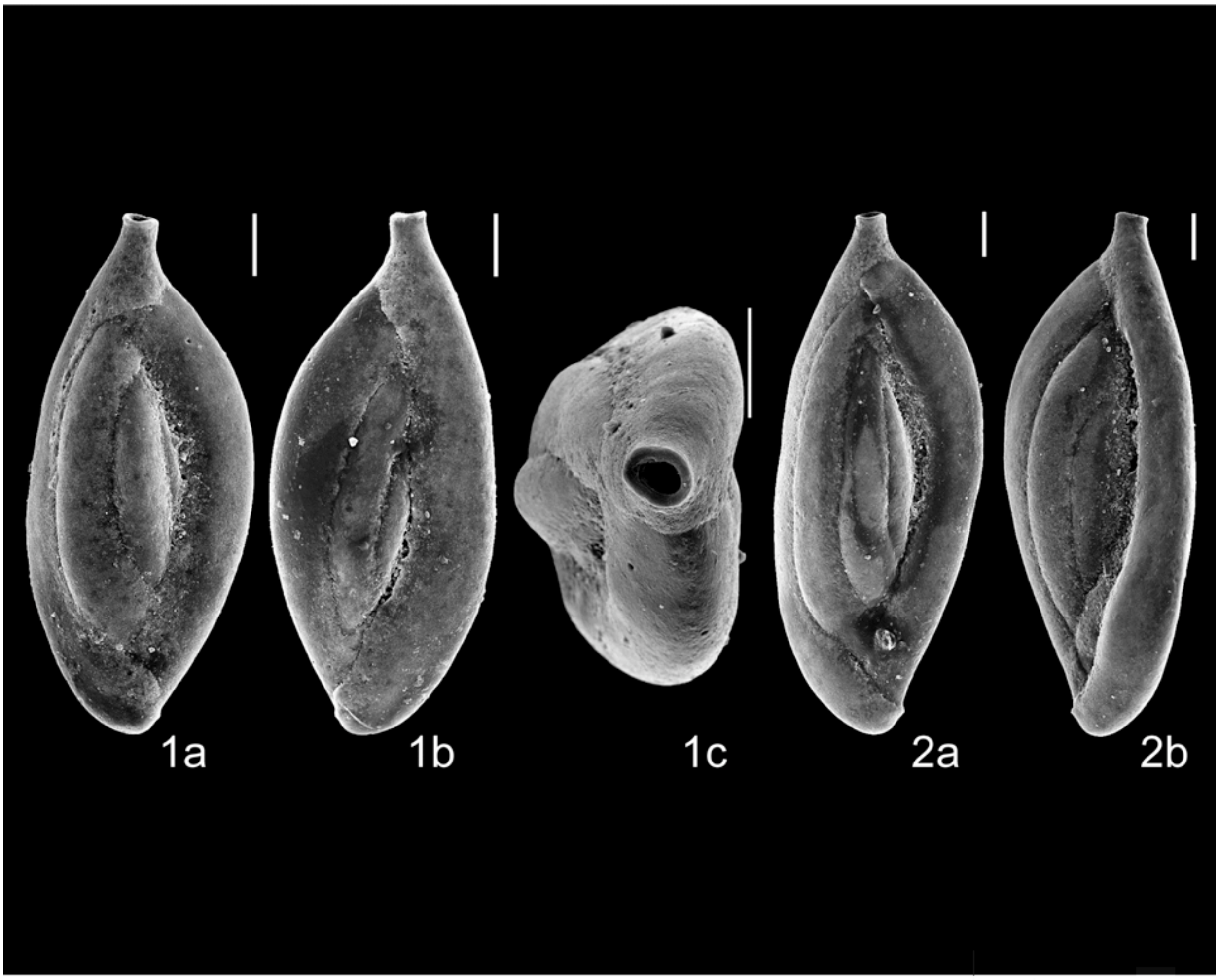

Plate 163

Scale bars = 50 µm

Sigmoilopsis schlumbergeri (Silvestri)

Plate 164

Scale bars = 50 µm

Siphonina pulchra Cushman

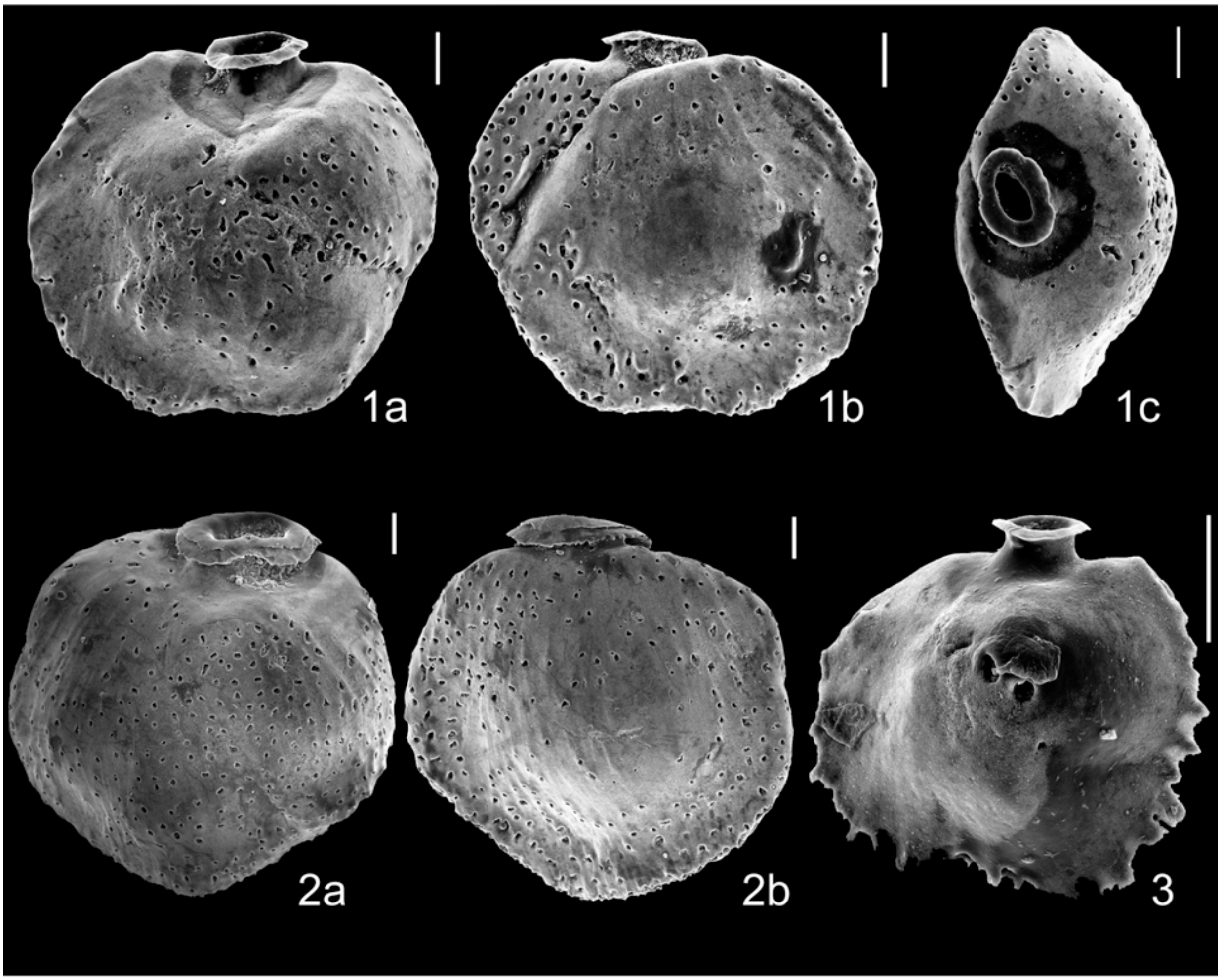

Plate 165

Scale bars = 50 μm

Siphonodosaria calomorpha (Reuss)

