gently depressed, horizontal. Wall very fine grained and highly polished. Aperture terminal, round, on a very slightly produced neck on the rounded upper chamber surface.

Remarks: The uncompressed uniserial stage is quite distinctive, and in contrast to Spirolina agglutinans d'Orbigny. Earland's species has uniserial chambers that are higher than the diameter of the coil, separated by sutures that are frequently oblique and alternating in orientation.

Superfamily HAPLOPHRAGMIACEA Eimer and Fickert, 1899

Family AMMOSPHAEROIDINIDAE Cushman, 1927

Subfamily AMMOSPHAEROIDININAE Cushman, 1927

Genus Adercotryma Loeblich and Tappan, 1952

Adercotryma glomerata (Brady)

Lituola glomerata BRADY, 1878, p. 433, pl. 20, fig. 1.

Haplophragmoides glomeratum (Brady). CUSHMAN, 1910a, p. 104, figs. 158-161.

Adercotryma glomeratum (Brady). BARKER, 1960, p. 70, pl. 34, figs. 15-18.---
LOEBLICH AND TAPPAN, 1953, p. 26, pl. 8, figs. 1-4.

Adercotryma glomerata (Brady). COLE, 1981, p. 29, pl. 4, fig. 8.---POAG, 1981, p. 35, pl. 15, fig. 2; pl. 16, fig. 2.---SCHRÖDER, 1986, p. 47, pl. 16, figs. 10,11.

Test streptospiral, thickness equal to diameter, one face more evolute with excavated center, and diameter of periphery greater here, periphery somewhat flattened, tapering toward opposite face of test, which is more involute and finely umbilicate; test quadrate conical in profile, equatorial outline circular. Chambers 4 in outer whorl, very much thicker than broad or high, inflated, increasing not too rapidly in size as added. Sutures distinct, depressed, straight. Wall quite coarsely agglutinated, fairly smoothly finished. Aperture interiomarginal, at ventral extremity of periphery, a fairly open low arch or slit running up to, and narrowing as it approaches, umbilicus.

Remarks: The shape of the test, with thickness equal to diameter, and extreme thickness of chambers as compared to other dimensions, is distinctive, along with

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**HOLOCENE BENTHIC FORAMINIFERA
FROM THE TROPICAL SOUTHWEST
PACIFIC OCEAN**

by

FREDERICK EUGENE CLARK, BSc. (Hons.), MSc.

**A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of
Doctor of Philosophy**

**Department of Earth Sciences
Carleton University
and the
Ottawa-Carleton Geoscience Centre
Ottawa, Ontario**

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**"HOLOCENE BENTHIC FORAMINIFERA
FROM THE TROPICAL SOUTHWEST
PACIFIC OCEAN"**

submitted by
FREDERICK EUGENE CLARK, BSc. (Hons.), MSc.

in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

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ABSTRACT

A suite of 62 samples, from the upper intervals of cores in the Scripps Institution of Oceanography collection, has been examined for its benthic foraminiferal faunas. The cores sampled ranged from 110 to 8900 m water depth, and are distributed across the tropical southwest Pacific Ocean, north and east of Australia. A total of 606 species were identified, and are systematically described herein. Of those species, 136 are not referable to species known to the present author. Many are new, but it remains to describe and name them in a refereed journal. Census data was obtained for each sample, and subjected to statistical analysis using a new Q-mode clustering algorithm that is based on fundamental statistical hypotheses. With the aid of this analysis, as well as a consideration of the faunas and their associated water masses, eleven benthic foraminiferal assemblages were identified. The assemblages characterized several water masses. Subtropical Lower Water (Upper Salinity Maximum), Antarctic Intermediate Water - Oxygen Maximum, and Antarctic Intermediate Water - Salinity Minimum were each represented by a single assemblage, this latter one on the Lord Howe Rise. The Deep Oxygen Minimum was represented by a pair of very dissimilar assemblages, one of them being a remarkably low diversity fauna apparently controlled by abundant clastic material of volcanic origin. A pair of assemblages with near coincident depth ranges spanned both the Deep Oxygen Minimum and Deep Water, without any apparent means to discriminate between the water masses. Antarctic Bottom Water (AABW), primarily below the lysocline but above the calcite compensation depth (CCD), was also represented by a pair of distinct assemblages with near coincident ranges. Very near the CCD, a Mixed Calcareous/Agglutinated Abyssal Assemblage characterized AABW, while below the CCD, the eleventh assemblage, the Abyssal Agglutinated Assemblage, was found, with only a few corroded calcareous specimens accompanying the agglutinated benthic faunas. Difficulties and limitations encountered in applying the clustering algorithm highlight the need for

improved and standardized sampling, processing, and analytical techniques for sound quantitative micropaleontological analysis.

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Dr. R.T. Patterson of Carleton University was particularly helpful in the final stages of the thesis, especially with respect to the statistical analysis. E. Fishbein of the Jet Propulsion Laboratory in Pasadena, California, kindly ran the data set using a cluster analysis algorithm that would otherwise have been unavailable, as it has not been commercially developed.

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CHAPTER 1. INTRODUCTION.

1.1. PURPOSE OF STUDY.

This study had at the outset three principal aims. The first of these was to produce an extensive systematic catalogue of Holocene benthic foraminiferal species from the tropical southwest Pacific Ocean. Most recently published studies in this and other areas have provided rather inadequate systematic treatments, frequently with limited synonymies, occasionally without proper descriptions, and almost never with any diagnosis to distinguish a given species from similar ones. The need for an up-to-date rigorous systematic treatment of the benthic foraminifera was increased by the publication of Loeblich and Tappan's (1987) revised classification of the foraminifera. The timing of the present study fortunately enabled incorporation of the results into this new taxonomic framework, rather than being put out of date in a matter of months.

The second principal objective of this study was the identification and characterization of benthic foraminiferal assemblages across a large area with a significant range of water depths, and presumably oceanographic parameters. A few relatively shallow samples were included in the hope that characteristic shallow species could be identified as an aid to the recognition of transported faunas.

The third objective, coupled to the second, was to relate the benthic foraminiferal assemblages to their associated water masses. One would like to be able to identify the values of parameters such as salinity, temperature, and dissolved constituents that control the distribution of any given benthic species or assemblage. Unfortunately, the core locations from which the foraminiferal samples were derived are not related in any systematic fashion to oceanographic data stations, and coincidence of the two is purely accidental. However, it should still be possible to establish a framework for the interpretation of older Tertiary material, particularly that already recovered during Deep Sea Drilling Project (DSDP) operations or anticipated from the Ocean Drilling Program (ODP), because the

principal water masses in the study area have been identified and characterized in previous papers.

1.2. PREVIOUS WORK.

One of the striking aspects of Holocene benthic foraminifera is that many species are cosmopolitan in nature. In addition, many extant species range through much of the Neogene. The result is that most papers on Holocene and even Neogene benthic foraminifera will have some relevance, even if only taxonomic, to this particular study, and could be construed as "previous work". This section will be restricted to some of the works foundational to the study of Holocene benthic foraminifera, as well some infrequently utilized references that were very useful in the course of this study.

Some of the important early studies of Neogene foraminifera, although dealing with fossil Tertiary forms rather than Holocene material, were important in identifying and describing many of the extant benthic species. Among the earliest of these were the works of d'Orbigny on the foraminifera in general (1826), then the foraminifera of Cuba (1839a), the Canary Islands (1839b), Central America (1839c), and the Vienna Basin (1846). Reuss published a number of significant studies on fossil foraminifera, primarily from Europe (1844, 1845, 1850, 1851a, 1851b, 1860, 1863, 1866, and 1867), and of more direct relevance to the present study was the work of Schwager (1866) on the fossil foraminifera from Car Nicobar in the archipelago between India and Indonesia.

The first major study of Recent deep-sea benthic foraminifera was that of Brady (1881, 1884) using samples collected during the Challenger Expedition. The next major monographic works were those produced by Cushman using materials collected principally by the "Albatross", dealing with the North Pacific Ocean (1910a, 1911, 1913a, 1914, 1915, and 1917a), the Atlantic Ocean (1922a, 1923, 1931, and others not cited herein), and the tropical Pacific Ocean (1932, 1933d, 1942, and

completed by Todd, 1965). The Discovery Reports (Heron-Allen and Earland, 1932; Earland, 1933, 1934, and 1936) describing the foraminifera recovered from the South Atlantic and Antarctic Oceans were another major contribution to the body of knowledge on Holocene benthic foraminifera. Buchner (1940) published a major study of the unilocular foraminifera from the Gulf of Nepal, while Parr (1950) reported on the foraminifera dredged from the area between Australia and Antarctica in the years 1929-1931, recording many new species, especially of unilocular foraminifera.

Barker (1960) attempted to update and stabilize the taxonomy of Brady's report, based on Brady's original figures but not his collections. Barker reproduced the original plates, with accompanying taxonomic notes for all figures. While Barker frequently discussed the distinction from other species not in Brady's material, they were discussed under their current generic assignment, and it was often impossible to track down the original reference. This was also the case for the species Brady did not erect himself.

A study by Belford (1966) on foraminifera from Papua and New Guinea was restricted to the Miocene and Pliocene sections, and omitted agglutinated, porcelaneous, and unilocular taxa. Nevertheless, it had many species in common with the present study, among them several not recorded elsewhere.

One of the most significant as well as controversial studies is that of McCulloch (1977) on the foraminifera from the Eastern Pacific, primarily those recovered by the Hancock Expeditions. There is a vast array of species described and illustrated, but McCulloch was a taxonomic "splitter", with seemingly the slightest difference from one specimen to another, or between her material and the types, being cause to erect a new species. Frequently there was insufficient diagnosis to allow subsequent workers to evaluate her decisions. Most current workers have avoided reference to McCulloch because of the daunting prospect of having to sort through the species and place the appropriate ones in synonymy. This author also

avoided McCulloch's work when possible, but it did yield many valid species, particularly of unilocular foraminifera, that could not be found in any other references. Many of her new species have thereby been substantiated, but it still remains for someone to work through her collections and published volumes to produce a series of taxonomic notes such as Barker did for Brady's work. McCulloch's work is too extensive to be simply ignored, but an inordinate effort must often be expended for the gains realized thereby.

The final major taxonomic work to be considered in this section is Patterson's (1986a) study of the benthic foraminifera from DSDP Site 357 on the Rio Grande Rise. It was particularly helpful because of its exhaustive treatment of the unilocular species.

Many of the species characterizing samples from relatively shallow water were identified with reference to the works by Collins (1958) on the Great Barrier Reef, Poag (1981) on the Gulf of Mexico, and Murray (1971) on British shelf seas in particular. These papers might not otherwise be thought of as particularly relevant to the present study.

One aspect of Cenozoic benthic foraminifera that has received a great deal of attention in the past twenty years is their ecology, particularly their relationship to water masses and their consequent usefulness as a paleoceanographic tool. The first major study in this regard was that of Phleger, Parker, and Peirson (1953) on the foraminifera, both benthic and planktonic, recovered from the North Atlantic Ocean by the Swedish Deep-Sea Expedition of 1947-48. Some twenty years passed before the appearance of Streeter's (1973) paper on the changes in North Atlantic benthic foraminifera over the last 150,000 years. Through the use of Q-mode factor analysis, Streeter identified assemblages which characterized water masses and could be used in core samples to track their shifts through time. This was an advance from the position of Phleger *et al.*, who believed that deep water conditions and the composition of the benthic faunas were uniform. Subsequently Schnitker

(1974) published a paper on the same area, also using Q-mode factor analysis and also incorporating the original data of Phleger *et al.* Perhaps one of the more significant contributions of these two more recent papers was the recognition that deep-sea benthic foraminifera were not controlled by bathymetry as such, but by water masses and their properties, which may be related indirectly to bathymetry.

Led by the example of these papers, many workers have subsequently published the results of similar studies for most of the world's oceans, aided in particular by the availability of core material from the DSDP. There has been very little work published on the present study area, the tropical southwest Pacific Ocean. The principal one is that of Burke (1981) on the benthic foraminifera of the Ontong Java Plateau, a submarine platform centered on the equator and 160° E Long. Three water masses and four benthic foraminiferal assemblages identified by Q-mode factor analysis were represented in a group of samples ranging from 1611 to 4332 m water depth. The paper by Woodruff and Douglas (1981), while concerned specifically with the Miocene section of DSDP Site 289 on the Ontong Java Plateau, has much useful and relevant information for the present study.

Corliss (1979) analyzed the benthic foraminiferal faunas of the southeast Indian Ocean, and in addition to distinguishing two water masses, Antarctic Bottom Water (AABW) and Indian Bottom Water (IBW), noted that two different foraminiferal assemblages characterized AABW, depending principally on the temperature of the water. Excellent summary papers on the relationship between deep-sea benthic foraminifera and bottom water masses for the world's oceans were provided by Schnitker (1980), and Douglas and Woodruff (1981). They provide a rather coarse or large-scale framework for the interpretation of foraminiferal data sets.

1.3. OCEANOGRAPHIC SETTING.

The area under study is characterized by two principal bottom water masses

which affect the deep basins (>3000 m water depth), and a number of subsurface water masses which influence the benthic foraminifera at lesser depths. The discussion of the principal sources of bottom water for the present study area depends on the paper by Mantyla and Reid (1983), while details of the water masses and their flow within the study area are found in the papers of Rockford (1960a, 1960b, 1960c) and Wyrski (1961, 1962).

The starting point for this discussion is Antarctic Bottom Water (AABW), a cold, dense, low salinity water mass which in its narrowest sense is restricted to the Atlantic-India Basin and the South Sandwich Trench (Mantyla and Reid, 1983). It is formed by the mixing of Circumpolar Water (CPW) with bottom waters from various Antarctic basins. Of the seven branches of bottom currents running northward, the one with the warmest, most saline, and least dense variety of AABW enters the Southwest Pacific Basin, a term used by Mantyla and Reid to embrace the entire study area and much beyond it. The temperature of the waters in this tongue is on the order of 0.3°C, and the salinity about 34.7‰. It is these relatively high values which enable this branch to pass into the Southwest Pacific Basin, which has no deep passages to connect it with the Antarctic basins and their very dense waters. The indirect path taken by these waters, and their mixing with less dense, warmer, and more saline waters, cause them to be least like typical AABW.

As this water mass moves northward, it mixes with overlying Lower Circumpolar Water (LCPW), which has a remnant North Atlantic Deep Water (NADW) component. This latter water mass is warmer, more saline, and has lower nutrient concentrations but higher oxygen content. It is seen clearly in a north-south profile as a salinity maximum and silica minimum sloping from the surface near 60° S Lat. to the sea floor at about 10° S Lat. (Mantyla and Reid, 1983). The resultant Deep Water is characterized by a salinity of 34.74‰, temperatures ranging from 1.4 to 1.9°C, and oxygen contents from 4.0 to 4.4 ml/l.

The deep basins of the present study area are considered by Wyrski (1961) to

be characterized by two principal bottom water masses which are modified not only by mixing with each other as well as shallower water masses, but also by the filtering action of sills between basins. Figure 1.1, adapted from Wyrski (1961, fig. 1), depicts the principal deep basins of the tropical southwest Pacific Ocean, those basins being delineated by the 3000 m isobath. This isobath is generally coincident with the upper limit of AABW.