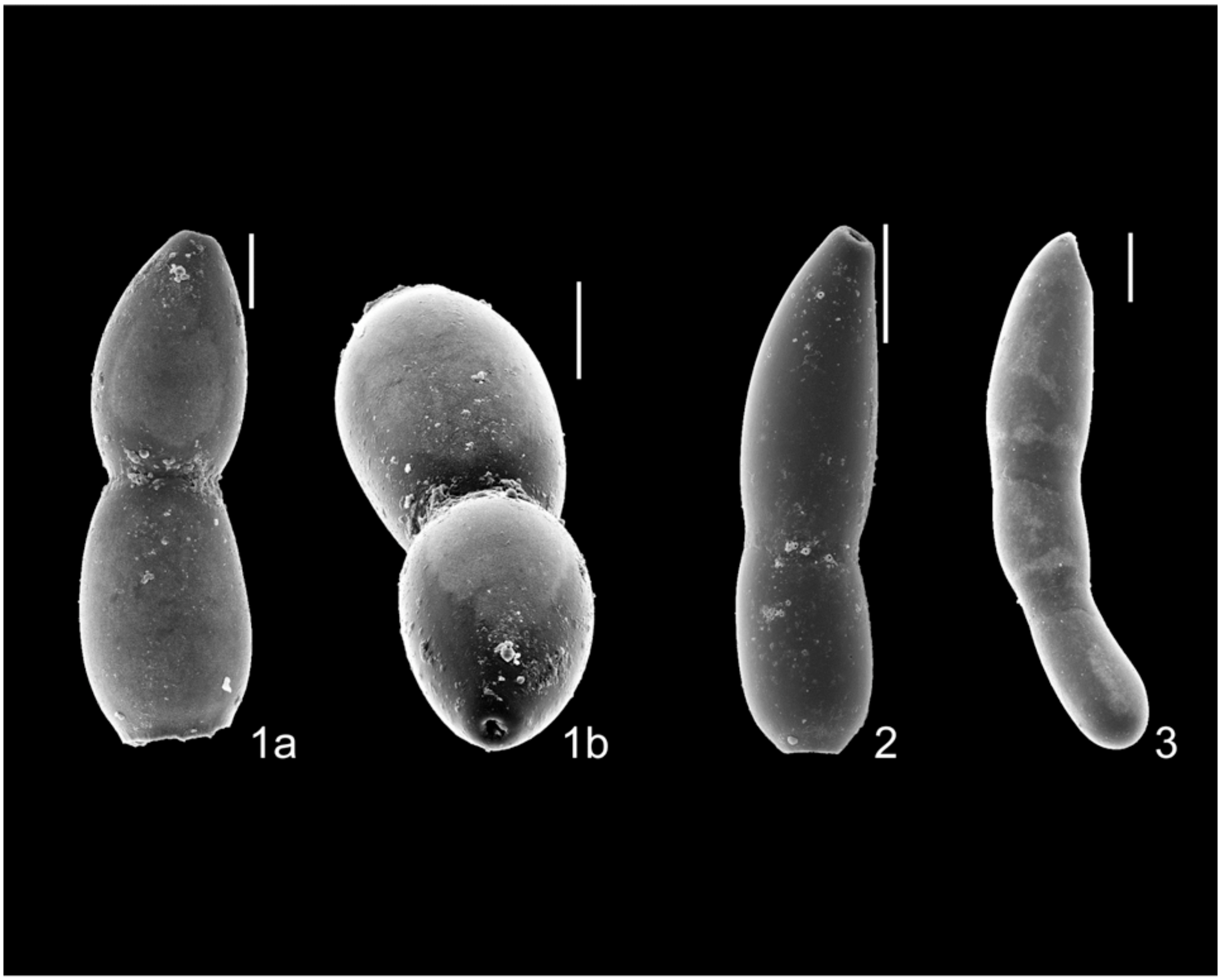

Plate 166

Scale bars = 50 µm

Siphotextularia rolshauseni Phleger and Parker

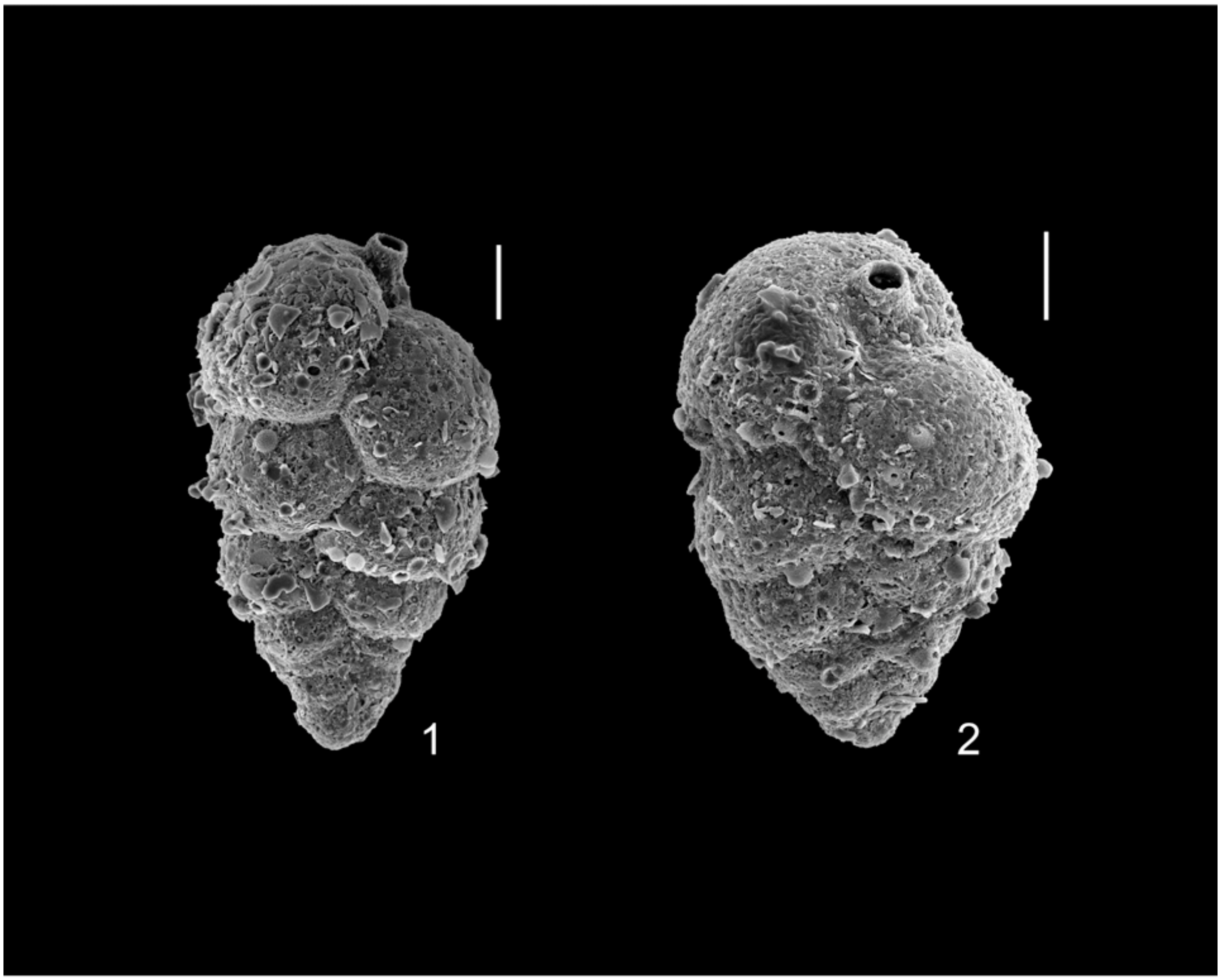

Plate 167 Scale bars = 50 μm

Spirillina vivipara Ehrenberg

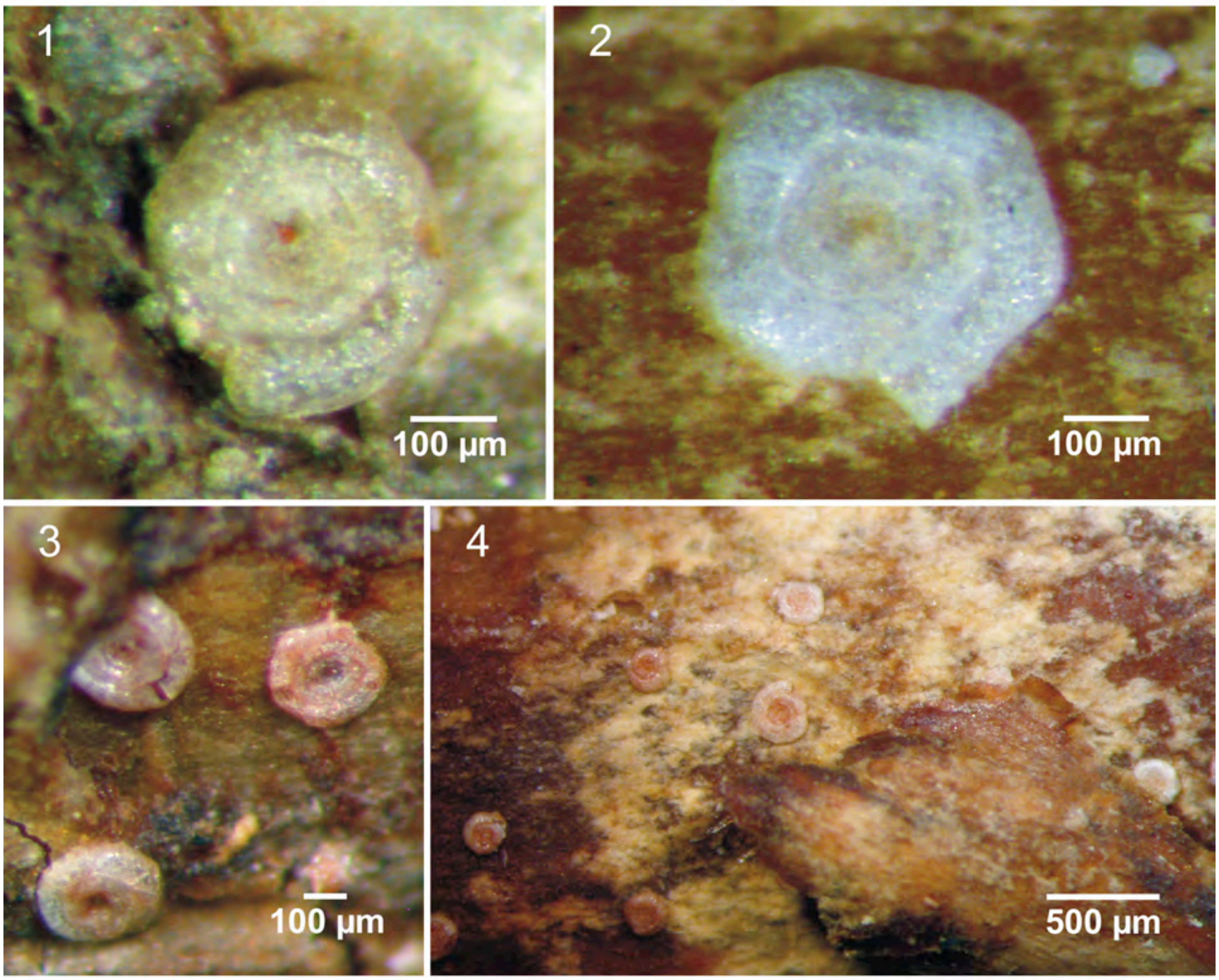

Plate 168

Spirillina vivipara Ehrenberg

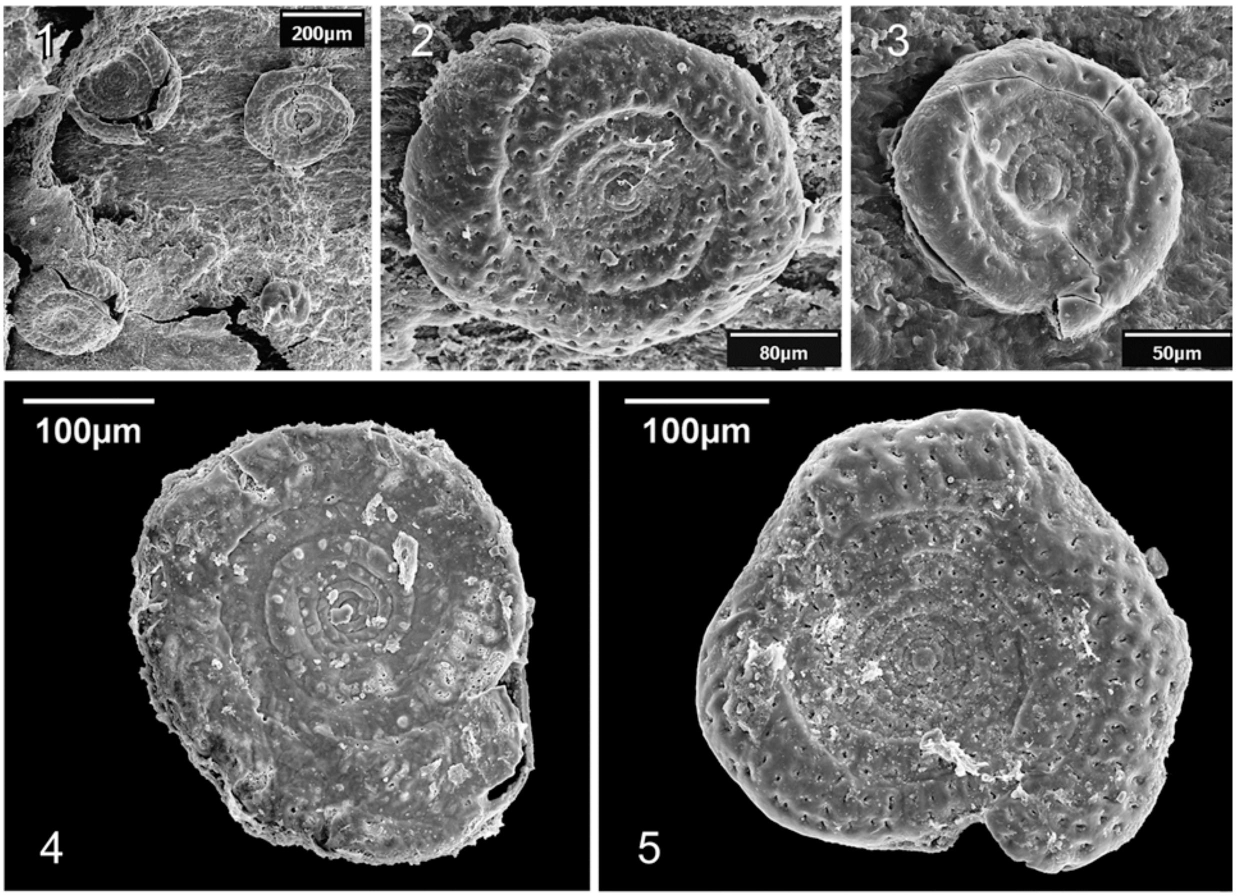

Plate 169

Spiroplectammina sp.

Plate 170

Scale bars = 50 μm

Stainforthia complanata (Egger)

Plate 171

Scale bars = 50 μm

Stainforthia compressa (Bailey)

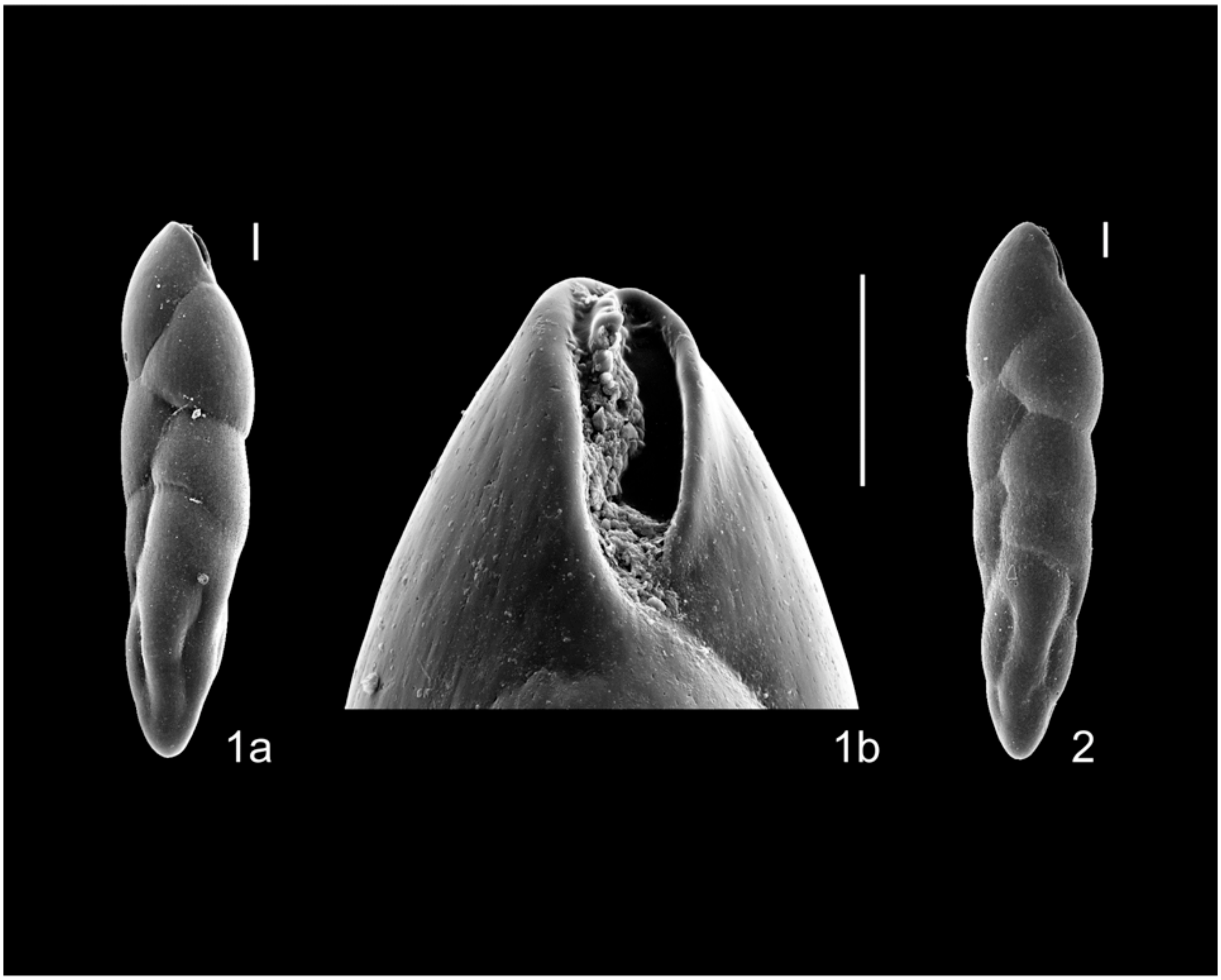

Plate 172

Scale bars = 50 μm

Stainforthia pontoni (Cushman)

Plate 173 Scale bars = 50 μm

Subreophax monile (Brady)

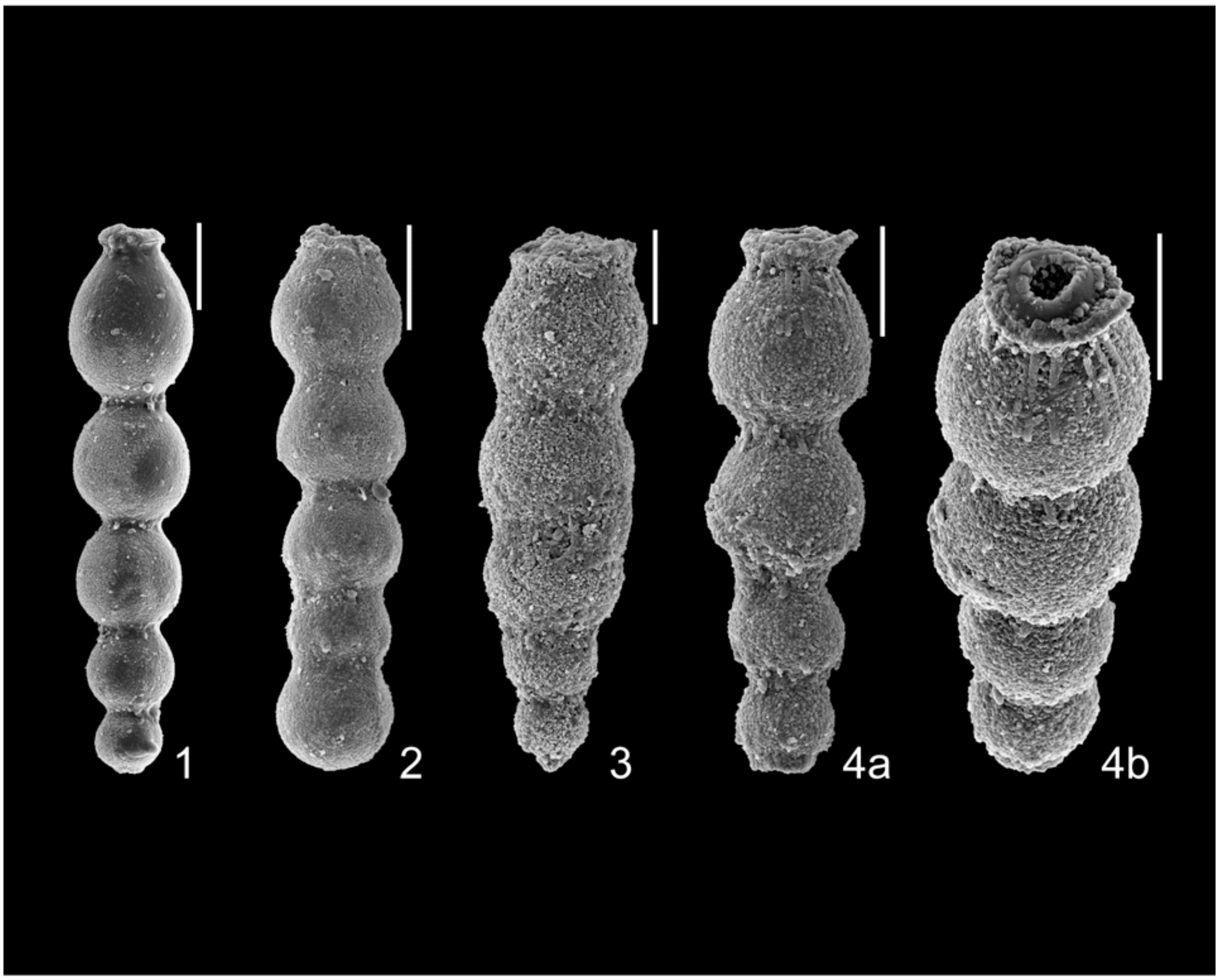

Plate 174

Scale bars = 50 μm

Tetrataxiella sp.