The southernmost of these basins is the East Australian Basin, the bulk of which lies beyond the present study area, but which serves as the place of entry for the modified AABW from the south. Its average depth is about 4600 m, but there are local depressions greater than 5000 m. Within the basin, values of salinity and oxygen content below 2000 m are the highest for the region, with a weak salinity maximum of 34.73‰ marking the last trace of NADW. Below 3500 m salinities and temperatures are generally lower, representing AABW. The minimum temperature recorded was 0.79°C at 4400 m, and the bottom water has oxygen concentrations of 4.23 to 4.54 ml/l. The water within the East Australian Basin represents one of the source water masses for the tropical southwest Pacific Ocean. The narrow deep channel running north from this basin allows deep water to pass, via two sills, into the Coral Sea Basin. Rochford (1960c) placed the sill depth at around 3000 m, while Wyrski (1961) estimated 2850 m.

The Coral Sea Basin has depths of 4400 to 4800 m on the abyssal plain, and several passages to other basins, the most noteworthy being what is now known as the Pocklington Trough. This trough has depths exceeding 3800 m, and allows waters to pass into the Solomon Basin to the north. Salinities within the Coral Sea Basin range from 34.722 to 34.731‰, oxygen content is in the range of 4.21 to 4.36 ml/l, and the minimum potential temperature is 1.46°C at 4500 m. Deep water may also pass directly to the New Hebrides Basin to the east, but Wyrski (1961) could not substantiate this hypothesis.

The Solomon Basin is partially subdivided by a ridge running southwest to

Figure 11. Deep basins of the tropical southwest Pacific Ocean, as defined by the 3000 m isobath (after Wyrtki, 1961).

northeast. The northern sub-basin contains the Bougainville-New Britain trench with the Planet Deep at 9140 m, while the southerly sub-basin, with the Woodlark Basin at its western end, has depths on the order of 4600 m. The sills separating the Solomon Basin from the Central Pacific Basin are at a depth on the order of 3000 m, which means that Pacific Deep Water (PDW) makes little contribution to the Solomon Basin. Salinities range from 34.710 to 34.713‰, oxygen content from 3.43 to 3.73 ml/l, and the minimum potential temperature is 1.63°C, at 7750 m. Bottom water flows eastward from this basin via the South Solomon Trench to an area immediately north of the New Hebrides Basin.

It is at this point that the low salinity (34.690‰), low oxygen (3.44 ml/l) bottom water of the Central Pacific Basin becomes relevant to the discussion. This water, which ascends from the Pacific abyss, is a derivative of AABW (Wyrski, 1961, 1962), but presumably has not been influenced by the remnant NADW in the LCPW. It is mixed with the relatively high salinity waters exiting the Solomon Basin and possibly the Coral Sea Basin as well. These waters have had their salinity reduced and temperature increased not only by mixing with overlying waters, but also by the filtering effect of sills, which trap the deepest, most dense waters within a basin, while allowing less dense water from shallower depths to pass to adjacent basins.

The New Hebrides Basin is a northwest-southeast trending basin with its greatest depths at about 7660 m in the southeast part. Its connection with the Central Pacific Basin is via a sill on the order of 3300 m at its deepest point, and its water is produced by the mixing of high and low salinity waters, producing intermediate salinities of 34.695 to 34.700‰, with low to intermediate values of oxygen content (3.52 to 3.69 ml/l), and a minimum potential temperature of 1.48°C at 4400 m. This basin has two major outlets, one via a sill at about 3000 m into the New Caledonia Trough or Basin, the other via a sill at 3400 m into the Fiji Basin.

The New Caledonia Trough lies between the Lord Howe Rise and Norfolk Ridge, and has a maximum depth of 4005 m. It shallows appreciably southward, to

2300 m in the center. Intermediate salinities in the range 34.694 to 34.701‰ and oxygen values from 3.57 to 3.69 ml/l prevail, while a relatively high minimum potential temperature of 1.63°C is recorded at 3450 m.

The Fiji Basin receives bottom water from the New Hebrides Basin, as well as the Central Pacific Basin, this latter over a ridge running southwest from the Fiji Islands with a sill depth of 3000 m. This latter contribution is presumably very significant, as the bottom water of the Fiji Basin is very like that of the Central Pacific Basin with respect to salinity, with values ranging from 34.690 to 34.691‰. Its maximum depth exceeds 5900 m, while the recorded temperature minimum is 1.52°C at only 4000 m water depth. Oxygen content ranges from 3.52 to 3.66 ml/l.

Rochford (1960a, 1960b, 1960c) and Wyrski (1962) described the water masses of the southwest Pacific Ocean, particularly the shallow and intermediate depth waters. In general, a strong stratification of the water masses into quasi-horizontal layers was observed, with reasonably distinct depth limits to those masses. It is these intermediate or subsurface water masses which will influence the distribution of benthic foraminifera outside the deep basins, at water depths less than 3000 m.

Wyrski (1962) formalized a number of core layers, each of which defines the center of a water mass where its properties are most strongly pronounced. Away from these core layers, the water masses begin to show the effects of mixing with other water masses. In certain cases Wyrski identified more than one core layer belonging to a single water mass. None of the water masses described originated within the study area.

i. Subtropical Lower Water (Upper Salinity Maximum).

The core layer of this water mass is characterized by a range of salinities from 35.50 to 35.95‰. The extreme values above 35.90‰ are found in elongate east-west tongues centered on 15° S Lat. and 30° S Lat., whose values decrease slightly toward the west, indicating flow in that direction. Oxygen content decreases northward from values of 4.8 ml/l and higher in the south to values as low as 3.0 ml/l in the

north, but the change is not uniformly distributed. Rather, there is an extremely sharp gradient from 4.4 down to 4.0 ml/l across a narrow zone running from 20° S Lat. at the eastern limit of the study area to 15° S Lat. at the western extremity. This separates Subtropical Lower Water into a northern, oxygen-poor and a southern, oxygen-rich component. The northern component, bounded above and below by the 35.00‰ surfaces, extends from 125 to 250 m depth, and is characterized by a temperature range of 21 to 24°C. The southern one extends from the surface down to 125 m, and has a temperature range of 18 to 25°C. The surface exposure of the southern component enables its high oxygen content to be maintained, while the northern component undergoes consumption of oxygen as it sinks.

ii. Upper Oxygen Minimum.

This water mass, which lies between 150 and 500 m water depth, is produced locally by the activity of oxygen-reducing processes below the euphotic zone. It is formed below the surface and should not be treated as the mixing product of Subtropical Lower Water and Antarctic Intermediate Water, although its temperature-salinity (T-S) relationships could be explained that way. Values of oxygen content for the core layer range from over 4.2 ml/l in the south to under 3.2 ml/l in the north, again with a strong gradient as for Subtropical Lower Water. Temperatures range from 12 to 24°C, and salinity ranges from 34.9 to 35.9‰.

iii. Antarctic Intermediate Water - Oxygen Maximum.

Rochford (1960c) noted that oxygen content increased with depth to a maximum just above a salinity minimum layer. This oxygen maximum occurs some 50 to 200 m above the salinity minimum associated with Antarctic Intermediate Water (Wyrski, 1962). Its core layer lies somewhere between 400 m in the north and 1000 m in the south. Its highest values, 4.8 ml/l and more, occur between Fiji and New Zealand, and coincide with the lowest values of the salinity minimum. This water mass enters from the east in this area, and its effect spreads west and

northwestward, its lowest value being 3.5 ml/l, north of Papua. Salinities range from 34.4 to 34.8‰, and temperatures from 5.4 to 9.5°C. This oxygen maximum and the underlying salinity minimum represent a single water mass. An oxygen maximum that occurs at higher temperatures and levels than the one associated with Antarctic Intermediate Water lies just to the south of the present study area. It represents Subantarctic Intermediate Water, and is not considered further herein.

iv. Antarctic Intermediate Water - Salinity Minimum.

This water mass enters not only from the east between Fiji and New Zealand, but also from the south. However, this latter component is not discernible within the study area. The area between 20 and 30° S Lat., and extending as far west as 170° E Long., has salinities of 34.40‰ or lower in the core layer, but beyond this, values soon exceed 34.45‰, reaching a maximum of 34.53‰ in the extreme northwest. The oxygen content of this water mass is fairly high, the result of its formation at the surface near the Antarctic Polar Front. The oxygen values in the eastern area of the salinity minimum reach 4.7 ml/l, but north of 15° S Lat. fall below 4.0, reaching a low of 3.0 ml/l or less north of New Britain (Rochford, 1960a; Wyrski, 1962). The depth of the core layer ranges from just over 1000 m in the south to just under 700 m (Rochford, 1960c, gave this latter limit as 800 m) in the north and in isolated pockets. Temperatures range from 4.2 to 6.0°C (Wyrski, 1962), the salinity minimum being most closely associated with the 5.0°C isotherm (Rochford, 1960c).

Between the salinity minimum or base of Antarctic Intermediate Water and the underlying Deep Oxygen Minimum is a phosphate maximum (Rochford, 1960c). It is found in the range of 1500 to 2000 m water depth in its strongest development in the Coral Sea, and decreases in phosphate and salinity as it passes southward due to mixing with the overlying water.

v. Deep Oxygen Minimum.

Low oxygen content characterizes the entire layer between approximately 1200 and 2500 m water depth, with a minimum at its center. Values increase from a low

of 2.8 ml/l near New Britain in the north, to a high of 3.5 ml/l in the south of the study area. While its T-S characteristics may be derived by mixing Antarctic Intermediate Water and Deep Water, both those masses have higher oxygen contents. Wyrski (1962) consequently believed that this oxygen minimum had to be formed by some oxygen-consuming process, and that its real center lies to the east in the central Pacific Ocean. The depth of the minimum itself is greater than 2000 m between Fiji and New Zealand, rising to 1600 m in much of the northwest of the study area. Temperatures range from 1.9 to 3.9°C, and salinities from 34.58 to 34.65‰.

vi. Deep Water and Bottom Water.

These water masses, representing the remnant NADW and AABW sources respectively, have already been discussed in regard to the deep basins.

CHAPTER 2. MATERIALS AND METHODS.

2.1 SOURCE AND PROCESSING OF SAMPLES.

All materials examined in this study came from the core collection of Scripps Institution of Oceanography (SIO), located in La Jolla, California and affiliated with the University of California, San Diego. From this collection, K. Hooper retrieved samples from the higher intervals of 166 cores. The cores were all from locations within the tropical southwest Pacific Ocean, in an area ranging from 0° to 30° S Latitude, and from 145° to 180° E Longitude. From this smaller collection, the present author selected a suite of 62 samples which ranged from 110 to 8900 m water depth, and were distributed within the study area as evenly as possible.

The cores from which the samples were taken were recovered in the course of several SIO cruises over a number of years. Details of those cruises are given in Table 2.1. The Cruise I.D. is the prefix given to all samples recovered during a particular expedition. The samples used in the present study are listed in Appendix I, with their latitude and longitude, water depth, interval within the core (the top being 0 cm), weight of sediment processed, and a brief note on the lithology. Occasionally, processing the entire sample yielded too few specimens for satisfactory statistical analysis. In these cases additional sample material was requested from SIO, who were able to furnish it for 12 cores. Because the new samples were not necessarily taken from the same place in the core, they have been treated separately from the original samples to avoid artificially combining two assemblages which may have been distinct. All sample material, whether stored originally at room temperature or refrigerated, was available to this author dry, in sealed plastic bags.

The samples were processed in the following manner. The weight of sample thought likely to yield 200 to 300 specimens of benthic foraminifera was chosen, and immersed in water for approximately one hour. Because the samples were not cemented or consolidated, they disaggregated readily, and the resultant slurry was

Cruise I.D.	Research Vessel	Cruise Dates	Expedition Name
DODO	Argo	May 1964 to Dec. 1964	DODO
ERDC	T. Washington	Sept. 1974 to May 1975	Eurydice
LSDH	Horizon	May 1962 to Aug. 1963	Lusiad
MSN	Argo	Aug. 1960 to Apr. 1961	Monsoon
NOVA-A	Argo	Apr. 1967 to Nov. 1967	NOVA
NOVA-H	Horizon	May 1967 to Aug. 1967	NOVA
NOVA-HV	Horizon	Aug. 1967 to Sept. 1967	NOVA, Leg V
PROA	Baird	Apr. 1962 to Aug. 1962	PROA
REC	C.S. Recorder	Jul. 1961 to Aug. 1961	Recorder

Table 2.1. Cruise information for samples used in present study.

washed through a pair of sieves, the upper one having a mesh opening of 125 μm , and the lower one 63 μm . These sieve sizes were selected for two reasons.

It is difficult to see small and/or juvenile benthic specimens on the order of 70 μm on a picking tray loaded with large specimens in the 150 to 200 μm size range, particularly when these larger foraminifera are predominantly planktonic. Not only do the larger specimens hide the smaller ones, but the eye has difficulty seeing everything when there is such a size range. As all benthic specimens were to be picked for statistical analysis, this method of splitting the sample into two size fractions led to more thorough picking in less time.

The second reason relates to a matter which has been the subject of some controversy. Quantitative foraminiferal studies have varied significantly in their choice of the minimum size range to be studied. Phleger *et al* (1953) used the size fraction $>149 \mu\text{m}$ in their study of North Atlantic benthic foraminifera, as did Streeter (1973), who selected this size to enable direct comparison with the results of Phleger *et al*. Schnitker's (1974) study utilized the $>125 \mu\text{m}$ size fraction, which would produce closely comparable results. Many subsequent workers, such as Corliss (1979), Mead (1985), and Belanger and Berggren (1986), have continued to select the $>150 \mu\text{m}$ fraction, and although their results are thereby directly comparable to the pioneering studies, it is also acknowledged by these authors that the choice is somewhat arbitrary, and is really controlled by the initial selection made by Phleger *et al*. Burke (1981) and Sejrup *et al* (1981) examined the $>125 \mu\text{m}$ fraction, while Lagoe (1977), Ingle *et al* (1980), Hermelin and Scott (1985), and Thomas (1985) used as their lower size limit something from 61 to 63 μm , depending on the author.

It was the belief of the present author that although adequate large-scale characterization of climatic and oceanographic regimes may be possible with the coarse fraction alone, there was much additional information in the smaller size fraction that could ultimately lead to much finer resolution of environments using benthic foraminifera. Certainly the paper of Corliss (1979) brings the point into

focus, for in 64 samples, only 33 different benthic species were recovered in the $>150\ \mu\text{m}$ fraction, a remarkably low number in view of the results obtained by workers using a much finer lower size limit, such as Hermelin and Scott (1985, 117 species in 11 samples) and Patterson (1986a, 277 species in 50 samples).