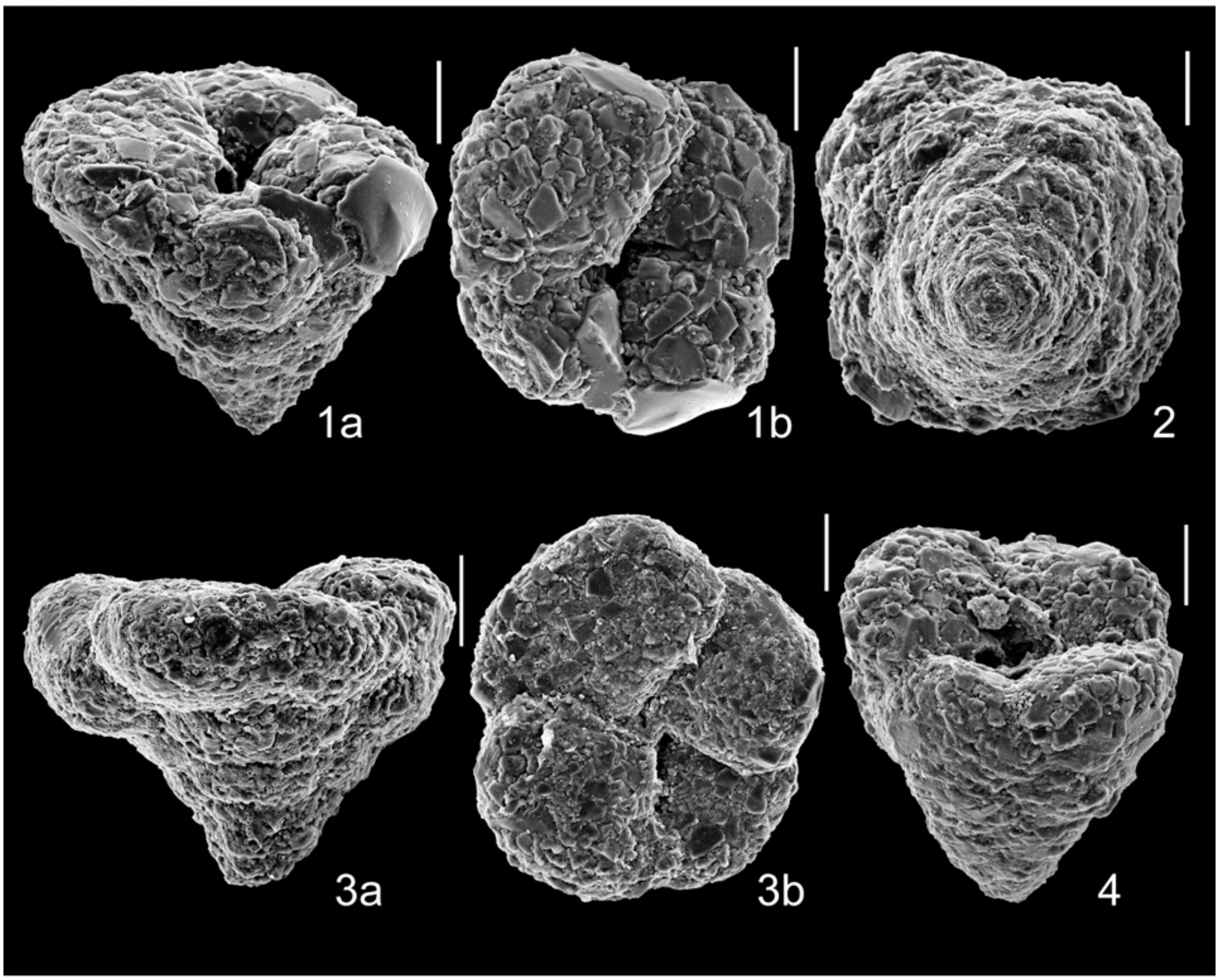

Plate 175

Scale bars = 50 μm

Textularia foliacea occidentalis Cushman

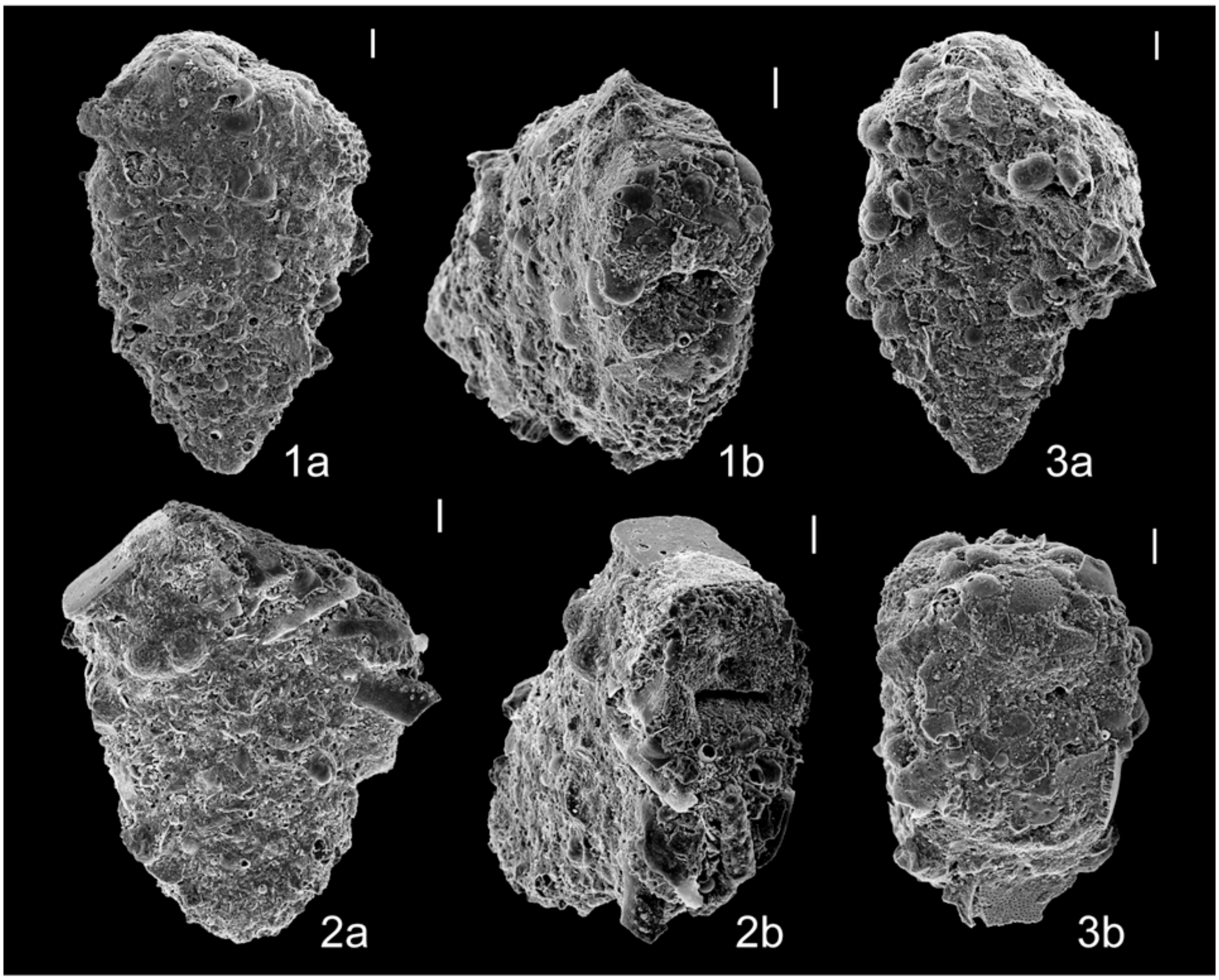

Plate 176

Scale bars = 50 µm

Textularia sp. cf. *T. mayori* Cushman

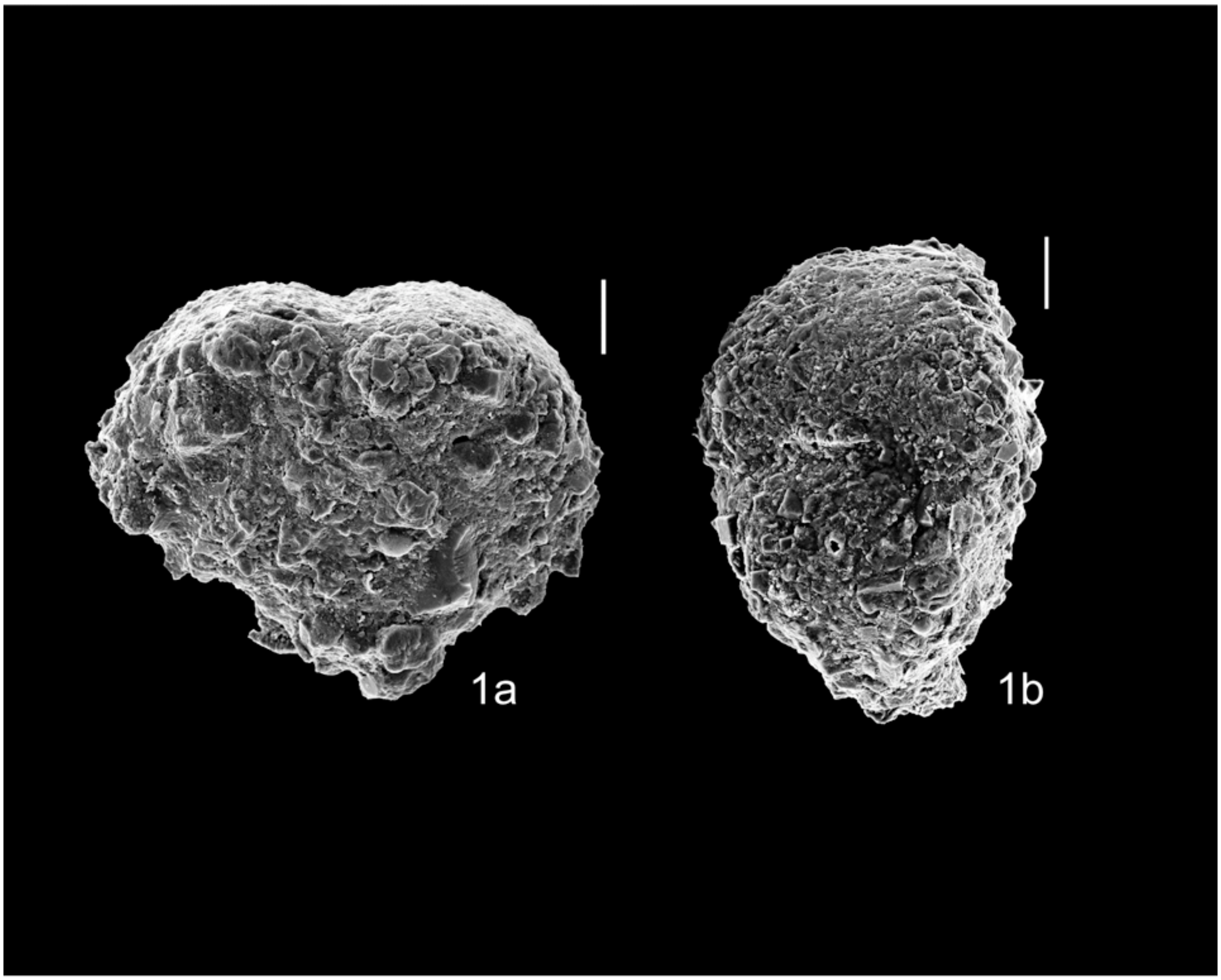

Plate 177

Scale bars = 50 μm

Textularia mexicana Cushman

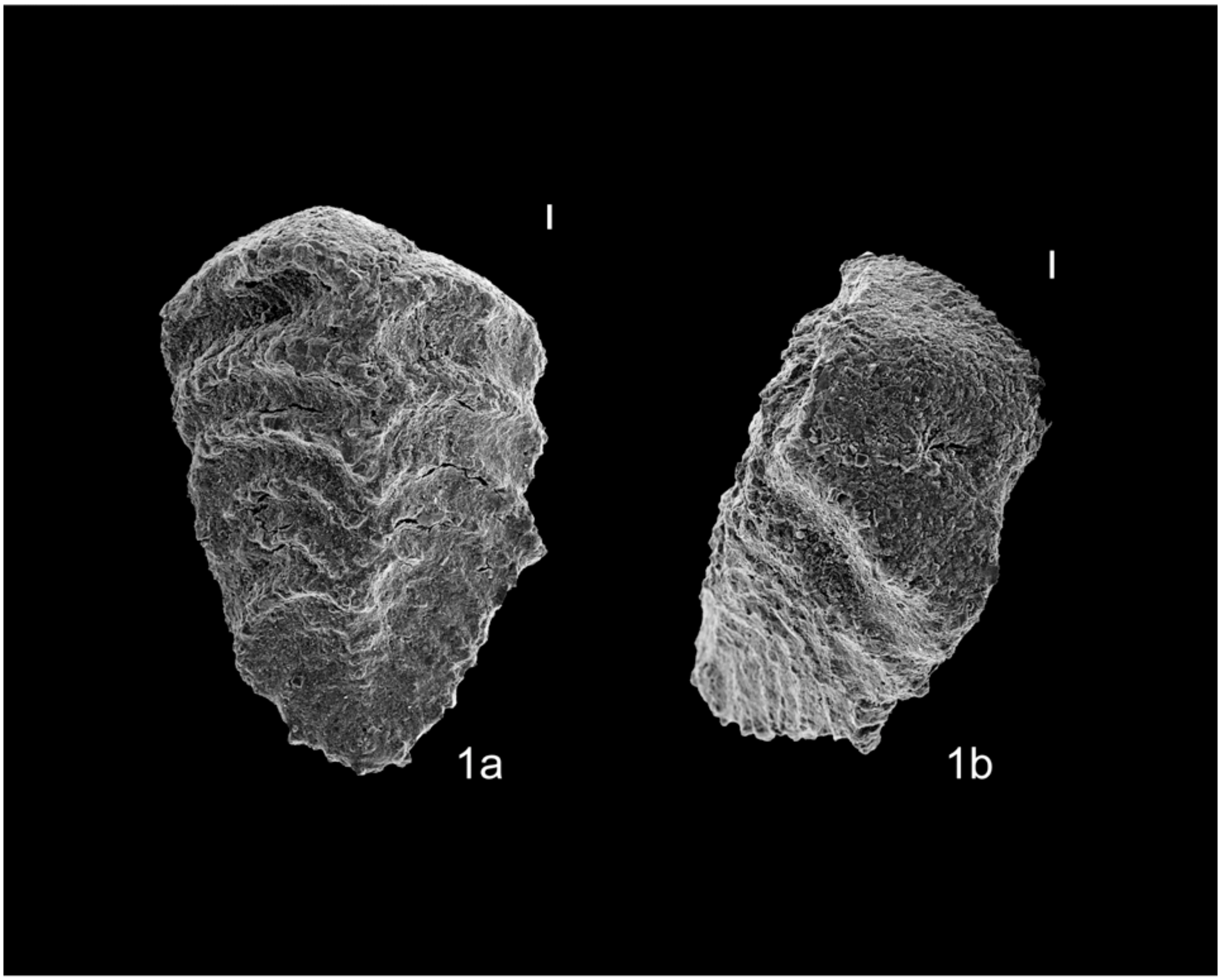

Plate 178

Scale bars = 50 μm

Textulariella barrettii (Jones and Parker)