One of the objectives of the present study had been to document the differences in fractional abundances between the coarse fraction alone and the combined coarse and fine fractions. Subsequent to the processing and picking of the samples for the present study, Schröder *et al* (1987) published an excellent analysis of this situation. They demonstrated that many numerically important species in deep sea benthic assemblages may be completely absent from the $>125\ \mu\text{m}$ fraction, but dominant in the $>63\ \mu\text{m}$ fraction. As well, certain species which have been regarded as significant or indicator species in previous papers, such as Hoeglundina elegans or Cibicides (Fontbotia in the present paper) wuellerstorfi, turn out to comprise but a few percent of the total benthic fauna when the finer fraction is taken into account. There was therefore no point to going through the same exercise in any detail in the present study, but this author does confirm their observations in a qualitative sense. For example, the species reported herein as Globocassidulina sp. A is represented by 131 specimens from 22 samples. In many of these it comprises 3 or 4 percent of the total benthic fauna, and in one case as much as 6 percent, yet only a single specimen was recovered in the $>125\ \mu\text{m}$ fraction. It is the practice and recommendation of this author that all specimens $>63\ \mu\text{m}$ be picked and counted.

Once the two size fractions were dried, all benthic foraminifera were picked from each and mounted on separate slides. In those cases where the sample aliquot produced far too many specimens, a sediment microsplitter was used to produce a more manageable fraction.

2.2. CENSUS DATA.

Because one of the objectives of the study was to do quantitative analysis of

the benthic foraminiferal faunas, some consideration was given to the optimum number of foraminifera to pick. Tschudy (1969), in discussing palynological studies, believed that 200 specimens was the ideal. By this point, the curve of number of species detected versus number of specimens picked flattens off. After that, the number of additional specimens that needs to be counted to detect additional species is very large, such that the labour expended apparently outstrips the information gained.

A major exercise in assessing picking and counting methods for all major microfossil groups was the subject of Utrecht Micropaleontological Bulletin 17. The section under investigation was the Lower Pliocene of Capo Rossello, Italy, and the benthic foraminifera were the responsibility of Brolsma (1978). That author picked 200 individuals from the $>125\ \mu\text{m}$ fraction, and an additional 100 specimens from the $>63\ \mu\text{m}$ fraction in case information was missed. For the single sample, five splits were picked, with the coarse fraction yielding a total of 55 species, with a maximum of 41 in the third split. Analysis of the results indicated similarity coefficient values of 70 to 81%, and the "Chi-square" test did not lead to the rejection of the hypothesis that the data fit the binomial distribution model. In other words, the splits (or statistical samples) could be considered fair representatives of the single rock sample (or statistical population), even though percent abundances of the four most common species could differ between splits by factors of two or three.

Brolsma noted that although the two size fractions within a sample differ strongly with respect to their assemblages, depth estimates produced using either or both of them were consistent within a given study. However, he cautioned that attempts to compare reference faunas with a fauna under study could be strongly influenced by the size fractions used. This was certainly the reasoning followed by Corliss, Mead, and Belanger and Berggren in their choice of $150\ \mu\text{m}$ as the lower size limit.

The present author proceeded on the assumption that the effort expended in picking significantly more than 200 specimens would far outweigh the significance of any information to be obtained thereby. It turned out that this is not completely the case.

A recent paper by Patterson and Fishbein (1989) is a major contribution to the understanding of the statistical significance of data. For any species, given the percent abundance of that species and the total number of specimens in the sample, the 95 percent confidence error boundaries can be calculated. The authors presented the results of this calculation graphically, with the result that the statistical significance of the presence of any individual species may be readily assessed.

Reference to their figure 1 shows that for a sample of some 200 counts, a species must be present at an abundance of 2 percent or more before it even exceeds the associated abundance error. In this sense, those rare species not encountered until the "200 + nth" specimen has been picked are seen to be no more than "noise" whose presence or absence may merely be a random effect to be expected within the bounds of statistical variance. Certainly they could not reliably be used to characterize a sample.

However, it is certainly not true that little additional information is gained by picking many specimens beyond 200. The same species, present at 3 percent in a sample of 200 specimens with an associated error of almost 2 1/2 percent, has an error of well under 1 1/2 percent if 600 specimens are picked. That is, the ability of statistical methods to resolve differences between samples and environments based on the less abundant species increases substantially as the number of specimens counted increases. Unfortunately their paper was published far too late in the course of the present study to address in the data gathering process. While the paper of Patterson and Fishbein does not render invalid any study not based on a large number of counts per sample (on the order of 600), it does place constraints on what can reliably be derived from a data set in which the bulk of the samples are

represented by somewhere between 200 and 300 specimens.

The census data or raw counts are given in Appendix II, which is a file on the computer diskette found in the pocket at the back of the thesis. It is named BENTHRAW.WK1, and is a Lotus 1-2-3 file for MS-DOS/IBM compatible computers. The samples are listed alphabetically by cruise name and numerically within cruises, while the species are listed alphabetically, by genus and by species within genus. Both sample names and species names are abbreviated, but are readily deciphered with reference to Appendix I for the samples and the Specific Index for the species.

2.3. STATISTICAL TECHNIQUES.

The foraminiferal census data was subjected to cluster analysis using a new clustering algorithm (Fishbein and Patterson, in prep.). A detailed description of the technique lies beyond the scope of the present paper and the expertise of its author. Nevertheless, a discussion of its merits relative to other methods of statistical analysis is warranted, as well as a description of what it does with the data. It is called the EWML algorithm, the name meaning "error-weighted maximum likelihood".

A sample with K number of species is located in K -dimensional space where each axis measures the fractional abundance of one of the species. The fractional abundances of the component species in any sample will almost certainly differ from those of any other. However, within a single environment two or more samples are expected to plot close to each other in "abundance space". A given environment will have a volume centered on a point of average species fractional abundance known as the centroid.

The aim of the analysis is to divide the samples into clusters or sets such that the members of those clusters are most alike, and the clusters each represent a single environment or biofacies. The optimal solution is regarded either as one in which the dissimilarity between clusters is maximized, or as one in which the dissimilarity

within clusters is minimized. Different statistical methods are required for these two approaches to the problem.

The first approach involves what are known as linkages, which are a measure of dissimilarity between clusters. They are used in clustering algorithms which merge pairs of similar clusters to form new ones. With "single linkage", dissimilarity is equal to the distance between the two closest points not in the same cluster. The opposite extreme, the distance between the two farthest points, forms the basis for "complete linkage". In both cases the dissimilarity measure is limited by the fact it depends on a single set of extreme points. This limitation has been circumvented by methods employing "average linkage", which is the average of all the distances between points in different clusters, and "centroid linkage", which is the distance between the centroids of the clusters being compared. Average and complete linkages, because they take into account the most widely separated points between the clusters, tend to separate clusters which may otherwise have close centroids. Single linkage tends to form long, ill-defined clusters, while centroid linkage may produce new clusters with centroids distant from any of the points. Quite apart from these limitations, these "linkage" techniques are not favoured because they operate on the hypothesis that samples from different environments or biofacies differ, that is, clusters are characterized by maximum dissimilarity to each other. Fishbein and Patterson (in prep.) prefer the more reasonable hypothesis that samples from the same environment are similar, that is, have minimum dissimilarity within environments.

Most techniques operating on this basis involve some measure of the average distance from the points in a cluster to the centroid, as an estimate of dissimilarity. The optimal solution would be that which minimizes the total within-cluster dissimilarity, but to do so requires the comparison of all possible arrangements. This is too computationally intensive for groups of more than 15 or so samples.

Most clustering algorithms are "joining" or "hierarchical" in nature. Initially

there are as many clusters as samples, but successive iterations reduce the total number of clusters by merging the pair which will have the least within-cluster dissimilarity. The dissimilarity associated with joining clusters belonging to the same environment will presumably be less than that associated with clustering across environmental boundaries. The K-means algorithm, which is a common sorting method, places each sample in the cluster that will produce the greatest decrease in within-cluster dissimilarity. Centroids are recalculated after each iteration, and the process ends when no samples can be moved or else the reduction in dissimilarity falls below some threshold value.

In addition to various clustering techniques, mention should be made here of factor or principal component analysis. In essence, this technique involves the mathematical extraction of a relatively small number of factors from a data set which explains as large a proportion of the data and its variance as possible. The factors are characterized by those species which have a high "loading" for that factor, and samples are grouped according to their relationship to factors as measured by their "factor score". Burke's (1981) paper on the benthic foraminifera from the Ontong Java Plateau is an example of this. The technique is a means of reducing a multivariate data set to something more easily managed, and may be used to determine the statistically important species within environments.

All of the methods described so far are flawed because they are not based on a statistical hypothesis, and fail to take account of the uncertainty associated with each species's fractional abundance. Fishbein and Patterson (in prep.) have developed a hierarchical Q-mode (samples compared to samples) clustering algorithm which deals with this uncertainty, determined in the manner described by Patterson and Fishbein (1989).

The starting point for the new clustering algorithm is the fact that each sample is represented in K-dimensional space, not by a discrete point, but by a volume known as the uncertainty volume, whose axes are defined by the uncertainty

for each species, and whose centroid is that point. The probability of collecting a sample depends on its distance from the centroid of the environment and its volume in abundance space. An environment is characterized by a standard ellipsoid whose axes's lengths are determined by the standard deviation of each of its K species, and it turns out that the probability for each sample being collected from a particular environment is the ratio of the uncertainty volume for that sample divided by the volume of the standard ellipsoid for the environment, multiplied by a weighting function dependent on the distance to the centroid determined by an appropriate statistical measure.

Frequently the uncertainty associated with rare species will exceed their departure from the environmental centroid, and the sample's principal coordinates uncertainties will be greater than the length of the related axes in the standard ellipsoid. Such axes are termed "unresolved axes", and in these instances the decrease in probability which results from the displacement of the sample from the environmental centroid is lost in or overwhelmed by the uncertainty of the fractional abundances for the sample.

In addition, when the number of samples, M , from an environment is less than the number of species, then there are $K+1-M$ axes that are "undetermined". There is insufficient information in the data set to estimate them, and their length is assumed to be equal to zero as a default to enable computation. The algorithm is very sensitive to this default (Fishbein, pers. comm.), and there is a great deal of uncertainty associated with undetermined axes.

The clustering algorithm is applied to the point that all samples are placed within a single cluster, which in most cases will be a clearly unreasonable solution to the problem. A plot is then made of the natural logarithm of the probability calculated for a particular clustering versus the number of clusters at that point in the analysis. Probability at the beginning should be 1, because each sample will be coincident with itself in abundance space, but probability decreases with each

clustering event. Ideally the probability decreases steadily but not too rapidly for much of the process, assuming that the clusters being formed thereby still represent individual environments or biofacies. Once clusters are formed by the joining of separate biofacies, the associated abundance volume should increase substantially, and probability decreases much more rapidly at this point. Depending on how well behaved the data set is and how well it represents separate environments, this rapid increase in the rate of decrease of probability will be readily detected, and will lie within a zone of a few clustering events. The composition of the clusters produced in the vicinity of the change can then be examined to determine the most biologically or palaeontologically reasonable solution, taking into account other kinds of information such as sediment type or oceanographic parameters.

CHAPTER 3. SYSTEMATICS.

3.1. INTRODUCTION.

The classification used for the species identified in the course of this study is that outlined by Loeblich and Tappan (1987) in Foraminiferal Genera and Their Classification. This supercedes their previous volume on the foraminifera within the Treatise on Invertebrate Paleontology series (Loeblich and Tappan, 1964). For a number of reasons, it represents a major adjustment for the worker, such as the present author, accustomed to dealing with the earlier volume.

There are of course many new genera which have been described in the intervening 23 years, and several of them have as their type previously described and often quite familiar species. For example, the genus Ioanella Saidova has Truncatulina tumidula Brady as its type species. However, that common deep-sea benthic species had been assigned for decades to the genus Eponides de Montfort. It can be difficult to get all such species assigned to their new or proper genus, when the genus is not well known and the old one is firmly associated with the species in most workers's minds. Fortunately, Loeblich and Tappan (1987) have included within the systematic index all species referred to within their volume, whether type species or otherwise. This index enabled the present author to correctly assign several species when there would otherwise have been no means other than chance to identify the changes that have occurred. Every named species in the present study has been checked against the systematic index in Loeblich and Tappan (1987), and all assignments made in accordance with their work.

Many genera from the Treatise with which most workers were familiar and comfortable have subsequently been split into several genera. In most cases the original genus stands, but with a reduced scope. This process has either been in the form of the erection of new genera (the unilocular foraminifera being an excellent example), or else the renewed recognition of the validity of genera that had been included in synonymy with others in the Treatise (for example, Angulogerina

Cushman is no longer placed in synonymy with Trifarina Cushman).

The suprageneric classification is also significantly different at the levels of Suborder and Superfamily in particular. The incorporation of many previously described and well known benthic foraminiferal species into the revised classification is one of the present paper's important contributions. There are also a few recently described genera not included in Loeblich and Tappan's 1987 work, but these have been successfully incorporated in the suprageneric classification, based either on information accompanying the type description, or else on a consideration of the characteristics of the higher ranks of the classification.

The systematic treatment of each species usually involves three parts. The first is the synonymy, which for previously described species has at least the type reference. The Catalogue of Foraminifera (Ellis and Messina, 1940 *et seq*) is indispensable in this regard, because it reproduces the type descriptions and figures for all species, many of which would not otherwise be available due to the age or obscurity of the reference. In addition, the synonymy includes most if not all references encountered by this author for that particular form. Within the synonymies, species entries or individual author entries preceded by a question mark indicate that the present author has reservations about placing them in synonymy. In contrast, doubt or uncertainty on the part of the original author is normally indicated by a question mark following the entry.

The second part is the description proper, which is a full description of the species based almost exclusively on those features discernible with a binocular reflected light microscope at magnifications up to X125. The descriptions generally begin with the chamber arrangement and test shape, followed by the chambers, sutures, wall, and aperture. Occasionally features not preserved in any of the specimens have been included in the description, but these are based on other references to the species and are noted as such.

The third and final part is the "Remarks" section. Although any pertinent or

useful comments not strictly part of the description may be included here, usually this section is given over to a summary of the characteristic features of the species and how it may be distinguished from other species. In this author's opinion, the major weakness of most taxonomic studies is the failure to discuss the reasons why the specimens have been referred to a particular species rather than some other similar one. The present paper is unconventional in one respect, namely that when species not otherwise described in the paper are referred to, the genus under which they were described is given rather than the current one to which they are assigned. This enables the reader to find the type description and figures of those species in the Catalogue, in order to open up the present work to proper evaluation and critical scrutiny. Dimensions of specimens are not given within the text, and only illustrated specimens will have their size noted, by means of magnification factors in the plate captions. This is in accord with the current practice of the Journal of Paleontology.

The illustrated specimens are deposited in the collection of the Geological Survey of Canada, in Ottawa, while all other material is in the collection of the Department of Earth Sciences at Carleton University.

3.2. SYSTEMATICS.

Order	FORAMINIFERIDA Eichwald, 1830
Suborder	ALLOGROMIINA Loeblich and Tappan, 1961
Family	ALLOGROMIIDAE Rhumbler, 1904
Subfamily	ARGILLOTUBINAE Avnimelech, 1952
Genus	<u>Nodellum</u> Rhumbler, 1913

Nodellum membranaceum (Brady)
(Plate 10, Figure 8)

Reophax membranacea BRADY, 1879, p. 53, pl. 4, fig. 9.

Reophax membranaceus Brady. CUSHMAN, 1910a, p. 90, fig. 126.

Nodellum membranaceum (Brady). BARKER, 1960, p. 66, pl. 32, figs. 1-4.---

SCHRÖDER, 1986, p. 28, pl. 1, fig. 3.

Test elongate, slender, uniserial, gently arcuate and gradually tapering, base rounded and apiculate. Chambers ellipsoidal to quite elongate oval, slightly inflated, generally but not consistently increasing in size as added. Sutures distinct, depressed, limbate, or may merely appear as constrictions. Wall chitinous, translucent amber-brown, often with numerous transverse wrinkles and constrictions. Aperture terminal, round.

Remarks: This form is completely distinctive. The description of the genus by Loeblich and Tappan (1987) allows only a proloculus and single long tubular chamber, with multiple and irregular constrictions. This species, which is the genotype, appears to be truly multilocular.

Suborder TEXTULARIINA Delage and Hérouard, 1896

Superfamily ASTRORHIZACEA Brady, 1881

Astrorhizaceans, genus and species indeterminate
(Plate 10, Figures 9,10)

Included herein are undivided tubular agglutinated specimens of a fragmentary nature. No proloculi are preserved, nor are any branching relationships or intact apertural ends. It is therefore impossible to assign them to particular genera, let alone species. It is tempting to distinguish rectilinear from curved forms, but a number of samples contain specimens of both that are almost certainly the same species. From the work of Schröder (1986) it is clear that grain size or nature of agglutinated material (e.g. sand grains, sponge spicules, foram tests) is not a valid basis for the distinction of species, as these factors vary within species and are substrate dependent. The specimens in this section range from finely agglutinated and smoothly finished, but not polished, to very coarse-grained and roughly finished, this latter extreme usually seen in rectilinear forms. Finer grained forms are more likely to be curved, but this is not a rule. The degree of cementation is also highly variable.

Family PSAMMOSPHAERIDAE Haeckel, 1894

Subfamily PSAMMOSPHAERINAE Haeckel, 1894

Genus Psammospaera Schulze, 1875

Psammospaera fusca Schulze

Psammospaera fusca SCHULZE, 1875, p. 113, pl. 2, fig. 8.---CUSHMAN, 1910a, p. 35, figs. 25-28.---BARKER, 1960, p. 36, pl. 18, figs. 1,5-8.

Test nearly spherical, coarsely agglutinated with poorly sorted grains, not much cement. Some specimens with sponge spicule passing through test wall as an axis. Aperture not readily apparent.

Remarks: The type figures are very poor, and much reliance is placed herein on Cushman and Barker for the identification of this species. Psammospaera parva Flint is evidently more finely agglutinated, with well sorted grains and much cement to produce a smoother test. It is doubtful whether the spicule, described for that species, is diagnostic.

Family SACCAMMINIDAE Brady, 1884

Subfamily SACCAMMININAE Brady, 1884

Genus Lagenammina Rhumbler, 1911

Lagenammina difflugiformis (Brady)

Reophax difflugiformis BRADY, 1879, p. 51, pl. 4, fig. 3.---SCHRÖDER, 1986, p. 43.

Proteonina difflugiformis (Brady). CUSHMAN, 1910a, p. 41, figs. 40,41.

Lagenammina difflugiformis (Brady). BARKER, 1960, p. 62, pl. 30, figs. 1-4.---COLE, 1981, p. 23, pl. 4, fig. 6.

Saccammina difflugiformis (Brady) forma typica. POAG, 1981, p. 81, pl. 49, fig. 1; pl. 50, fig. 1.

Test unilocular, spherical to ellipsoidal or barely pyriform, base apiculate in fine-grained specimens. Wall may be finely agglutinated and smoothly finished to coarse-grained, rough, and poorly cemented. Aperture terminal, round, on neck which is longer and more slender the finer the grain size.

Remarks: The long neck distinguishes this species from Proteonina atlantica

Cushman, which has no neck, and P. ovata Cushman, which has a very short neck on an ovate test. Schröder (1986) pointed out the possibility that these forms are single chambers from broken specimens of Reophax, although the most likely possibility, Hormosina ovicula Brady, has pyriform chambers without stolons, which would be needed to produce apparent apertural necks.

Superfamily HIPPOCREPINACEA Rhumbler, 1895

Family HIPPOCREPINIDAE Rhumbler, 1895

Subfamily HYPERAMMININAE Eimer and Fickert, 1899

Genus Hyperammina Brady, 1878

Hyperammina laevigata Wright

Hyperammina elongata Brady var. laevigata WRIGHT, 1891, p. 466, pl. 20, fig. 1.---CUSHMAN, 1910a, p. 61, fig. 75.

Hyperammina laevigata Wright. BARKER, 1960, p. 46, pl. 23, figs. 9,10.---COLE, 1981, p. 10, pl. 1, fig. 7.---SCHRÖDER, 1986, p. 34, pl. 6, fig. 3.

Test elongate, slender, arcuate and subcylindrical. Proloculus elongate oval to subfusiform, with bluntly pointed base, followed by single unbroken tube, initially of lesser diameter and not increasing appreciably with growth, with numerous irregular transverse constrictions. Wall very finely agglutinated and polished. Aperture a circular opening at end of tube.

Remarks: Other species of the genus have either a rounded base or a bulbous and globular proloculus, and are thereby distinguished. The smooth wall of this species is also somewhat distinctive.

Superfamily AMMODISCACEA Reuss, 1862

Family AMMODISCIDAE Reuss, 1862

Subfamily AMMODISCINAE Reuss, 1862

Genus Ammodiscus Reuss, 1862

Ammodiscus incertus (d'Orbigny)

Operculina incerta d'ORBIGNY, 1839a, p. 49, pl. 6, figs. 16,17.

Ammodiscus incertus (d'Orbigny). CUSHMAN, 1910a, p. 73, figs. 95,96.---CUSHMAN, 1921, p. 62, pl. 5, figs. 1,2.---INGLE et al., 1980, p. 131, pl. 9, fig. 9.

Cornuspira incerta? (d'Orbigny). BARKER, 1960, p. 78, pl. 38, fig. 2.

Involutina tenuis (Brady). ?BARKER, 1960, pl. 38, figs. 5,6.

Ammodiscus tenuis Brady. ?INGLE *et al.*, 1980, p. 131, pl. 9, fig. 1.---?POAG, 1981, p. 37, pl. 7, fig. 2; pl. 8, fig. 2.

Test planispiral, proloculus followed by single, unbroken, finely agglutinated tube. Microspheric form with 8 or more whorls, each broader than high in cross section, with fairly pronounced concavity to faces of test, wall completely fine-grained. Megalospheric form with approximately 5 whorls, each about as high as broad in cross section, faces of test only slightly concave, wall with scattered large platy grains. Aperture at open or distal end of tube.

Remarks: It appears that A. tenuis is the megalospheric form of A. incertus (Cushman, 1910a). Ammodiscus reesi LeRoy has coarser grains on the adumbilical or inner portion of the whorl, i.e. the grain size of each whorl is graded.

Subfamily AMMOVERTELLININAE Saidova, 1981

Genus Glomospira Rzehak, 1885

Glomospira gordialis (Jones and Parker)

Trochammina squamata var. gordialis JONES AND PARKER, 1860, p. 304.

Gordiammina gordialis (Jones and Parker). CUSHMAN, 1910a, p. 76, figs. 98-100.

Glomospira gordialis (Jones and Parker). BARKER, 1960, p.78, pl. 38, figs. 7-9.--- HERMELIN AND SCOTT, 1985, p. 210, pl. 1, fig. 2.

Test complanate, medium to finely agglutinated, consisting of a single unbroken chamber which is coiled in an almost planispiral fashion, but with frequent excursions from a true planispiral mode. The coiling may even be open, with the whorls touching at only a few points. Aperture at open or distal end of tube.

Remarks: The complanate nature of this species serves to distinguish it from the globular Repmantina charoides.

Subfamily USBEKISTANIINAE Vyalov, 1968

Genus Reomanina Suleymanov, 1966

Reomanina charoides (Jones and Parker)
(Plate 11, Figure 3)

Trochammina squamata var. charoides JONES AND PARKER, 1860, p. 304.

Gordiammina charoides (Jones and Parker). CUSHMAN, 1910a, p. 77, figs. 101-106.

Glomospira charoides (Jones and Parker). BARKER, 1960, p. 78, pl. 38, figs. 10-16.---
INGLE *et al.*, 1980, p. 136, pl. 9, fig. 6.---POAG, 1981, p. 67, pl. 7, fig. 4; pl. 8,
fig. 4.

Test globular, very finely agglutinated, consisting of a high-spired and often irregularly coiled single tubular chamber that either coils in streptospiral fashion, or increases then reduces coil diameter as whorls are added and translated from the proloculus. Aperture at open or distal end of tube.

Remarks: This species differs from G. gordialis, which is complanate.

Superfamily HORMOSINACEA Haeckel, 1894

Family HORMOSINIDAE Haeckel, 1894

Subfamily REOPHACINAE Cushman, 1910

Genus Hormosinella Shchedrina, 1969

Hormosinella distans (Brady)

Reophax distans BRADY, 1881, p. 50.---BRADY, 1884, pl. 31, figs. 18-22.---
CUSHMAN, 1910a, p. 85, fig. 119.---CUSHMAN, 1921, p. 66, pl. 12, fig. 2.---
BARKER, 1960, p. 64, pl. 31, figs. 18-22.---INGLE *et al.*, 1980, p. 144, pl. 8, fig.
4.---SCHRÖDER, 1986, p. 44, pl. 16, figs. 3-5,9.

NOT Reophax distans Brady. COLE, 1981, p. 24, pl. 16, fig. 24.

Test elongate, uniserial, somewhat arcuate or curved, proloculus unknown. Chambers ovate to broad fusiform, both ends drawn out into long, slender stolons, presumably by which chambers were connected, there being no specimens of more than a single chamber. Wall medium to coarsely agglutinated, roughly finished. Aperture terminal, round, with slightly thickened or flared rim.

Remarks: The chamber shape distinguishes this species from R. gracilis, which also lacks stolons. Cole's specimen is referred herein to this latter species on the basis of these two features.

Genus Reophax de Montfort, 1808

Reophax agglutinatus Cushman

Reophax agglutinatus CUSHMAN, 1913b, p. 637, pl. 79, fig. 6.---CUSHMAN, 1921, p. 73, pl. 14, fig. 2.---BARKER, 1960, p. 62, pl. 30, fig. 13.---COLE, 1981, p. 22, pl. 16, fig. 21.

Test elongate, uniserial, generally curved, chambers inflated, subpyriform to ellipsoidal, increasing slowly in size as added. Sutures depressed, distinct to obscure. Wall very coarsely agglutinated, frequently and supposedly characteristically with tests of foraminifera, also with very large sand grains that may exceed test diameter, very rough. Aperture terminal, round, with slightly thickened and smooth rim.

Remarks: The combination of chamber shape, wall coarseness, and slow increase in chamber size is distinctive.

Reophax gracilis Earland

Reophax distans Brady var. gracilis EARLAND, 1933, p. 76, pl. 2, fig. 21.

Reophax distans Brady. COLE, 1981, p. 24, pl. 16, fig. 24.

Test elongate, slender, rectilinear to very slightly irregular but not arcuate, tapering very slowly, base rounded. Chambers very elongate pyriform, almost immediately twice as long as broad, eventually three times so, with rounded lower shoulders. Sutures distinct, depressed, may be slightly oblique. Wall quite coarsely agglutinated, roughly finished. Aperture terminal, round, with slightly produced neck or thin lip.

Remarks: This species is distinguished from R. distans Brady, which has somewhat more fusiform chambers and very elongate stolons, and from R. guttifer Brady, which has less elongate chambers with distinct short stolons, rather than produced apertural ends as has the present species. There is a significant problem with the present species, in that Earland's type figure is a composite, there being no specimen from the type material with more than 2 chambers. There is also a degree of variability in chamber shape not seen in the present material, but without

reference to the type material it is not possible to assess whether that is of any significance. The transfer of Cole's specimens has already been discussed.

Reophax sp. cf. R. rostratus Höglund

Reophax rostrata HÖGLUND, 1947, p. 87, p. 89, t.f. 57-60, pl. 9, fig. 8; pl. 26, figs. 44-51; pl. 27, figs. 20-23.---COLE, 1981, p. 26, pl. 4, fig. 5.

Test elongate, uniserial, barely tapering and barely arcuate. Chambers 1 1/2 to 2 times higher than broad, inflated, subpyriform, quite strongly embracing. Sutures distinct, depressed, straight, may be slightly oblique. Wall coarsely agglutinated. Aperture terminal, round, on produced neck.

Remarks: The few fragmentary specimens lack the rather long neck and slight lip of Höglund's specimens, hence the uncertainty in assignment. There is no tendency to develop stolons as is common in other species with elongate chambers.

Reophax scorpiurus de Montfort

Reophax scorpiurus de MONTFORT, 1808, p. 331, p. 330, t.f. [no #]---CUSHMAN, 1910a, p. 83, figs. 114-116.---CUSHMAN, 1921, p. 65, pl. 6, fig. 6.---BARKER, 1960, p. 62, pl. 30, figs. 12, 14-17.---MURRAY, 1971, p. 19, pl. 2, figs. 5-8.---SCHRÖDER, 1986, p. 42, pl. 14, figs. 1-5.

Test uniserial, tapering quite rapidly and irregularly curved or arcuate. Chambers asymmetrically pyriform, inflated, increasing quite rapidly in size as added. Sutures distinct, strongly constricted, straight. Wall coarsely agglutinated, roughly finished. Aperture terminal, round, slightly produced.

Remarks: The tapering, twisted rather than arcuate test, with coarsely agglutinated pyriform chambers is distinctive.

Subfamily HORMOSININAE Haeckel, 1894

Genus Pseudonodosinella Saidova, 1970

Pseudonodosinella nodulosa (Brady)
(Plate 11, Figure 6)

Reophax nodulosa BRADY, 1879, p. 52, pl. 4, figs. 7, 8.---COLE, 1981, p. 25, pl. 2, fig. 10.

Reophax nodulosus Brady. CUSHMAN, 1910a, p. 87, fig. 122.---CUSHMAN, 1921, p. 68, pl. 10, figs. 1, 2; pl. 12, fig. 5.---BARKER, 1960, p. 64, pl. 31, figs. 3-9, not 1, 2.---SCHRÖDER, 1986, p. 45, pl. 15, fig. 11.

Test elongate, uniserial, usually straight to gently arcuate. Chambers barely pyriform, quite strongly embracing, inflated. Megalospheric form stout, only 4 chambers in present material, with large ellipsoidal proloculus and rounded base, followed by series of chambers, the first of which is smaller in diameter, thereafter very gradually enlarging. Microspheric form slender, 9 chambers tapering from proloculus and very strongly embracing, pyriform shape barely discernible. Sutures distinct, depressed, horizontal. Wall fine to medium-grained, quite smoothly finished. Aperture terminal, round, very slightly produced with thickened but not projecting rim.

Remarks: Hormosina ovaliformis Cushman has more elongate ellipsoidal chambers which do not embrace so strongly. Loeblich and Tappan (1987) pointed out that the specimens in Barker (1960), pl. 31, figs. 1 and 2 are referable to Nodosinella gaussica Rhumbler (now assigned to Nodosinum Hofker, 1930), having a radiate aperture and coarser wall.