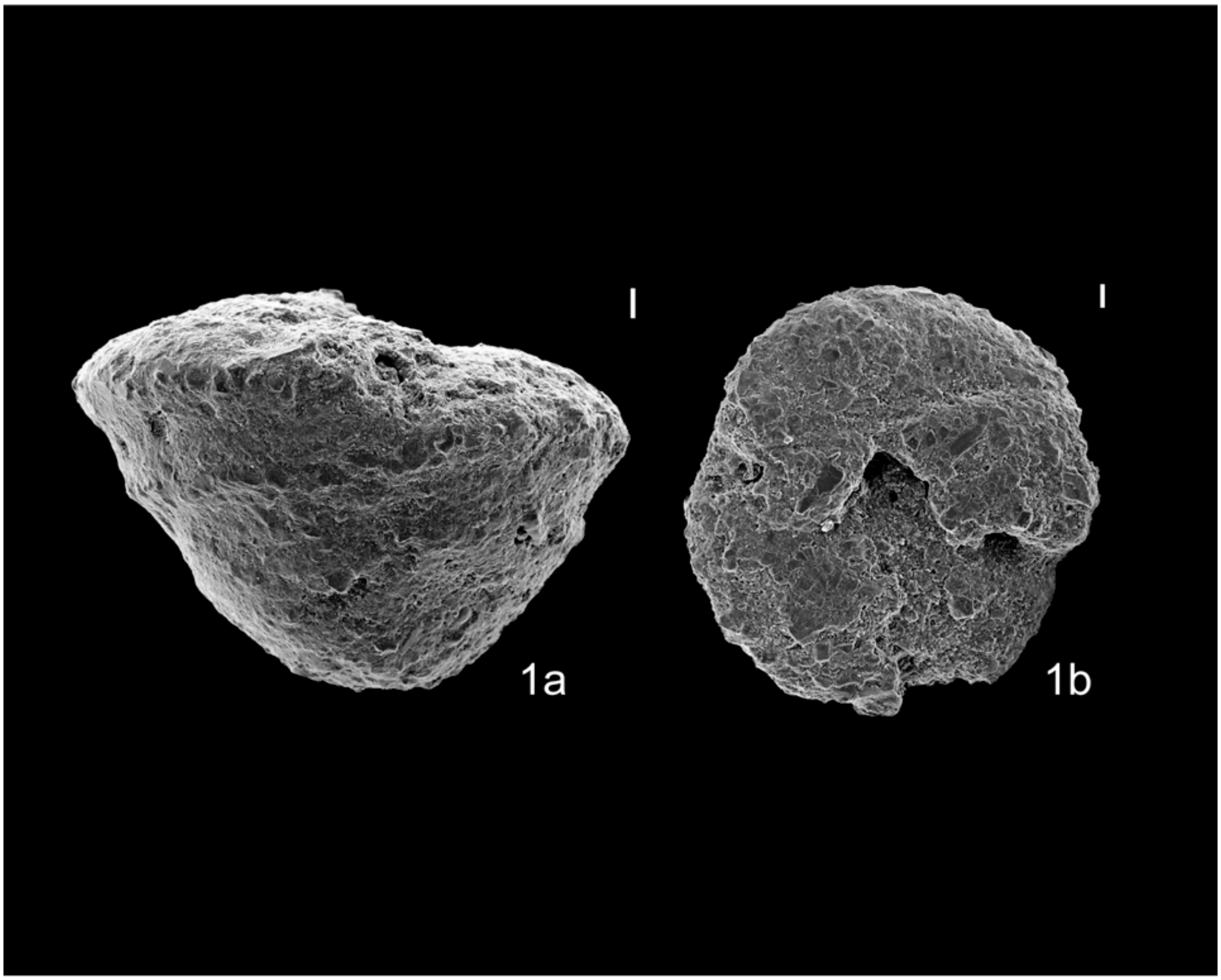

Plate 179

Scale bars = 50 μm

Trifarina bradyi Cushman

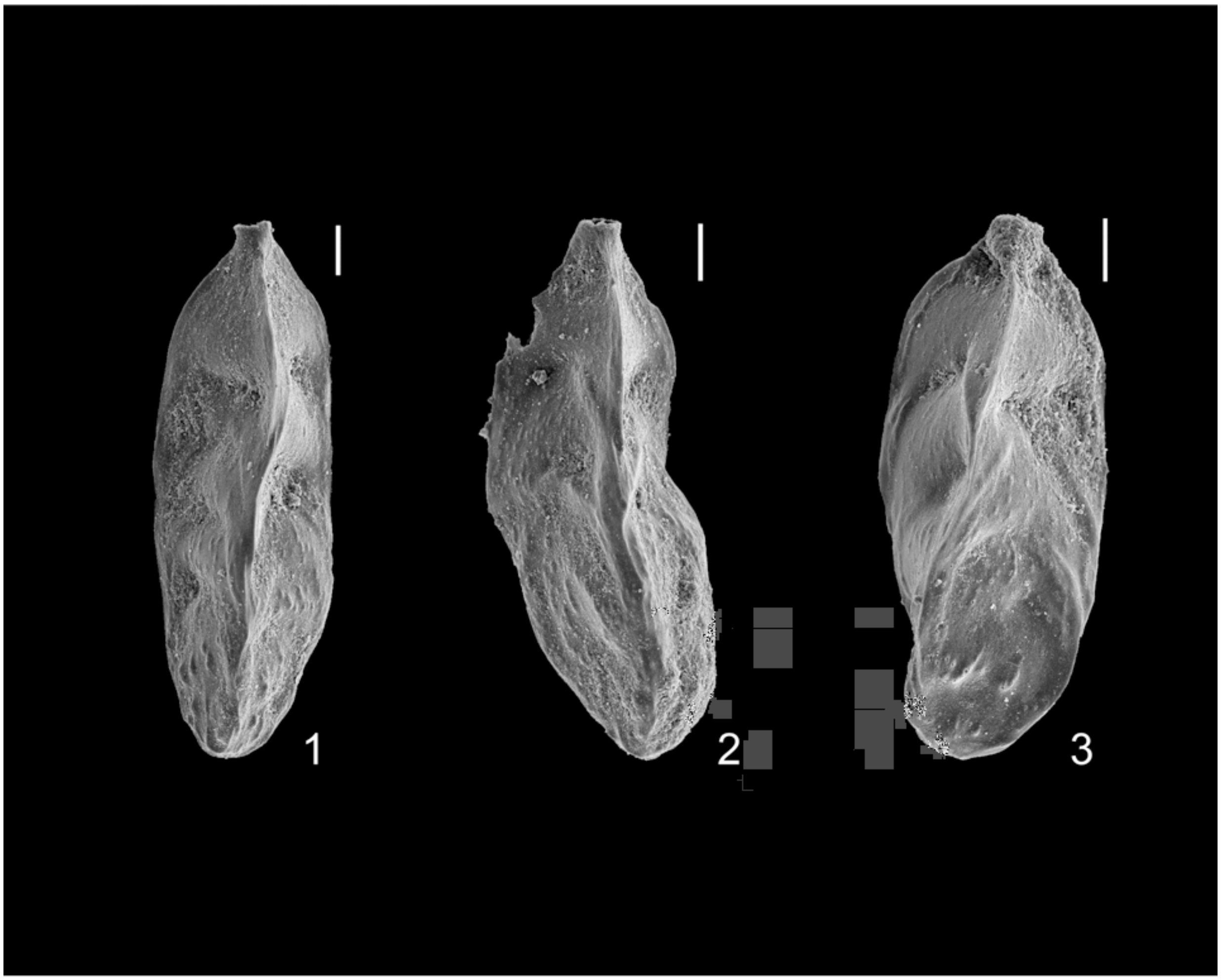

Plate 180

Scale bars = 50 μm

Trifarina jamaicensis (Cushman and Todd)

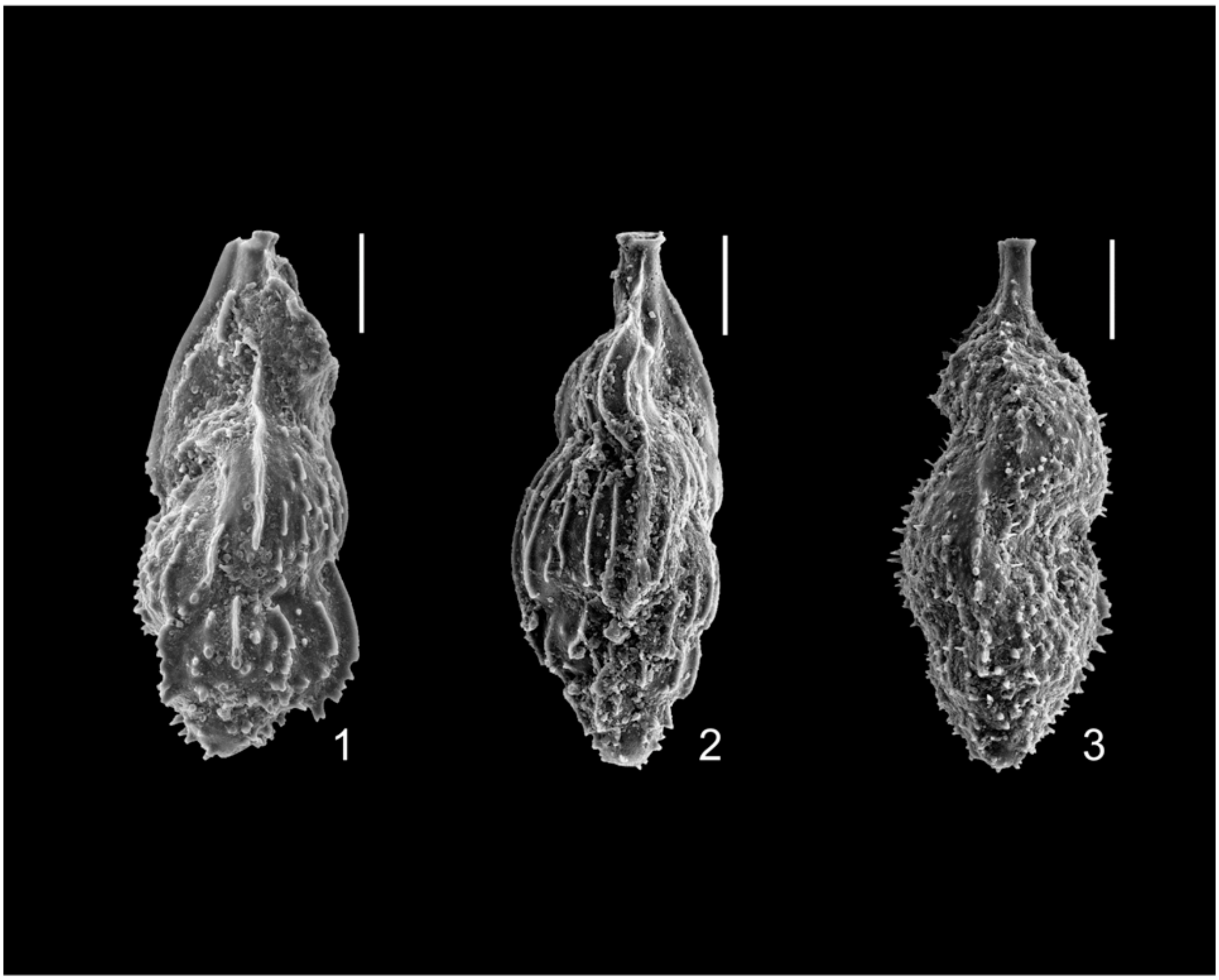

Plate 181

Scale bars = 50 μm

Triloculina tricarinata d'Orbigny

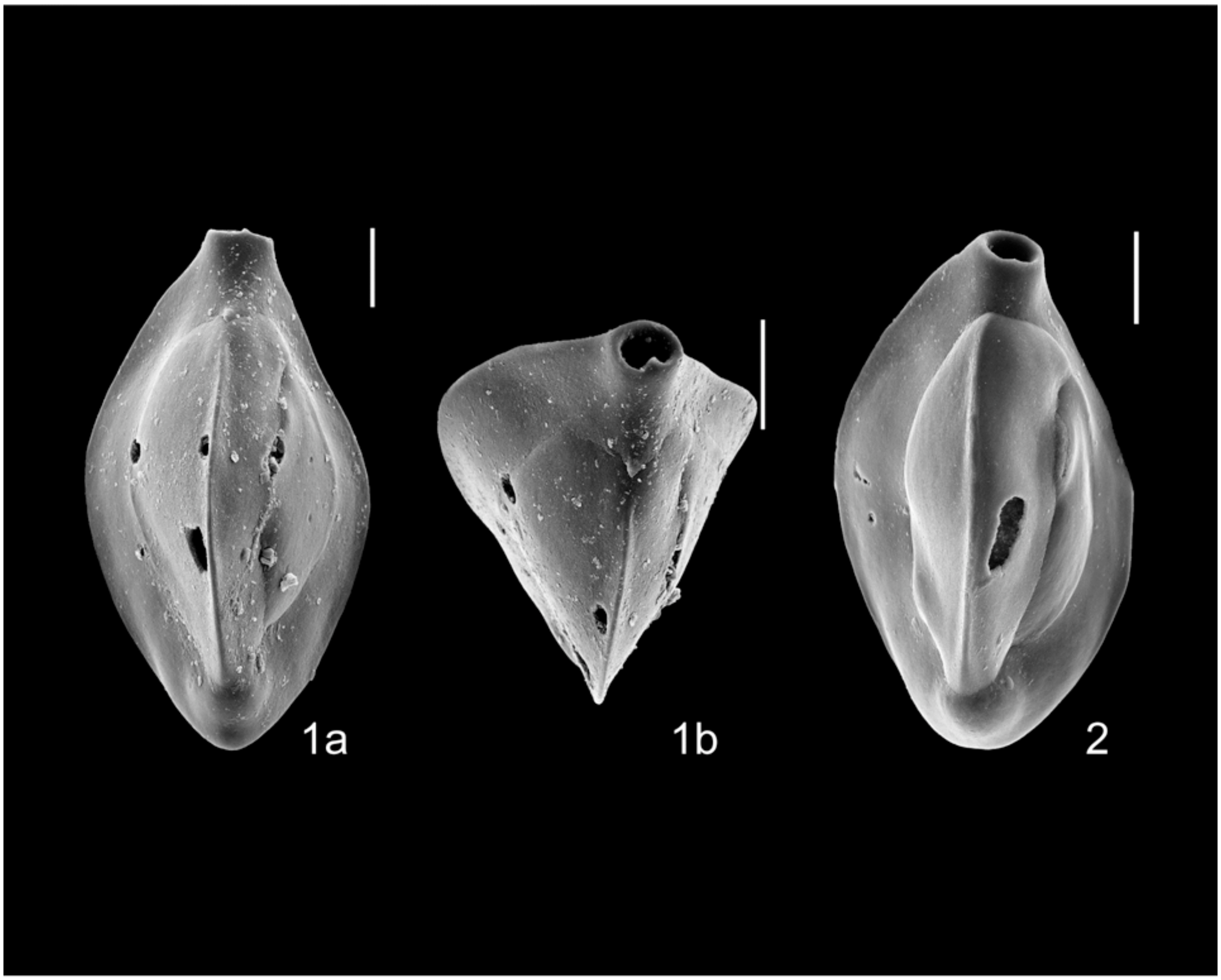

Plate 182

Scale bars = 50 μm

Usbekistania charoides (Jones and Parker)

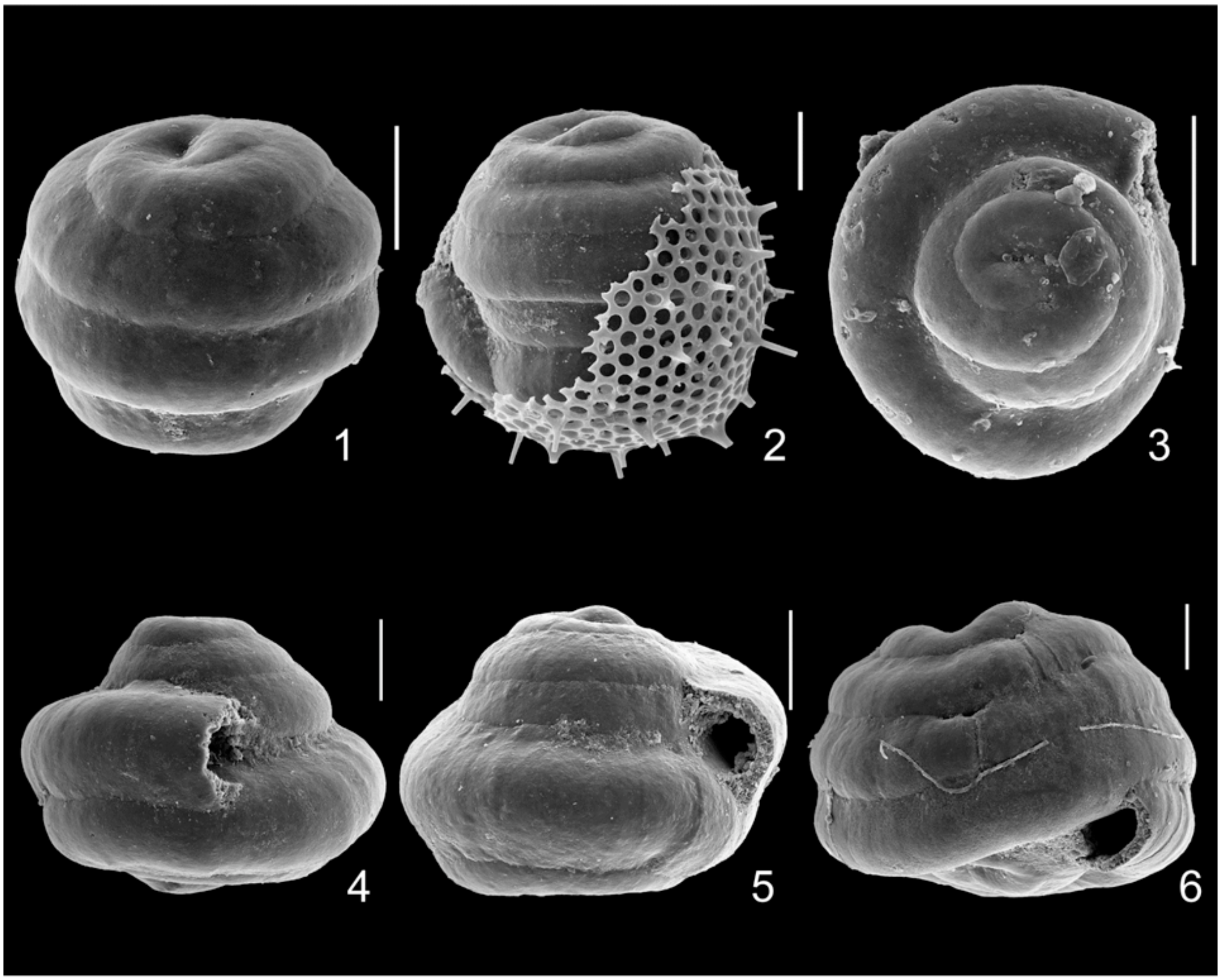

Plate 183

Scale bars = 50 µm

Uvigerina auberiana d'Orbigny

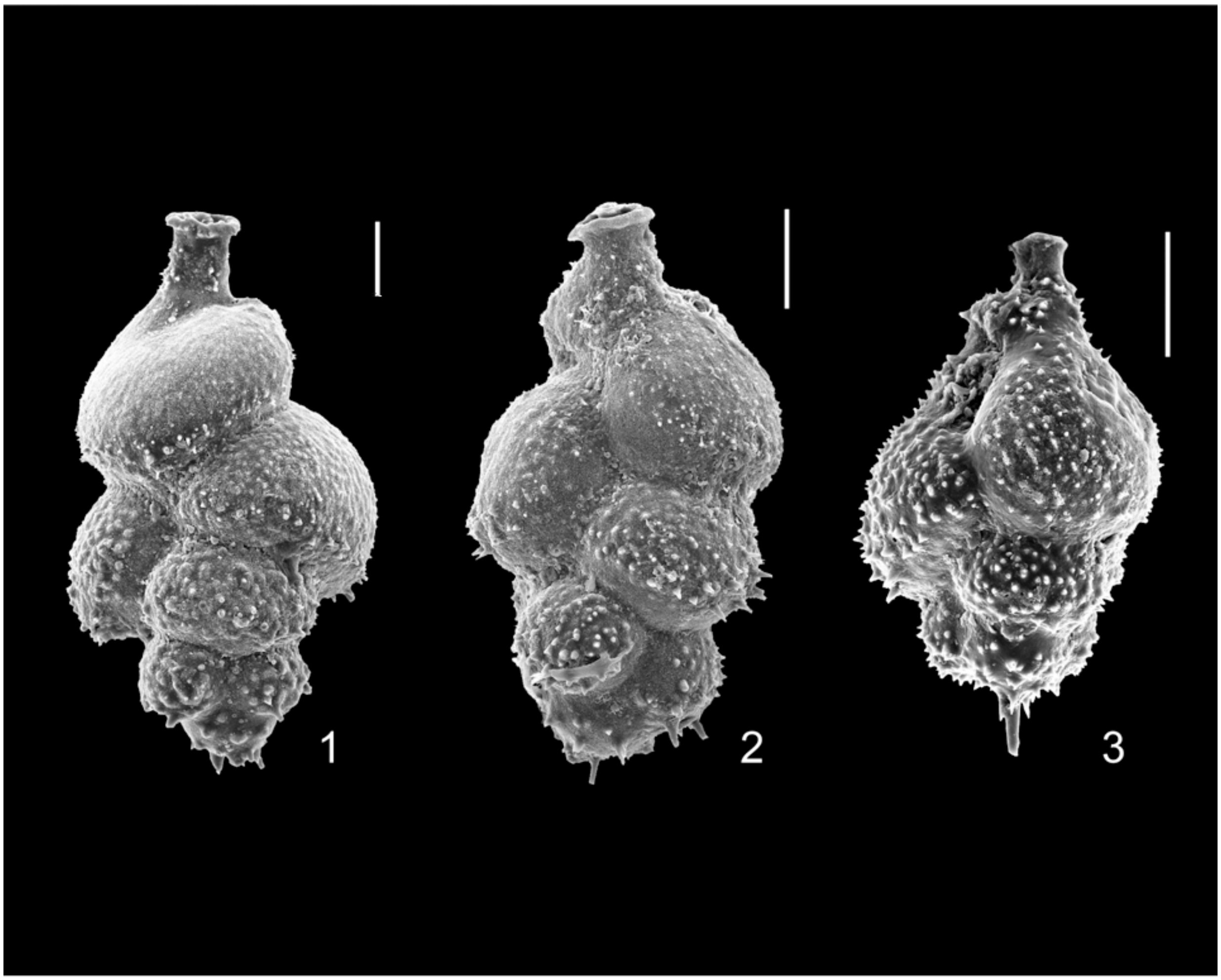

Plate 184

Scale bars = 50 μm

Uvigerina bellula Bandy

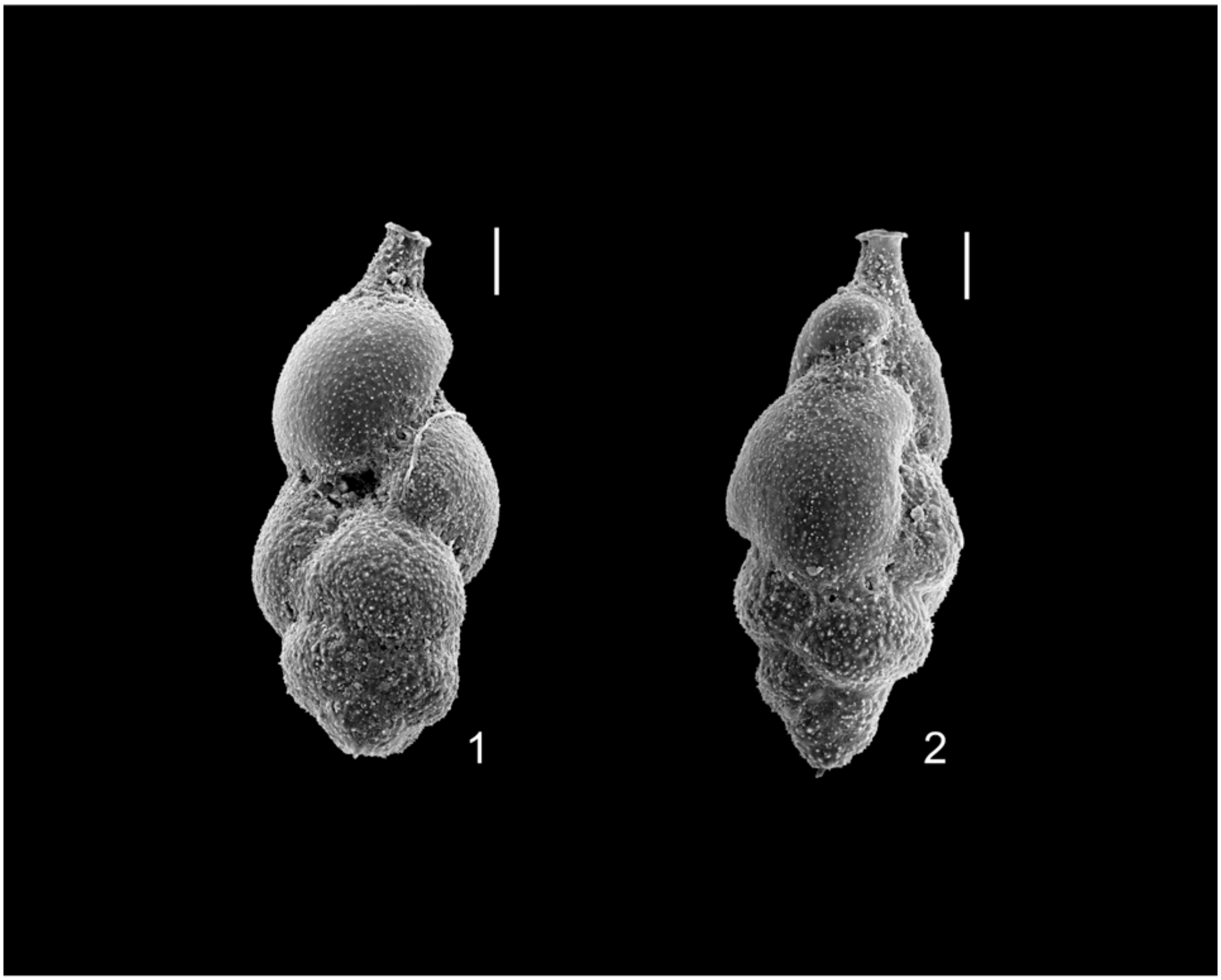

Plate 185

Scale bars = 50 µm

Uvigerina flintii Cushman

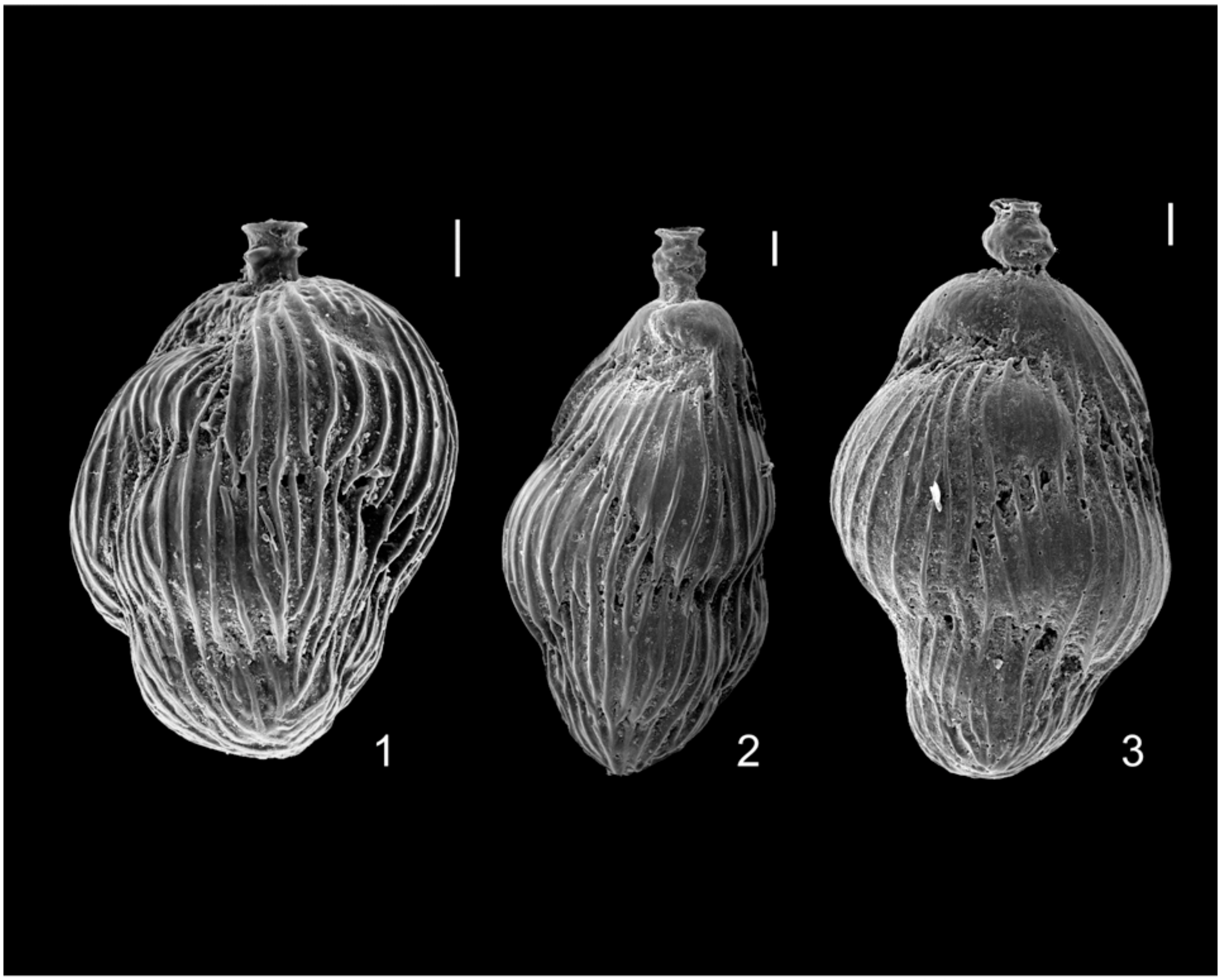

Plate 186

Scale bars = 50 μm

Uvigerina peregrina Cushman

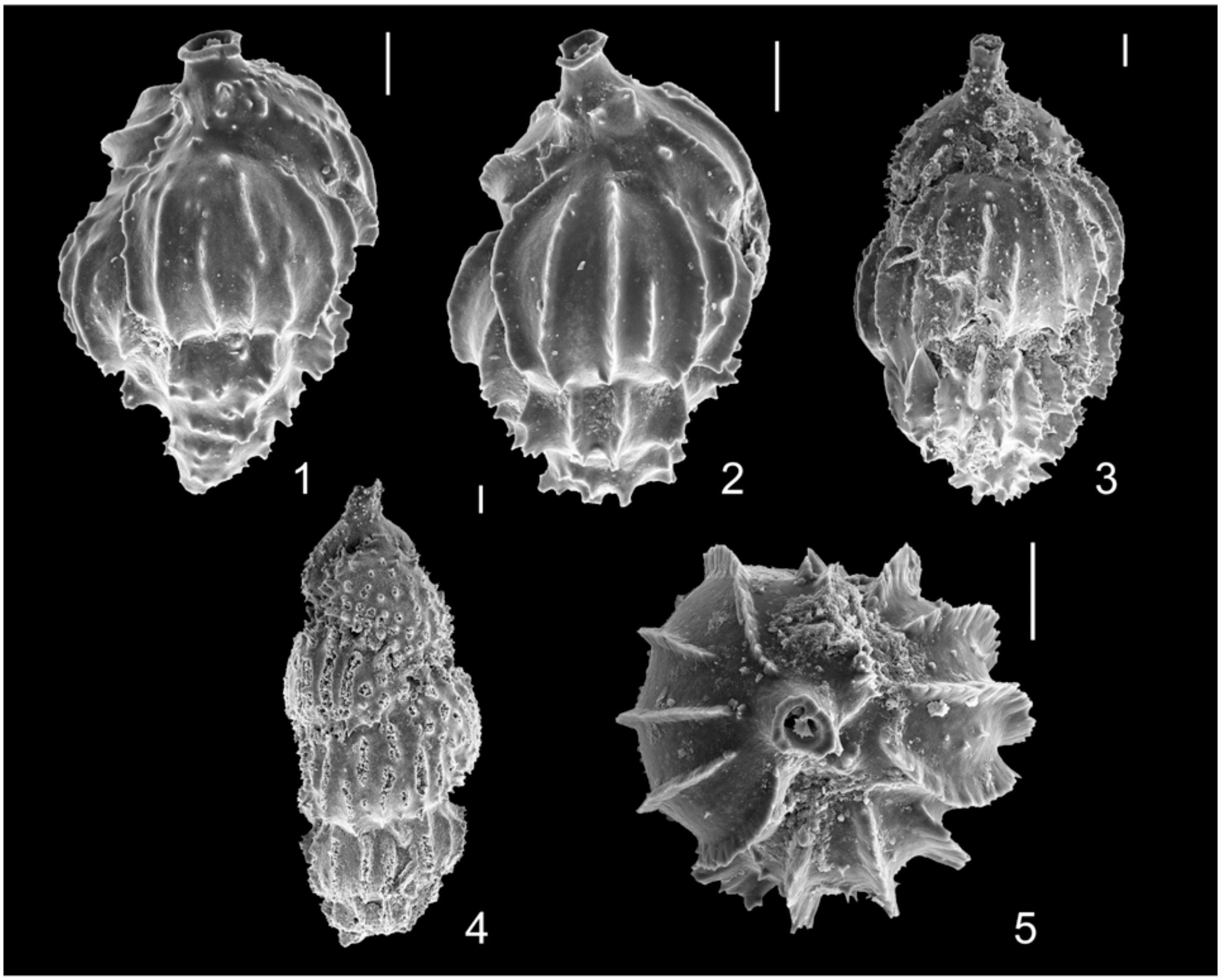

Plate 187

Scale bars = 50 µm

Vaginulinopsis subaculeata (Cushman)