Superfamily LITUOLACEA de Blainville, 1827

Family HAPLOPHRAGMOIDIDAE Maync, 1952

Genus Buzasina Loeblich and Tappan, 1985

Buzasina galeata (Brady)
(Plate 11, Figures 11,12)

Trochammina galeata BRADY, 1881, p. 52.---BRADY, 1884, pl. 40, figs. 19-23.

Ammochilostoma galeata (Brady). CUSHMAN, 1910a, p. 127, figs. 198-201.

Cystammina galeata (Brady). BARKER, 1960, p. 82, pl. 40, figs. 19-23.---SCHRODER, 1986, p. 54, pl. 17, figs. 12,13.

Buzasina galeata (Brady). LOEBLICH AND TAPPAN, 1987, p. 65, pl. 48, figs. 5-7.

Test planispiral, wholly involute, thick and asymmetrically ovate in outline, periphery broadly rounded. Chambers increasing rapidly in size as added, and very strongly embracing, only 3 visible in outer whorl, last chamber at least 3/4 of test size, and twice as thick as penultimate chamber. Sutures distinct, very gently depressed. Wall medium-grained and smoothly finished. Aperture areal, oval to

barely crescentiform, near base of final chamber, surrounded by thin produced lip, upper surface of lip a continuation of periphery, such that the whole almost resembles a neck

Remarks: The very thick, strongly embracing planispiral form with its areal aperture is distinctive.

Buzasina ringens (Brady)

Trochammina ringens BRADY, 1879, p. 57, pl. 5, fig. 12.

Haplophragmoides ringens (Brady). CUSHMAN, 1910a, p. 107, fig. 166.---
CUSHMAN, 1921, p. 81, pl. 15, fig. 2.

Alveolophragmium ringens (Brady). BARKER, 1960, p. 82, pl. 40, figs. 17,18.

Cribrostomoides ringens (Brady). COLE, 1981, p. 30, pl. 4, fig. 14.---SCHRÖDER, 1986, p. 47, pl. 18, figs. 13,14.

Buzasina ringens (Brady). LOEBLICH AND TAPPAN, 1987, p. 65, pl. 48, figs. 2-4.

Test planispiral, wholly involute, compressed but not strongly so, periphery angled but rounded, lobulate. Chambers 4 in outer whorl, petaloid, inflated, increasing rapidly in size as added. Sutures distinct, depressed, radial and gently curved. Wall finely agglutinated, highly polished. Aperture an areal and equatorial arcuate slit, near base of final chamber, completely surrounded by rim or lip that is usually darker orange.

Remarks: This form is easily distinguished from B. galeata by its compressed test with more numerous and less strongly embracing chambers. The apertural characteristics are sufficient to distinguish it from Haplophragmoides bradyi.

Genus Cribrostomoides Cushman, 1910

Cribrostomoides grandiformis (Cushman)

Haplophragmoides grandiformis CUSHMAN, 1910b, p. 440, fig. 11.---CUSHMAN, 1921, p. 82, pl. 11, fig. 2.

Test planispiral, involute, biumbilicate but umbilici neither deep nor broad, periphery very gently lobulate, well rounded. Chambers 7 or so in outer whorl, equilateral to angular in outline, increasing slowly in size as added, gently inflated.

Sutures distinct, radial, straight, slightly depressed. Wall coarsely agglutinated, roughly finished. Aperture oval, transverse and basal, with surrounding lip.

Remarks: The involute planispiral test, not much compressed, distinguishes this species from most, while the equilateral rather than elongate triangular chambers distinguish it from Haplophragmium crassimargo Norman.

Cribrostomoides sp. cf. C. rotulatus (Brady)

Haplophragmium rotulatum BRADY, 1881, p. 50.---BRADY, 1884, pl. 34, figs. 5,6.

Haplophragmoides rotulatum (Brady). CUSHMAN, 1910a, p. 104, figs. 156,157.---BARKER, 1960, p. 70, pl. 34, figs. 5,6.---SCHRÖDER, 1986, p. 46, pl. 18, figs. 2-4.

Cribrostomoides rotulatum (Brady). POAG, 1981, p. 56, pl. 11, fig. 3; pl. 12, fig. 3.

Test nearly planispiral, biumbilicate with broad and deeply excavated umbilici, inner whorls exposed but obscure, periphery essentially non-lobulate, very broadly rounded, axial section mushroom-shaped. Chambers 8 or 9 in outer whorl, not much inflated, increasing very rapidly in thickness as added, final chamber 3 times as thick as initial chamber of outer whorl. Sutures obscure, nearly radial and straight. Wall very coarsely agglutinated, roughly finished. Aperture compressed oval, surrounded by fine lip, near base of apertural face which is oblique to axis of coiling.

Remarks: Brady (1884), Cushman (1910a), and Barker (1960) all used the same illustrations for this species, a form with a truncate periphery and obscure aperture, described by Cushman as interiomarginal. Poag's form has a very elongate areal slit aperture with lip, and a well rounded periphery, while Schröder (1986) illustrated specimens with a rounded periphery and what appears to be an interiomarginal aperture (see pl. 18, fig. 4, a reflected light photograph, as the SEM photos are not clear on this feature), which would explain the generic assignment. The unifying feature is the very rapid increase in test thickness, and resultant deeply excavated umbilical regions. Nevertheless, there is a possibility that the specimens of Poag, Schröder, and the present study may represent more than one species, and not

necessarily the one Brady described and illustrated.

Cribrostomoides scitulum (Brady)

Lituola (Haplophragmium) scitulum BRADY, 1881, p. 50.

Haplophragmium scitulum Brady. BRADY, 1884, pl. 34, figs. 11-13.

Haplophragmoides scitulum (Brady). CUSHMAN, 1910a, p. 103, figs. 153-155.

Alveolophragmium scitulum (Brady). BARKER, 1960, p. 70, pl. 34, figs. 11-13.

Cribrostomoides scitulum (Brady). COLE, 1981, p. 30, pl. 4, fig. 12.

Cribrostomoides scitulum (Brady). POAG, 1981, p. 56, pl. 11, fig. 4; pl. 12, fig. 4.

Recurvoides scitulum (Brady). SCHRÖDER, 1986, p. 48, pl. 17, figs. 1-4.

Test nearly planispiral, partially evolute and biumbilicate, whorls embracing almost half of preceeding whorl height, umbilici broad and fairly deep, periphery mildly lobulate and well rounded. Chambers 9 or more in outer whorl, increasing steadily in size as added and barely inflated. Sutures rather obscure, curved and nearly radial but angled anteriorward, barely depressed. Wall medium-grained but quite smoothly finished. Aperture an ovate slit, nearly interiomarginal, with barely discernible surrounding lip.

Remarks: The aperture and coarse-grained, non-alveolar wall serve to distinguish this species from Cyclammina, while the open umbilicus with partially embraced whorls, and anteriorly directed sutures are distinctive within the genus. The slight asymmetry of the early stage probably represents the typical development of Cribrostomoides, and not the full streptospiral arrangement of Recurvoides.

Cribrostomoides sphaeriloculus (Cushman)

Haplophragmoides sphaeriloculum CUSHMAN, 1910a, p. 107, fig. 165.---CUSHMAN, 1921, p. 83, pl. 15, fig. 3.

Haplophragmoides sphaeriloculus Cushman. SCHRÖDER, 1986, p. 47, pl. 18, figs. 1-7.

Test initially barely streptospiral, later planispiral, biumbilicate with narrow deep umbilici, periphery lobulate and well rounded. Chambers globular, inflated, increasing quite rapidly in size as added, 4 to 5 in outer whorl. Sutures distinct,

depressed, radial, straight. Wall with much medium-grained material, quite smooth. Aperture a small oval slit, nearly interiomarginal, surrounded by fine lip.

Remarks: The planispiral form with globular chambers is readily distinguished from most species, and from Haplophragmium nitidum Goës by this latter species's chambers which are 1 1/2 times thicker than they are high or broad.

Cribrostomoides subglobosus (G.O. Sars)
(Plate 11, Figures 4,5)

Lituola subglobosa SARS, 1872, p. 253.

Haplophragmoides subglobosum (G.O. Sars). CUSHMAN, 1910a, p. 105, figs. 162-164.---CUSHMAN, 1921, p. 81, pl. 15, fig. 1.

Cribrostomoides bradyi CUSHMAN, 1910a, p. 108, fig. 167.---CUSHMAN, 1921, p. 83, pl. 17, fig. 1.

Alveolophragmium subglobosum (G.O. Sars). BARKER, 1960, p. 70, pl. 34, figs. 7,8,10,14? [Barker's "?"].---INGLE *et al*, 1980, p. 130, pl. 3, fig. 10.

"Cribrostomoides bradyi Cushman". BARKER, 1960, p. 70, pl. 34, fig. 9.

Cribrostomoides subglobosum (G.O. Sars). COLE, 1981, p. 31, pl. 4, fig. 13.---POAG, 1981, p. 57, pl. 11, fig. 2; pl. 12, fig. 2.

Cribrostomoides subglobosus (G.O. Sars). SCHRÖDER, 1986, p. 48, pl. 18, figs. 15,16.

Test nearly planispiral, may have early streptospiral stage, wholly involute and usually biumbilicate, umbilici small and occasionally deep, periphery very gently lobulate and very broadly rounded. Chambers 5 to rarely 6 in outer whorl, increasing particularly rapidly in thickness as added, slightly inflated, triangular in outline. Sutures distinct, gently depressed, radial and straight. Wall medium to coarsely agglutinated, roughly finished. Aperture equatorial or almost so, areal, an oval completely surrounded by smooth raised lip, no denticulation observed.

Remarks: Barker, Poag, and Schröder all included C. bradyi, which is the genotype, in synonymy with the present species, which would mean that Lituola subglobosa becomes the genotype. The critical question is whether or not the cribrate aperture of Cushman's species is merely an exceptional terminal development. The thick, planispiral, biumbilicate form without globular chambers is

distinctive.

Genus Haplophragmoides Cushman, 1910

Haplophragmoides bradyi (Robertson)
(Plate 11, Figures 7,8)

Trochammina bradyi ROBERTSON, 1891, p. 388.

Haplophragmoides bradyi (Robertson). MURRAY, 1971, p. 25, pl. 5, figs. 1,2.---
POAG, 1981, p. 68, pl. 13, fig. 4; pl. 14, fig. 4.---SCHRÖDER, 1986, p. 46, pl. 18,
fig. 8.

Test planispiral, compressed, wholly involute, umbilicate, periphery barely to well lobulate and rounded to angled but not acute. Chambers inflated, 4 to 6 per whorl, increasing fairly rapidly in size as added. Sutures distinct, gently to well depressed, radial, nearly straight. Wall finely agglutinated, polished. Aperture an interiomarginal equatorial slit, with extremely fine bordering lip.

Remarks: This species is distinguished by its compression, low number of chambers, and apertural form. In many respects it looks like an agglutinated version of Pullenia subcarinata, with that species's attendant range of variation. It should not be confused with either Cribrostomoides bradyi Cushman or Cyclammina bradyi Cushman, both of which are also planispiral agglutinated forms, differing particularly in apertural characteristics.

Haplophragmoides trullissata (Brady)
(Plate 11, Figures 9,10)

Trochammina trullissata BRADY, 1879, p. 56, pl. 5, figs. 10,11.

Cyclammina bradyi CUSHMAN, 1910a, p. 113, fig. 174.

Cyclammina pusilla Brady. CUSHMAN, 1921, p. 87, pl. 16, fig. 4.

Haplophragmoides trullissata (Brady). CUSHMAN, 1932, p. 5, pl. 1, fig. 4.

Cyclammina trullissata (Brady). BARKER, 1960, p. 82, pl. 40, fig. 13.---SCHRÖDER, 1986, p. 49, pl. 17, fig. 9.

Test planispiral, compressed, nearly involute, umbilical regions excavated and previous whorls barely visible, periphery very gently lobulate, angled but rounded, not acute. Chambers rarely as few as 7, usually 9 in outer whorl, increasing fairly

rapidly in size as added, elongate triangular and gently inflated. Sutures distinct, radial, depressed and straight to slightly sinuate. Wall finely agglutinated, polished. Aperture an interiomarginal equatorial arch, very much confined, bordered by fairly high, thin lip.

Remarks: This species completely lacks both the alveolar wall structure and multiple areal pores or aperture which characterize Cyclammina Brady. Otherwise it looks very much like that genus, and the confusion in the literature concerning its generic placement is understandable. Schröder (1986) was probably right in saying it is likely a transitional form between the two genera. Barker (1960) pointed out that Cushman erected C. bradyi on the basis of specimens that were truly H. trullissata, and so his species is a junior synonym of the present one. The present species has more chambers per whorl and an angled periphery to distinguish it from H. bradyi. Cyclammina pusilla Brady is characterized by a thin, sharp, lobulate periphery and some 15 chambers to the outer whorl, and thus Cushman (1921) appears to have been in error.

Family DISCAMMINIDAE Mikhalevich, 1980

Genus Discammina Lacroix, 1932

Discammina compressa (Goës)

Lituolina irregularis (Romer) var. compressa GOËS, 1882, p. 141, pl. 12, figs. 421-423.

Haplophragmoides emaciatum (Brady). CUSHMAN, 1910a, p. 102, figs. 150-152.

Discammina compressa (Goës). BARKER, 1960, p. 68, pl. 33, figs. 26-28.---POAG, 1981, p. 58, pl. 9, fig. 4; pl. 10, fig. 4.---SCHRÖDER, 1986, p. 48, pl. 17, figs. 7,8.---LOEBLICH AND TAPPAN, 1987, p. 68, pl. 52, figs. 1-4.

Test planispiral, evolute, strongly flattened, faces very gently excavated, periphery slightly lobulate and rounded but irregularly so due to the coarsely agglutinated wall. Chambers rather obscure, 7 to 8 in outer whorl, latterly somewhat inflated. Sutures often very obscure initially, later apparently gently depressed and straight, but indistinct. Wall very coarsely agglutinated with lots of sponge spicules on an organic membrane, very fragile. Aperture areal, but may be fully basal,

nevertheless surrounded by lip.

Remarks: It is not possible, without destroying the few specimens present, to evaluate the inner structure, but the type description of Discammia implies a single unbroken if constricted tube, with some transverse organic partitions which are not only free of any agglutinated material, but are not necessarily related to chamber terminations. As Schröder (1986) pointed out, this distinctive form is still surrounded by some confusion, partly related to the fact that Goës placed Haplophragmium emaciatum Brady in synonymy with his species, even though his had a marked tendency to uncoil, while Brady's did not.

Family LITUOLIDAE de Blainville, 1827
Subfamily AMMOMARGINULININAE Podobina, 1978
Genus Ammobaculites Cushman, 1910

Ammobaculites sp. A
(Plate 10, Figures 11-13)

Ammobaculites agglutinans (d'Orbigny). BARKER, 1960, p. 66 (pars), pl. 32, fig. 21 only.

Ammobaculites agglutinans var. filiformis Earland. BARKER, 1960, p. 66 (pars), pl. 32, fig. 23 only.

Ammobaculites filiformis Earland. POAG, 1981, p. 36, pl. 7, fig. 3; pl. 8, fig. 3.

Ammobaculites agglutinans var. 1 SCHRÖDER, 1986, p. 51, pl. 21, figs. 7,8.

Test small, elongate, with an initial planispiral coil of one whorl after proloculus, 5 subglobular chambers in whorl, increasing very little in size as added, with distinct radial depressed sutures and rounded periphery. This is followed by a rectilinear to rarely arcuate cylindrical uniserial stage of 5 or more chambers which are initially barely broader than high, becoming higher than broad, barely inflated, strongly appressed, and increasing very slowly in size as added. Uniserial chambers greater in diameter than thickness of coil, but only 2/3 of coil diameter, which has its greatest dimension oblique to test axis. The uniserial portion is not a tangential continuation from the coil, but is at 90° to the expected direction. Sutures distinct,

gently depressed, horizontal. Wall very fine grained and highly polished. Aperture terminal, round, on a very slightly produced neck on the rounded upper chamber surface.

Remarks: The uncompressed uniserial stage is quite distinctive, and in contrast to Spirolina agglutinans d'Orbigny. Earland's species has uniserial chambers that are higher than the diameter of the coil, separated by sutures that are frequently oblique and alternating in orientation.

Superfamily HAPLOPHRAGMIACEA Eimer and Fickert, 1899

Family AMMOSPHAEROIDINIDAE Cushman, 1927

Subfamily AMMOSPHAEROIDININAE Cushman, 1927

Genus Adercotryma Loeblich and Tappan, 1952

Adercotryma glomerata (Brady)

Lituola glomerata BRADY, 1878, p. 433, pl. 20, fig. 1.

Haplophragmoides glomeratum (Brady). CUSHMAN, 1910a, p. 104, figs. 158-161.

Adercotryma glomeratum (Brady). BARKER, 1960, p. 70, pl. 34, figs. 15-18.---
LOEBLICH AND TAPPAN, 1953, p. 26, pl. 8, figs. 1-4.

Adercotryma glomerata (Brady). COLE, 1981, p. 29, pl. 4, fig. 8.---POAG, 1981, p. 35, pl. 15, fig. 2; pl. 16, fig. 2.---SCHRÖDER, 1986, p. 47, pl. 16, figs. 10, 11.

Test streptospiral, thickness equal to diameter, one face more evolute with excavated center, and diameter of periphery greater here, periphery somewhat flattened, tapering toward opposite face of test, which is more involute and finely umbilicate; test quadrate conical in profile, equatorial outline circular. Chambers 4 in outer whorl, very much thicker than broad or high, inflated, increasing not too rapidly in size as added. Sutures distinct, depressed, straight. Wall quite coarsely agglutinated, fairly smoothly finished. Aperture interiomarginal, at ventral extremity of periphery, a fairly open low arch or slit running up to, and narrowing as it approaches, umbilicus.

Remarks: The shape of the test, with thickness equal to diameter, and extreme thickness of chambers as compared to other dimensions, is distinctive, along with

the streptospiral arrangement.

Adercotryma sp. A

Test apparently streptospiral, but outer appearance is low trochospiral, conical, thickness less than diameter, dorsal side flat, evolute, ventral side convex, involute, non-umbilicate, periphery gently lobulate, acute within the limits of coarse grain size, outline rather square with rounded corners. Chambers 4 in outer whorl, gently inflated, increasing fairly rapidly in size as added, on dorsal side radially much shorter than broad, on ventral side triangular. Sutures distinct, depressed, radial and straight. Wall coarsely agglutinated and quite roughly finished. Aperture interiomarginal, an almost comma-shaped arch or loop, apex toward periphery and barely removed from umbilical ventral chamber extremity, that is, just below apex of cone.

Remarks: This species looks remarkably like an agglutinated version of Globorotalia crassaformis Galloway and Wissler. It is readily distinguished from A. glomerata by its lesser test thickness and different profile, quadrate equatorial section, and more rapid chamber increase.

Genus Ammosphaeroidina Cushman, 1910

Ammosphaeroidina grandis Cushman

Ammosphaeroidina grandis CUSHMAN, 1910b, p. 442, figs. 17-19.---CUSHMAN, 1921, p. 98, pl. 9, fig. 4; pl. 16, fig. 5.

Cystammina pauciloculata (Brady). BARKER, 1960, p. 84, pl. 41, fig. 2 only.---COLE, 1981, p. 39, pl. 5, fig. 8.

Test streptospiral and strongly embracing, somewhat globose but slightly compressed, periphery broadly rounded and very gently lobulate. Chambers 4 in outer whorl, 3 comprising periphery and the fourth visible from one face, increasing quite rapidly in size as added, final chamber comprising half of test, gently inflated. Sutures distinct, gently depressed, very slightly curved and radial. Wall fine to medium-grained, very smoothly finished. Aperture a very low interiomarginal arch or slit, centered on umbilicus, where suture between preceding

pair of chambers meets umbilicus.

Remarks: The true interiomarginal aperture without bordering lip and globose shape distinguish this species from Cystammina pauciloculata, hence the transfer of the specimens of Barker and Cole. There is no type figure of Haplophragmium sphacroidiniformis Brady, which supposedly is smaller and more roughly finished (Cushman, 1910b). It is likely the specimen figured by Brady (1884, also Barker, 1960) as pl. 41, fig. 2 is not this latter species, which Brady mentioned in the text without referring that specimen to his species.

Genus Cystammina Neumayr, 1889

Cystammina pauciloculata (Brady)

Trochammina pauciloculata BRADY, 1879, p. 58, pl. 5, figs. 13,14.

Ammochilostoma pauciloculata (Brady). CUSHMAN, 1910a, p. 126, fig. 197.

Cystammina pauciloculata (Brady). BARKER, 1960, p. 84, pl. 41, fig. 1, not fig. 2.---
INGLE *et al.*, 1980, p. 134, pl. 9, fig. 11.---SCHRÖDER, 1986, p. 54, pl. 17, figs.
14,15.---LOEBLICH AND TAPPAN, 1987, p. 82, pl. 68, figs. 1-6.

NOT Cystammina pauciloculata (Brady). COLE, 1981, p. 39, pl. 5, fig. 8.

Test small, streptospiral, rounded throughout and over 1 1/2 times as long as broad. Chambers few, only 4 exposed (4 from one face, 3 from the other), inflated, subglobular, not strongly embracing. Sutures distinct, depressed, straight. Wall medium to finely agglutinated, smoothly finished. Aperture a very low areal slit near the 2 earliest-formed chambers of the outer whorl, with distinct fine surrounding lip.

Remarks: The distinction between this species and Ammosphacroidina grandis has already been discussed, as has the transfer to that species of specimens previously referred to the present one.

Subfamily RECURVOIDINAE Alekseychik-Mitskevich, 1973

Genus Budashevaella Loeblich and Tappan, 1964

Budashevaella sp. A

Test large, streptospiral, equidimensional in lateral view, faces flattened, inner

whorls visible on both sides, periphery gently lobulate and broadly rounded. Chambers 6 in outer whorl, inflated and quite strongly embracing, increasing steadily in size as added and all more or less in one plane, without major shifts in coiling axis. Sutures distinct, radial and straight to slightly curved, may be incised rather than merely depressed. Wall fine to medium grained, but smoothly finished, thick. Aperture a fairly large interiomarginal arch, with weakly developed bordering lip.

Remarks: The interiomarginal aperture distinguishes this from Recurvoides, while the flattened faces distinguish it from Thalmannammina. The genus has a reported range of Upper Eocene to Miocene (Loeblich and Tappan, 1987), and the single specimen is unusual in being distinctly grey while other agglutinated forms in the same sample are in the brown-orange spectrum. The specimen may be reworked.

Genus Recurvoides Earland, 1934

Recurvoides contortus Earland
(Plate 10, Figures 6,7)

Haplophragmoides scitulum "oval variety" EARLAND, 1933, pl. 3, figs. 11,12.

Recurvoides contortus EARLAND, 1934, p. 91, pl. 10, figs. 7-19.---COLE, 1981, p. 31, pl. 5, fig. 1.---LOEBLICH AND TAPPAN, 1987, p. 83, pl. 68, figs. 7-9.

Test streptospiral, appearing to be almost planispiral between two major discernible shifts of 90° in coiling direction, periphery broadly rounded. Chambers 6 or more per whorl, increasing slowly in size as added, at best barely inflated, and quite thick with respect to height and breadth. Sutures most often obscure, discernible when gently depressed. Wall quite coarsely agglutinated and roughly finished. Aperture small, horizontal, areal and ovate, surrounded by smooth lip.

Remarks: The very strong and distinct shifts in coiling direction, coupled with the total lack of umbilici, characterize this species.

Recurvoides trochamminiforme Höglund

Recurvoides trochamminiforme HÖGLUND, 1947, p. 149, p. 138, t.f. 120, pl. 11, figs. 7,8; pl. 30, fig. 23.---COLE, 1981, p. 32, pl. 17, figs. 3,4.

Test small, streptospiral, axis of coiling shifts gradually and regularly, translating chambers ventralward; ventral side umbilicate, dorsal side with inner whorls visible, periphery lobulate and rounded. Chambers 6 in outer whorl, inflated, somewhat triangular in outline, not appressed. Sutures distinct, depressed, radial and straight. Wall finely agglutinated and polished. Aperture areal, nearly interiomarginal, with very fine surrounding lip.

Remarks: Lituola (Haplophragmium) turbinatum Brady has appressed chambers, R. contortus has drastic shifts in coiling direction, and R. laevigatum Höglund has inner whorls clearly visible on both sides of the test.

Recurvoides? sp. A

Test apparently initially streptospiral, much of outer whorl appears low trochospiral, but final few chambers show complete change in orientation, with strong rapid shifts, periphery lobulate and rounded. Chambers inflated and subglobular, increasing quite rapidly in size as added, on the order of 5 per "whorl", whorls not readily defined. Sutures distinct, depressed, radial and straight. Wall quite coarsely agglutinated, but rather smoothly finished. Aperture areal, nearly interiomarginal, a large irregular oval bordered by distinct rim, aperture often directed back in the direction whence the chamber has been translated, not in any sense "umbilical-ward".

Remarks: The globigeriniform chambers and appearance, distinct streptospiral coiling, and retral orientation of the aperture are distinctive.

Genus Thalmannammina Pokorny, 1951

Thalmannammina conglobata (Brady)

Trochammina conglobata BRADY, 1884, p. 341, pl. 40, figs. 8,9.---BARKER, 1960, p. 82, pl. 40, figs. 8,9.

Test large, robust, streptospiral with highly variable coiling axis, mildly compressed, periphery lobulate and very broadly rounded. Chambers strongly inflated and subglobular, usually thicker than broad. Sutures distinct, depressed,

radial and somewhat curved. Wall finely agglutinated, polished. Aperture a low, broad basal or interiomarginal arch, with slightly flared bordering lip.

Remarks: The only species which needs to be distinguished from this one is Trochammina coronata Brady, which is more strongly compressed with most chambers in one plane.

Superfamily LOFTUSIACEA Brady, 1884

Family CYCLAMMINIDAE Marie, 1941

Subfamily CYCLAMMININAE Marie, 1941

Genus Cyclammina Brady, 1879

Cyclammina sp. cf. C. compressa Cushman

Cyclammina compressa CUSHMAN, 1917b, p. 653, pl. 16, fig. 2.---CUSHMAN, 1921, p. 85, pl. 16, fig. 2.

Test planispiral, periphery slightly lobulate and strongly angled but not acute. Chambers numerous in outer whorl, increasing very slowly in size as added. Sutures distinct, gently depressed, more or less radial but somewhat sinuate. Wall extremely fine-grained and polished, rich red-brown in colour, and very thick, especially on faces but not so much the apertural face, and alveolar. Aperture unknown in present material.

Remarks: There is but a single fragment consisting of the peripheral portion of 4 1/2 chambers. The wall structure, nature of the periphery, and suture style all suggest this species, which is most notable for its angled periphery, rather than the rounded one of C. cancellata Brady.

Superfamily SPIROPECTAMMINACEA Cushman, 1927

Family SPIROPECTAMMINIDAE Cushman, 1927

Subfamily SPIROPECTAMMININAE Cushman, 1927

Genus Spiropectammina Cushman, 1927

Spiropectammina biformis (Parker and Jones)

Textularia agglutinans d'Orbigny var. biformis PARKER AND JONES, 1865, p. 370, pl. 15, figs. 23,24.

Spiroplectammina biformis (Parker and Jones). BARKER, 1960, p. 92, pl. 45, figs. 25-27.---INGLE et al, 1980, p. 144, pl. 5, fig. 9.---COLE, 1981, p. 34, pl. 6, fig. 3.---SCHRÖDER, 1986, p. 51, pl. 21, fig. 14.

Test elongate, slender, parallel-sided or nearly so, gently compressed, periphery rounded. Early planispiral coil followed by rectilinear biserial stage of comparable width, chambers initially barely broader than high, finally higher than broad, little inflated, in 4 pairs. Sutures distinct, gently depressed. Wall usually finely agglutinated and smoothly finished, depending upon substrate. Aperture an interiomarginal arch.

Remarks: The smooth, parallel-sided test with chambers about the same breadth as height is distinctive.

Spiroplectammina bulbosa (Cushman)

Spiroplecta bulbosa CUSHMAN, 1911, p. 5, fig. 1.---CUSHMAN, 1921, p. 102, pl. 20, fig. 1.

Test elongate, compressed, periphery lobulate and acute. Initial large, lenticular, biumbonate planispiral coil followed by elongate biserial stage of 4 pairs of chambers, narrower than coil and decreasing in width as each pair added. Chambers broader than high, becoming as high as broad. Sutures distinct, limbate, oblique and slightly concave upward. Wall rough but finely agglutinated. Aperture a rather high interiomarginal arch.

Remarks: The large lenticular coil followed by a narrowing biserial stage with acute margins is distinctive.

Genus Spiroplectinella Kisel'man, 1972

Spiroplectinella sp. A

Test elongate, tapering quite rapidly and uniformly from rounded base, nearly twice as long as broad, apertural end convex and angled in outline, cross-section compressed, elongate and rhomboidal, margins acute and carinate, carina thin and ragged, may have blunt flat spines, usually at sutures. Initial coil consists of proloculus and 3 to 4 chambers, thereafter chambers biserial, initial pair wider than

coil, low and broad, slightly oblique, very gently inflated. Sutures limbate, depressed. Wall quite finely agglutinated and well cemented, but rough. Aperture interiomarginal, at base of inflated upper surface of final chamber, a low arch with thin upper margin.

Remarks: Textularia carinata d'Orbigny, which belongs in this genus, has very regular and long carinal spines at the sutures, and the outline is biconvex because the rate of increase in test width decreases with growth. Textularia pseudocarinata Cushman shows no initial coil, and has coarse-grained sutures that are evidently raised.

Family PSEUDOBOLIVINIDAE Wiesner, 1931

Genus Parvigenerina Vella, 1957

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.