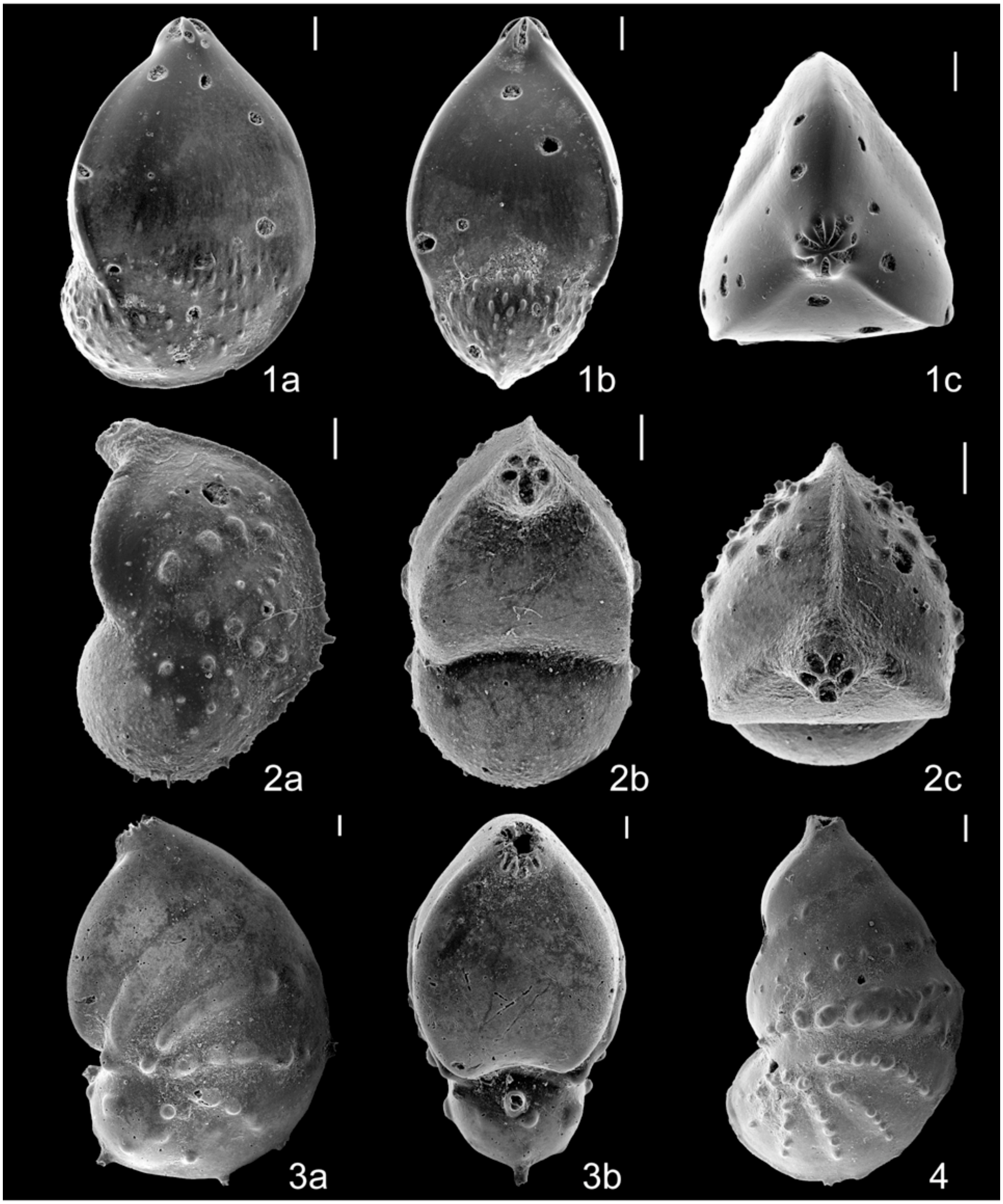

Plate 188

Scale bars = 50 μm

Valvulineria glabra Cushman

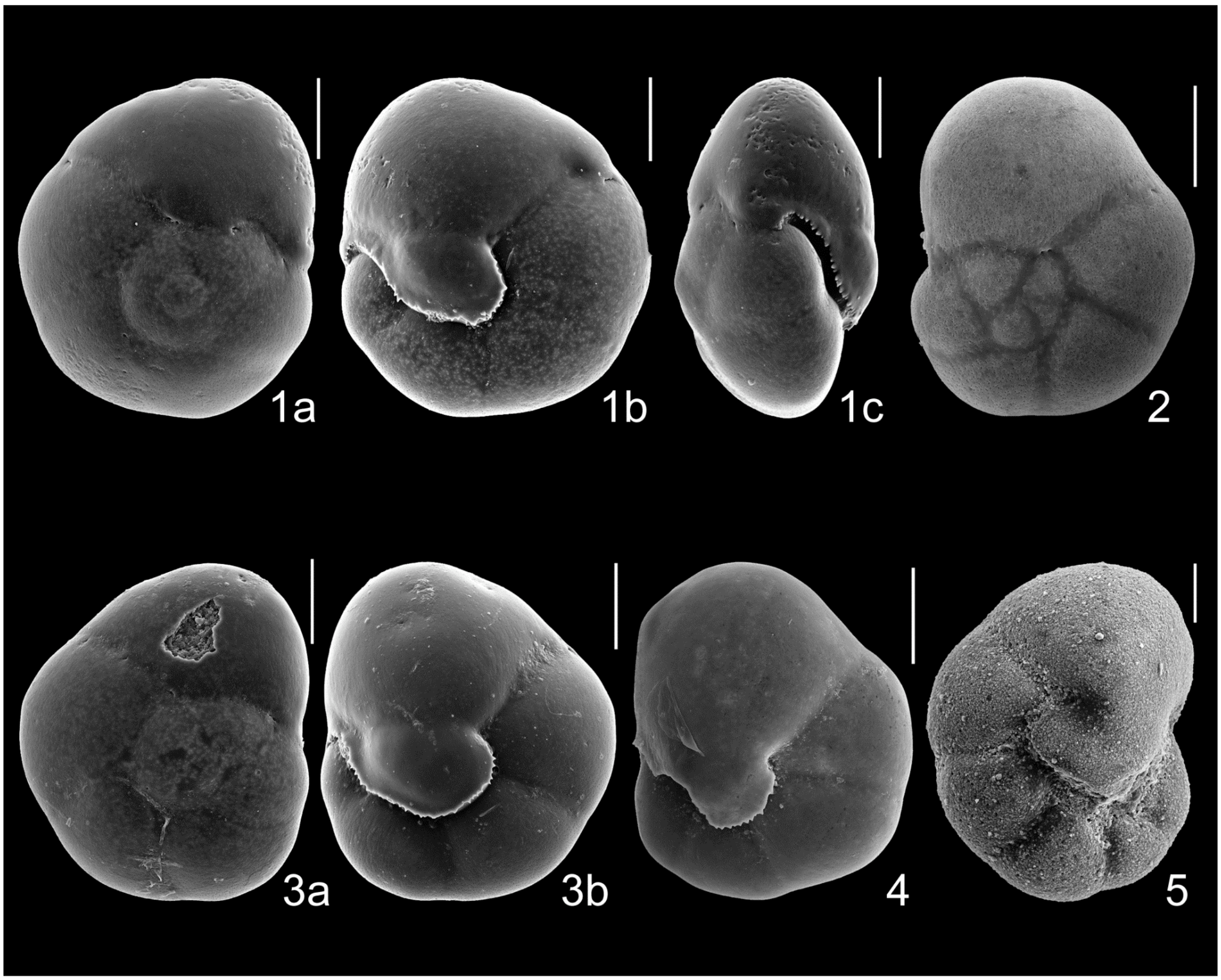

Plate 189

Scale bars = 50 μm

Valvulineria mexicana Parker

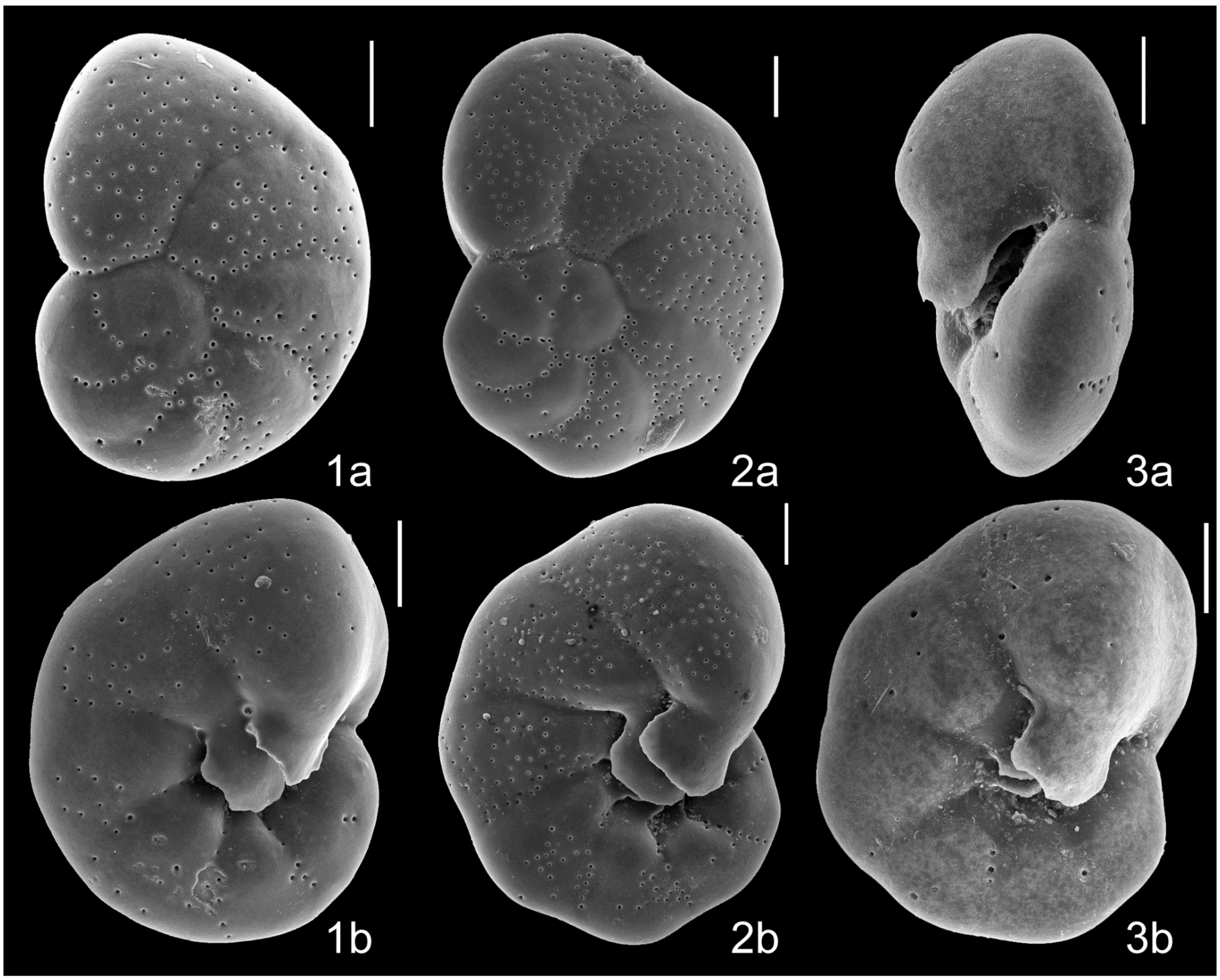

Plate 190

Scale bars = 50 μm

Vasiglobulina reticulata Poag