Test elongate, slender and tapering, biserial, compressed and slightly twisted about axis, periphery rounded and lobulate with deeply depressed sutures, base unknown. Chambers inflated, subglobular but becoming much higher than broad, and tending to uniserial development. Sutures distinct, depressed, between successive chambers strongly oblique and curved, between chambers of same series horizontal. Wall quite finely agglutinated and smoothly finished. Aperture terminal, round, on very short neck or possibly with long lip, but not both.

Remarks: The tendency to an alternating uniserial chamber arrangement distinguishes this species from those of Siphotextularia.

Superfamily TROCHAMMINACEA Schwager, 1877

Family TROCHAMMINIDAE Schwager, 1877

Subfamily TROCHAMMININAE Schwager, 1877

Genus Ammoglobigerina Eimer and Fickert, 1899

Ammoglobigerina advena (Cushman)

Trochammina advena CUSHMAN, 1922b, p. 20, pl. 1, figs. 2-4.---COLE, 1981, p. 37, pl. 8, fig. 3.

Test very low trochospiral, dorsal side flattened with all chambers visible, ventral side with small umbilicus, periphery gently lobulate and rounded. Chambers 4 per whorl, inflated but quite closely appressed, radial dimension not quite half of tangential one, and somewhat petaloid in dorsal view, increasing fairly rapidly in size as added. Sutures distinct, depressed, radial. Wall coarsely agglutinated, rough. Aperture a very small interiomarginal umbilical-extraumbilical arch, with bordering lip.

Remarks: The flat dorsal side without projecting inner whorls, and the petaloid chamber shape on that side, distinguish this species. A comparison of this species with *Trochammina inflata* illustrates the fact that the distinction between these two genera may not always be clear-cut.

Ammoglobigerina globigeriniformis (Parker and Jones)

Lituola nautiloidea Lamarck var. *globigeriniformis* PARKER AND JONES, 1865, p. 407, pl. 15, figs. 46,47; pl. 17, figs. 96-98.

Trochammina globigeriniformis (Parker and Jones). CUSHMAN, 1910a, p. 124, figs. 193-195.---CUSHMAN, 1921, p. 96, pl. 11, figs. 4,5.---INGLE *et al.*, 1980, p. 146, pl. 5, figs. 12,13.---COLE, 1981, p. 37, pl. 7, figs. 2,3.---POAG, 1981, p. 85, pl. 13, fig. 1; pl. 14, fig. 1.

Trochammina globigeriniformis (Parker and Jones) var. *pygmaea* ?HOGLUND, 1947, p. 200, t.f. 182, pl. 17, fig. 3.---MURRAY, 1971, p. 35, pl. 10, figs. 1,2.

Ammoglobigerina globigeriniformis (Parker and Jones). BARKER, 1960, p. 72, pl. 35, figs. 10,11.---LOEBLICH AND TAPPAN, 1987, p. 120, pl. 128, figs. 9,10.

Trochammina cf. globigeriniformis Parker and Jones. SCHRODER, 1986, p. 52, pl. 19, figs. 5-8.

Test low trochospiral, inner whorls on dorsal side not projecting, periphery lobulate and very broadly rounded. Chambers 3 1/2 to 4 in outer whorl, inflated, subglobular and appressed, increasing rapidly in all dimensions as added. Sutures distinct, depressed, radial. Wall medium to coarsely agglutinated, fairly smooth.

Aperture a small umbilical arch.

Remarks: The uncertainty on the part of Schröder (1986) lies not in any doubt as to the correspondence of her specimens to those of other authors, but rather in the fact that the type figures are poor and the description quite sketchy. The very low number of rapidly enlarging subglobular chambers is distinctive. Höglund's form differs only in having an exceptionally large final chamber to produce an outer whorl with but 3 chambers, but it is otherwise identical and should probably be considered an extreme within the species. Murray illustrated specimens with both 3 and 4 chambers in the outer whorl, and they are included in synonymy.

Genus Paratrochammina Brönnimann, 1979

Paratrochammina sp. cf. P. squamata
(Jones and Parker)

Trochammina squamata JONES AND PARKER, 1860, p. 304.---CUSHMAN, 1921, p. 95, pl. 17, fig. 2; pl. 22, fig. 6.

NOT Trochammina squamata Jones and Parker. CUSHMAN, 1910a, p. 120, fig. 187.--BARKER, 1960, p. 84, pl. 41, fig. 3.

Trochammina rotaliformis Heron-Allen and Earland. MURRAY, 1971, p. 39, pl. 12, figs. 1-5.

Trochammina sp. cf. T. squamata Jones and Parker. COLE, 1981, p. 39, pl. 6, figs. 10, 11.

Siphotrochammina squamata (Jones and Parker). POAG, 1981, p. 82, pl. 13, fig. 2; pl. 14, fig. 2.

Trochammina cf. squamata Parker and Jones. SCHRÖDER, 1986, p. 53, pl. 19, figs. 12-15.

Test trochospiral, concavo-convex, dorsal side almost hemispherical, periphery somewhat lobulate and asymmetrically rounded. Chambers 3 1/2 to 4 per whorl, on dorsal side petaloid and quite strongly inflated, on ventral side subtriangular to petaloid and less strongly inflated. Sutures distinct, depressed, on dorsal side strongly oblique, on ventral side radial, curved to sigmoid. Wall finely agglutinated and smooth, less so dorsally. Aperture umbilical, under thin undulose margin of chambers, successive apertures remaining open into umbilicus.

Remarks: The forms illustrated by Cushman (1910a) and Barker (1960) under this species do not belong, being far too flattened, even to the extent the chamber surfaces are sunken or flat, and the aperture is extraumbilical. There was no type figure for the species, and the type description embraced several forms, many not closely related. This species needs stabilizing, for which the reader is referred to Schröder's (1986) excellent discussion. The present specimens agree very well with those of both Schröder and Cole, except in the latter paper they have as many as 5 chambers per whorl. Poag's forms should not be assigned to Siphotrochammina Saunders, wherein the aperture is at the end of a tubular umbilical chamber extension. Nevertheless, those specimens do have an unusually restricted aperture, although the test shape and strongly inflated chambers are distinctive. Murray's specimens are referred herein to the present species because T. rotaliformis has on the dorsal side arcuate, narrow chambers and radial sutures, while the ventral side has triangular, relatively uninflated chambers.

Genus Trochammina Parker and Jones, 1859

Trochammina sp. cf. T. inflata (Montagu)

Nautilus inflatus MONTAGU, 1808, p. 81, pl. 18, fig. 3.

NOT? Trochammina inflata (Montagu). CUSHMAN, 1910a, p. 121, fig. 188.

Trochammina inflata (Montagu). BARKER, 1960, p. 84, pl. 41, fig. 4.---MURRAY, 1971, p. 35, pl. 10, figs. 3-6.---LOEBLICH AND TAPPAN, 1987, p. 122, pl. 129, figs. 20-23.

Trochammina inflata var. (Montagu). INGLE et al, 1980, p. 146, pl. 8, figs. 1-3.

Trochammina sp. cf. T. inflata (Montagu). COLE, 1981, p. 38, pl. 7, fig. 4.

Test low trochospiral, biconvex, whorls displaced ventralward, umbilicus very narrow, periphery lobulate and rounded. Chambers 5 to 5 1/2 in outer whorl, inflated but radially appressed, curved thin quadrangular on dorsal side, triangular on ventral side. Sutures distinct, radial, depressed, straight. Wall medium-grained and quite smoothly finished. Aperture a very low interiomarginal extraumbilical slit, with very fine bordering lip.

Remarks: There is a problem with this species, in that there is only a type figure of the dorsal side, and the distribution is thought by many to be restricted to marsh environments. Ingle *et al* assumed their specimens were "redeposited from littoral or neritic depths" (1980, p. 146). Either this latter view needs to be modified, or else the present deep marine benthic form is an isomorph of the shallow marsh species. The low number of inflated but not subglobular chambers and their ventralward translation are distinctive. Cushman (1910a) illustrated a form that is apparently too planoconvex, with flattened to depressed ventral chamber surfaces.

Trochammina nana (Brady)

Haplophragmium nana BRADY, 1881, p. 50.---BRADY, 1884, pl. 35, figs. 6-3.

Trochammina nana (Brady). CUSHMAN, 1910a, p. 123, figs. 190-192.---LOEBLICH AND TAPPAN, 1953, p. 50, pl. 8, fig. 5.---BARKER, 1960, p. 72, pl. 35, figs. 6-8.---COLE, 1981, p. 38, pl. 6, fig. 12.

Test low trochospiral and somewhat irregular in later stages, with some chambers added outside plane of coiling, dorsal side evolute and rather flattened, ventral side involute, with final chamber produced ventralward, periphery lobulate and rounded. Chambers 6 in outer whorl, subglobular and radially compressed. Sutures distinct, depressed, radial. Wall moderately finely agglutinated, smoothly finished and rather fragile and glassy. Aperture interiomarginal, extraumbilical, bordered by substantial lip.

Remarks: This species is distinguished by its flattened form, glassy wall, and irregular but not streptospiral chamber arrangement.

Trochammina rotaliformis Heron-Allen and Earland

Trochammina inflata (Montagu) var. BALKWILL AND WRIGHT, 1885, pl. 13, figs. 11,12.

Trochammina rotaliformis HERON-ALLEN AND EARLAND, 1911, p. 309.

NOT *Trochammina rotaliformis* Heron-Allen and Earland. MURRAY, 1971, p. 39, pl. 12, figs. 1-5.

Test trochospiral, dorsal side quite strongly convex, ventral side somewhat flattened, with deep narrow umbilicus, periphery lobulate and asymmetrically

rounded. Chambers 6 in outer whorl, inflated, increasing steadily in size as added, on dorsal side thin curved quadrangular, on ventral side equilateral triangular. Sutures distinct, depressed, radial and straight. Wall finely agglutinated and smoothly finished. Aperture a small interiomarginal umbilical-extraumbilical opening, bordered by fine lip.

Remarks: The planoconvex test and the shape of the chambers on both sides are distinctive. Murray's specimens have already been discussed with reference to Paratrochammina sp. cf. P. squamata.

Subfamily TROCHAMMINELLINAE Brönnimann, Zaninetti, and Whittaker, 1983

Genus Pseudotrochammina Frerichs, 1969

Pseudotrochammina dehiscens (Frerichs)
(Plate 11, Figures 1,2)

Ammoglobigerinoides dehiscens FRERICHS, 1969a, p. 1, pl. 1, fig. 1; pl. 2, fig. 1.

Test rather high trochospiral, a low cone that flares very rapidly, with lobulate and rounded periphery. Chambers globular, inflated. 3 per whorl, chambers within whorls of comparable size, but successive whorls increase rapidly in size, quite closely appressed. Sutures distinct, depressed, straight. Wall quite coarsely agglutinated, rough. Aperture a very small subhorizontal oval opening, centered over first chamber of final whorl rather than penultimate one, not quite basal, surrounded by very fine lip.

Remarks: This species is distinguished from Trochammina quadriloba Höglund by its apertural characteristics as well as having 3 instead of 4 chambers per whorl. Other species of the genus are low trochospiral and compressed.

Superfamily VERNEUILINACEA Cushman, 1911

Family PROLIXOPLECTIDAE Loeblich and Tappan, 1985

Genus Karrerulina Finlay, 1940

Karrerulina apicularis (Cushman)

Caudryina apicularis CUSHMAN, 1911, p. 69, fig. 110.---CUSHMAN, 1921, p. 151, pl. 29, fig. 7.

Karrerella (Karrerulina) apicularis (Cushman). BARKER, 1960, p. 94, pl. 46, figs. 17-19.

Karrerella apicularis (Cushman). COLE, 1981, p. 43, pl. 3, fig. 1.---POAG, 1981, p. 72, pl. 15, fig. 5; pl. 16, fig. 5.---SCHRÖDER, 1986, p. 55, pl. 22, fig. 14.

Test elongate, nearly cylindrical, base bluntly pointed. Chambers initially in a few high trochospiral whorls, with test tapering rapidly, thence triserial for 2 to 3 whorls and test parallel-sided, remaining so for adult biserial stage. Chambers inflated, higher than broad and closely appressed to test axis. Sutures distinct, depressed. Wall quite coarsely agglutinated and rough. Aperture terminal, round, on short neck produced toward inner margin, without lip.

Remarks: The terminal aperture with neck is characteristic, and allows this form to be distinguished from the otherwise similar Eggerella advena.

Family VERNEUILINIDAE Cushman, 1911

Subfamily VERNEUILININAE Cushman, 1911

Genus Gaudryina d'Orbigny, 1839

Gaudryina convexa Cushman

Gaudryina convexa CUSHMAN, 1911, p. 66, fig. 10.

Test elongate, tapering from bluntly pointed base, initially triserial and trihedral with acute margins, later biserial, with one face continuous with trihedral face, the other convex, to produce a somewhat semicircular to trapezoidal section. Chambers significantly broader than high, gently inflated on convex face. Sutures obscure, limbate and flush on flat face, depressed on convex face. Wall coarsely agglutinated and very roughly finished. Aperture a large low interiomarginal arch on depressed re-entrant at upper chamber surface.

Remarks: The final chambers are inflated and rounded on G. triangularis and vars. Cushman, as well as on G. robusta Cushman. Gaudryina quadrangularis Bagg has compressed sides and a quadrangular section in the biserial portion.

Gaudryina sp. A

Test trihedral and triserial for the most part, flaring rather rapidly, may rarely become quadrate in section during biserial development, margins slightly carinate, faces may be slightly concave, base acute. Chambers uninflated, initially triserial, later a brief biserial stage usually develops with triangular section, rarely becomes quadrate. Sutures limbate, flush, somewhat arched. Wall finely agglutinated, smoothly finished. Aperture a small interiomarginal arch, occasionally with slight bordering lip.

Remarks: This smooth trihedral form is also distinguished by its flush sutures and carinate angles.

Superfamily ATAXOPHRAGMIACEA Schwager, 1877

Familv GLOBOTEXTULARIIDAE Cushman, 1927

Subfamily GLOBOTEXTULARIINAE Cushman, 1927

Genus Globotextularia Eimer and Fickert, 1899

Globotextularia anceps (Brady)

Haplophragmium anceps BRADY, 1884, p. 313, pl. 35, figs. 12-15.

Globotextularia anceps Brady. CUSHMAN, 1910a, p. 125, fig. 196.

Globotextularia anceps (Brady). BARKER, 1960, p. 72, pl. 35, figs. 12-15.---
LOEBLICH AND TAPPAN, 1987, p. 143, pl. 150, figs. 1-7.

Test unusual, initially very high trochospiral with several chambers per whorl, soon reduced to 3 per whorl to produce a tapering Eggerella-like stage, rounded in section and virtually without inflation. After a few whorls follows what appears to be a biserial stage with a shifting axis, composed of globular, inflated chambers which produce what appears to be, but is not, a trochoid whorl attached to the earlier stage. Sutures distinct throughout, initially flush and somewhat limbate, increasingly depressed as formed. Wall quite finely agglutinated and smoothly finished. Aperture in the terminal stage nearly basal and conformable to the upper surface of penultimate chamber, not umbilical, surrounded by a narrow lip.

Remarks: This species is completely distinctive.