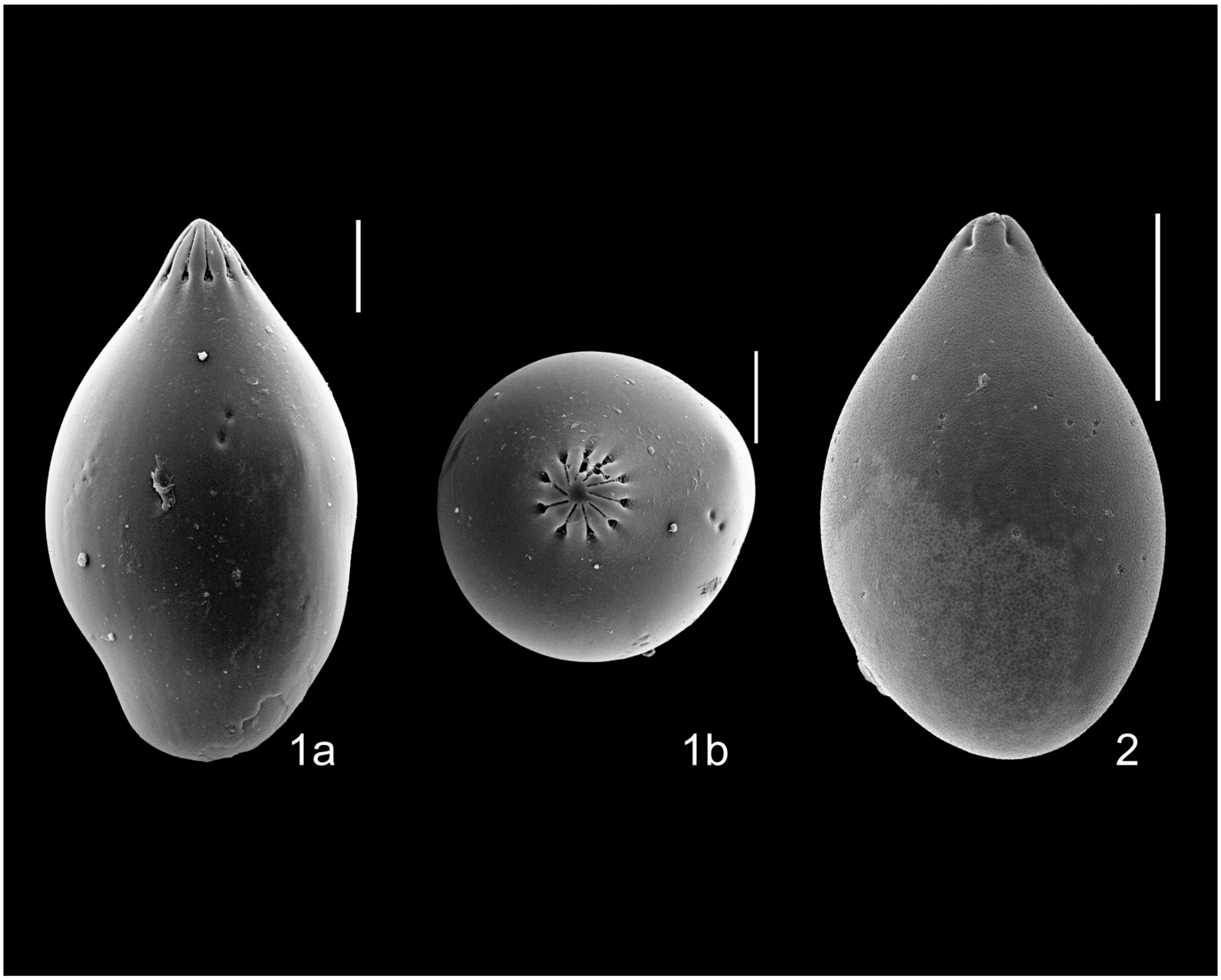

Plate 191

Scale bars = 50 µm

Veleroninoides jeffreysii (Williamson)

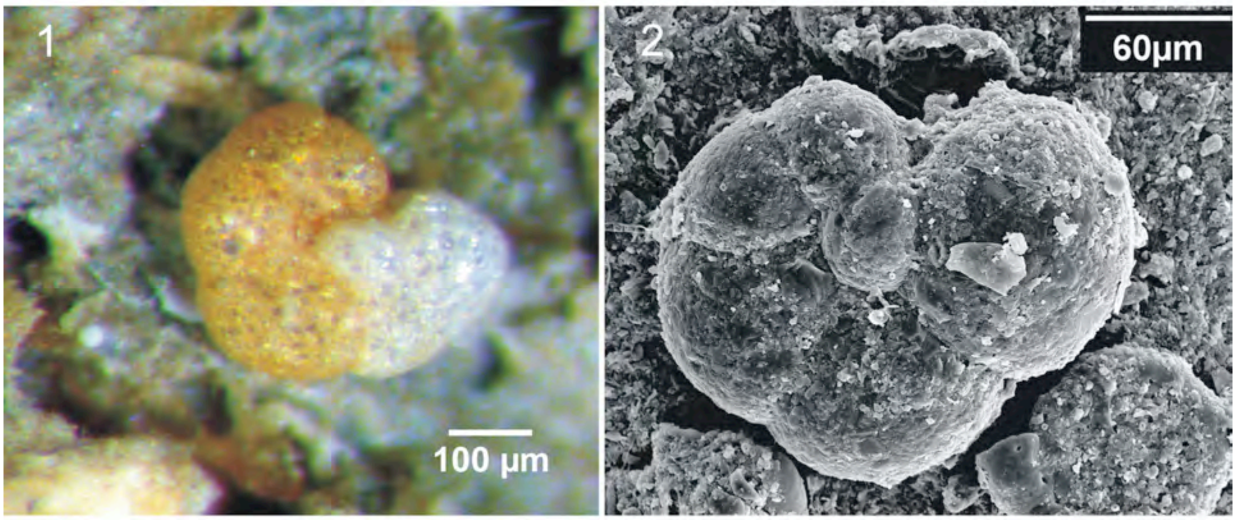

Plate 192

Veleroninoides wiesneri (Parr)

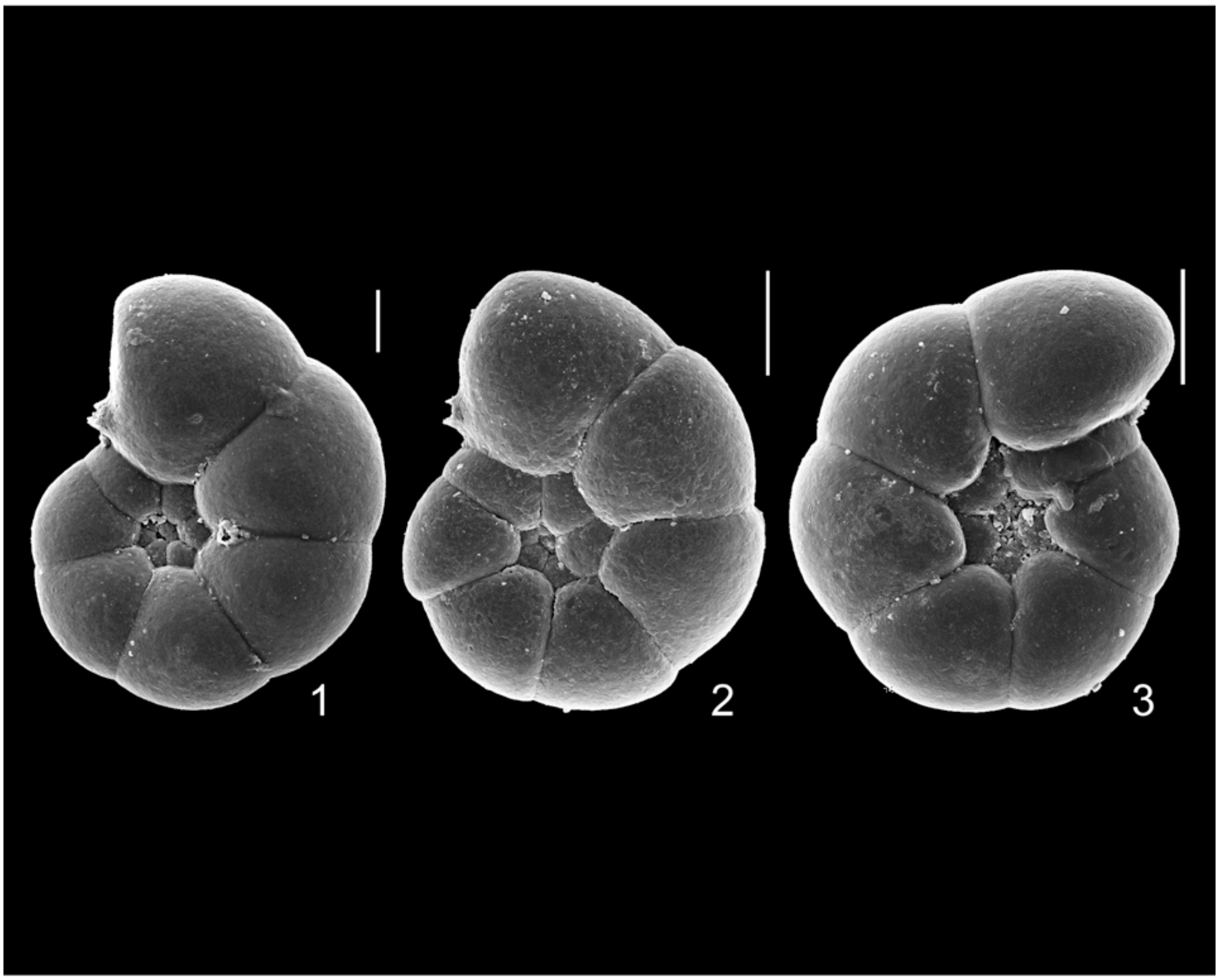

Plate 193

Scale bars = 50 µm

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.