Superfamily TEXTULARIACEA Ehrenberg, 1838

Family EGGERELLIDAE Cushman, 1937

Subfamily DOROTHIINAE Balakhmatova, 1972

Genus Dorothia Plummer, 1931

Dorothia brevis Cushman and Stainforth

Dorothia brevis CUSHMAN AND STAINFORTH, 1945, p. 18, pl. 2, fig. 5.

NOT? Dorothia brevis Cushman and Stainforth. BOLTOVSKOY, 1978, p. 158, pl. 3, fig. 31.

Test initially trochospiral, almost immediately becoming biserial and flaring very rapidly such that test is as broad as long. Chambers mildly inflated, sutures slightly depressed. Wall finely agglutinated and smoothly finished. Aperture an interiomarginal slit without bordering lip.

Remarks: Karrerella bradyi in some aspects strongly resembles this species, but the former is more elongate with a distinct intermediate triserial stage, and has a lip surrounding the aperture. The specimen figured by Boltovskoy has a lipped aperture, and may belong to K. bradyi.

Dorothia scabra (Brady)

Gaudryina scabra BRADY, 1884, p. 381, pl. 46, fig. 7.---CUSHMAN, 1911, p. 62, figs. 100,101.---CUSHMAN, 1921, p. 146, pl. 28, fig. 5.

Dorothia scabra (Brady). BARKER, 1960, p. 94, pl. 46, fig. 7.

Test elongate, stout, base rounded, initial trochospiral portion very brief and tapering rapidly, thereafter biserial, gently compressed, margins very broadly rounded. Chambers about as high as broad, gently inflated. Sutures distinct, gently depressed in biserial stage. Wall fairly coarsely agglutinated, smoothly finished. Aperture a low interiomarginal arch.

Remarks: Gaudryina flintii Cushman is more strongly tapering and much more lobulate, while G. paupercula Cushman is as broad as long, with very few chambers.

Subfamily EGGERELLINAE Cushman, 1937

Genus Eggerella Cushman, 1935

Eggerella advena (Cushman)

Verneuilina advena CUSHMAN, 1922c, p. 141.---HÖGLUND, 1947, p. 185, p. 189, t.f. 169, pl. 13, fig. 11.

Verneuilina europeum CHRISTIANSEN, 1958, p. 66.

Eggerella advena (Cushman). COLE, 1981, p. 42, pl. 6, fig. 2.

Verneuilinoides europeum (Christiansen). COLE, 1981, p. 42, pl. 6, fig. 1.

Test small, elongate, initially a few high trochospiral whorls, thereafter triserial, tapering very gradually from bluntly rounded base. Chambers subglobular, inflated, quite strongly appressed, may become higher than broad. Sutures distinct, depressed. Wall finely agglutinated and smoothly finished. Aperture a small interiomarginal arch at base of recessed or hooded apertural face.

Remarks: Verneuilina europeum was erected to embrace very small specimens described by Höglund in his emendation of the present species. The distinction is not considered herein to be valid. Bulimina scabra Williamson is more strongly tapering, the final whorl quite broad with respect to the preceeding ones.

Eggerella bradyi (Cushman)

Verneuilina bradyi CUSHMAN, 1911, p. 54, fig. 87.---CUSHMAN, 1921, p. 141, pl. 27, fig. 4.

Eggerella bradyi (Cushman). BARKER, 1960, p. 96, pl. 47, figs. 4-7.---
BOLTOVSKOY, 1978, p. 158, pl. 3, fig. 33.---CORLISS, 1979, p. 5, pl. 1, figs. 3,4.---BURK 1981, pl. 1, fig. 6.---MEAD, 1985, p. 225, pl. 1, fig. 1.---
BELANGER AND BERGGREN, 1986, p. 331, pl. 1, fig. 1.

Test elongate, high trochospiral for one or two whorls at most, followed by regular triserial chamber arrangement. Chambers somewhat inflated, but broader than high. Wall very finely agglutinated and smoothly finished. Aperture nearly interiomarginal, an arcuate slit, concave up, surrounded completely by a distinct rim or lip.

Remarks: Karrerella bradyi (Cushman) is remarkably similar, but in addition to having a biserial terminal stage, is also characterized by an aperture which follows the upper surface of the penultimate chamber and is therefore convex

upward.

Genus Karreriella Cushman, 1933

Karreriella bradyi (Cushman)

Gaudryina bradyi CUSHMAN, 1911, p. 67, fig. 107.---CUSHMAN, 1921, p. 149, pl. 29, fig. 3.---CUSHMAN, 1932, p. 13, pl. 3, figs. 8,9.

Karreriella bradyi (Cushman). BARKER, 1960, p. 94, pl. 46, figs. 1-4.---MURRAY, 1971, p. 47, pl. 16, figs. 1-4.---CORLISS, 1979, p. 5, pl. 1, figs. 5,6.---HERMELIN AND SCOTT, 1985, p. 212, pl. 1, fig. 8.---BELANGER AND BERGGREN, 1986, p. 331, pl. 1, fig. 2.

Karreriella novangliae (Cushman). BARKER, 1960, pl. 46, not fig. 8, figs. 9,10 only.

Dorothia brevis Cushman and Stainforth. ?BOLTOVSKOY, 1978, p. 158, pl. 3, fig. 31.

Test elongate, with very brief initial trochospiral stage, rapidly becoming triserial, then biserial for the greatest part of its length. Chambers mildly to quite strongly inflated, nearly globular and often somewhat distorted. Wall very finely agglutinated and smoothly finished. Aperture not quite interiomarginal, a low slit following the contour of the penultimate chamber and surrounded by a raised rim. Aperture often distinctly eccentric, especially in earliest biserial whorls.

Remarks: The distinction of this species from D. brevis and Eggerella bradyi has already been discussed, as has the problem with Boltovskoy's figured specimen. The occasional distortion of specimens recovered in the present study is not considered sufficient to warrant assignment to Gaudryina baccata Schwager, which is strongly twisted, or G. baccata var. novangliae Cushman, which is somewhat less frequently twisted and has a more strongly lipped aperture than Schwager's species.

Family TEXTULARIIDAE Ehrenberg, 1838

Subfamily TEXTULARIINAE Ehrenberg, 1838

Genus Textularia DeFrance, 1824

Textularia agglutinans d'Orbigny

Textularia agglutinans d'ORBIGNY, 1839a, p. 144, pl. 1, figs. 17,18,32-34.---CUSHMAN, 1911, p. 9, fig. 10.---CUSHMAN, 1921, p. 106, pl. 20, fig. 8.---CUSHMAN, 1932, p. 10, pl. 2, figs. 5-7.---BARKER, 1960, p. 88, pl. 43, figs. 1-3.---COLE, 1981, p. 35, pl. 17, fig. 6.

Test elongate, biserial, gently compressed, tapering gradually from rounded base, periphery well rounded. Chambers inflated, at least 1 1/2 times as broad as high, increasing steadily but not rapidly in size as added. Sutures distinct, depressed, nearly horizontal. Wall rather coarsely agglutinated and roughly finished. Aperture a fairly large interiomarginal arch.

Remarks: The rounded periphery and steady increase in all chamber dimensions is quite distinctive. Textularia earlandi Parker is much more elongate, and slender, with chambers as high as broad.

Textularia candeiana d'Orbigny

Textularia candeiana d'ORBIGNY, 1839a, p. 143, pl. 1, figs. 25-27.

NOT Textularia candeiana d'Orbigny. CUSHMAN, 1911, p. 12, figs. 14-17.

Test elongate, biserial, tapering quite strongly from acute base, quite strongly compressed, periphery initially acute, eventually broadly rounded. Chambers broader than high throughout, initially barely inflated, but increasingly inflated as added, thickness also rapidly increasing, upper chamber surfaces strongly inflated and upper test outline rounded. Sutures distinct, increasingly depressed as added, somewhat oblique. Wall rather coarsely agglutinated and roughly finished. Aperture a very broad and rather low interiomarginal arch.

Remarks: The rapid increase of test breadth and thickness, and the change from acute to rounded periphery, distinguish this species from most. Textularia sp. A, to which Cushman's specimens are herein referred, is truncate at the top, the upper surfaces are somewhat sunken, and the aperture is very narrow, almost semicircular.

Textularia fistulosa Brady

Textularia sagittula DeFrance var. fistulosa BRADY, 1884, p. 362, pl. 42, figs. 19-22.-
--BARKER, 1960, p. 86, pl. 42, figs. 19-22.

NOT Textularia sagittula DeFrance var. fistulosa Brady. CUSHMAN, 1921, p. 104, pl. 20, fig. 6.

Test elongate, biserial, tapering gradually, strongly compressed, lenticular in

section, margins acute apart from tubules. Chambers broader than high, very slightly inflated, with margins extended as tubules, usually broken but with tendency to be directed basalward. Sutures distinct, slightly depressed, oblique. Wall fairly finely agglutinated but roughly finished. Aperture an interiomarginal arch.

Remarks: Textularia agglutinans d'Orbigny var. fistula Cushman has a more rounded section, with appressed subglobular chambers that would be rounded in section if not for the tubulose extensions. Cushman (1921) illustrated a fragment that was parallel-sided with well inflated broad chambers, and it does not belong to either species.

Textularia horrida Egger

Textularia horrida EGGER, 1893, p. 270. pl. 6, figs. 11,12.---CUSHMAN, 1911, p. 10, fig. 12.

Test biserial, flaring quite rapidly, slightly longer than broad, faces flattened, periphery rounded. Chambers slightly inflated, a bit broader than high, increasing fairly rapidly in breadth and thickness as added. Sutures depressed, somewhat obscured due to texture. Wall very coarsely and irregularly agglutinated, with much protruding material. Aperture a low interiomarginal arch.

Remarks: This species is distinguished from most coarsely agglutinated forms by its rapidly tapering outline, and from the remainder by its flattened faces with rounded margins.

Textularia milletti Cushman

Textularia milletti CUSHMAN, 1911, p. 13, figs. 18,19.

Spiroplectammina milletti (Cushman). CUSHMAN, 1932, p. 7, pl. 1, fig. 5.

Test biserial, stout, as broad as long, strongly compressed with flattened faces and acute margins, base very broadly rounded. Fairly large proloculus followed by strongly arched and laterally embracing chambers while test increases very rapidly in breadth, thereafter less strongly arched and embracing, and test tapering less rapidly, upper surface of test broadly rounded. Chambers with inflated upper

surfaces and depressed lateral faces, and sutures depressed, producing series of transverse curved ridges and depressions on the face of test. Wall rough but very clear on chamber faces. Aperture a low interiomarginal opening.

Remarks: The chamber arrangement is easily seen because of the clear chamber faces, and there is definitely no initial coil. Rather, the chambers are strongly arched and embracing at that point. Textularia conica d'Orbigny var. corrugata Heron-Allen and Earland is much thicker, has rounded margins, and a very coarse surface.

Textularia sp. A

Textularia candeiana d'Orbigny. CUSHMAN, 1911, p. 12, figs. 14-17.

Test elongate, biserial, quite rapidly tapering, base rounded to bluntly pointed, apertural end broad and truncate, periphery initially acute or narrowly rounded, later broadly rounded. Chambers broader than high throughout, increasing very rapidly in thickness and breadth as added, only later chambers significantly inflated, upper chamber surfaces somewhat sunken, but margins still convex. Sutures distinct, horizontal, nearly flush becoming gently depressed. Wall quite roughly finished. Aperture a nearly semicircular opening in interiomarginal depression.

Remarks: The distinction of this species from T. candeiana has already been discussed.

Textularia sp. B

Test biserial, triangular in outline, as broad as long and apical angle obtuse, base somewhat rounded, test compressed with acute and carinate margins, carinae ragged, thin, and broad. Chambers very low and broad, only rarely inflated at all, increasing very rapidly in breadth and fairly rapidly in thickness as added. Sutures obscure, subhorizontal. Wall finely agglutinated but roughly finished. Aperture a low opening, with thin upper border, at depressed inner margin, upper chamber surfaces sunken below raised and rounded margins.

Remarks: Textularia abbreviata d'Orbigny has a lobulate rather than ragged outline, and is relatively thicker, while T. conica d'Orbigny has rounded rather than acute margins.

Textularia sp. C

Test elongate, biserial, compressed but rather thick, not quite twice as long as broad, tapering from unknown but probably narrowly rounded base, straight sided; periphery barely lobulate, obscured somewhat by coarse grain size, rounded, faces of test concave. Chambers broader than high, becoming gently inflated. Sutures initially obscure, later distinct when gently depressed, slightly oblique. Wall quite coarsely agglutinated and roughly finished. Aperture a fairly large interiomarginal arch.

Remarks: This form is distinguished by its relatively gradual taper, and rounded periphery with excavated faces.

Subfamily SIPHOTEXTULARIINAE Loeblich and Tappan, 1985

Genus Siphotextularia Finlay, 1939

Siphotextularia catenata (Cushman)

Textularia catenata CUSHMAN, 1911, p. 23, figs. 39,40.---CUSHMAN, 1921, p. 112, pl. 23, fig. 5.

Siphotextularia flintii (Cushman). MURRAY, 1971, p. 33, pl. 9, figs. 6-8.

Siphotextularia catenata (Cushman). CORLISS, 1979, p. 5, pl. 1, figs. 1,2.

Siphotextularia sp. BURKE, 1981, pl. 1, figs. 4,5.

Siphotextularia rolshauseni Phleger and Parker. HERMELIN AND SCOTT, 1985, p. 217, pl. 1, figs. 6,7.

Test elongate, biserial, periphery rounded and lobulate. Chambers subglobular, inflated, increasing steadily and regularly in size as added. Sutures distinct, depressed, at an oblique angle to axis of test. Wall finely agglutinated, smoothly finished. Aperture subterminal, rounded, on short neck.

Remarks Textularia flintii Cushman has chambers much broader than high, hence Murray's specimens are referred herein to the present species. Siphotextularia

rolshauseni Phleger and Parker is characterized by a much less rapid increase in test width, being almost parallel-sided, with sutures nearly perpendicular to the test axis. Corliss believed it to be a junior synonym of S. catenata. The specimen illustrated by Hermelin and Scott in pl. 1, fig. 7 is definitely S. catenata, while the specimen in pl. 1, fig. 6 is likely the same, although this is uncertain as it is only an edge view.

Siphotextularia concava (Karrer)

Plecanium concavum KARRER, 1868, p. 129, pl. 1, fig. 3.

Textularia concava (Karrer). ?CUSHMAN, 1911, p. 22, fig. 38.

NOT Textularia concava (Karrer). CUSHMAN, 1932, p. 13, pl. 3, fig. 6.

Siphotextularia concava (Karrer). BARKEK, 1960, p. 86, pl. 42, figs. 13,14.

Test elongate, biserial, almost 1 1/2 times as long as broad, tapering quite rapidly from base which is acute to bluntly pointed, section compressed and quadrate to slightly rhomboid, with 4 distinct marginal angles, faces excavated and periphery convex. Chambers low and broad, very slightly arched. Sutures flush, oblique, slightly limbate. Wall quite finely agglutinated but rough. Aperture slightly oval, near base of final chamber, surrounded by very fine lip.

Remarks: This species is characterized by its concave faces, and so Cushman's (1911) identification is questioned because his specimen does not apparently have concave faces nor angled margins. The form illustrated by Cushman (1932) has acute compressed margins and a fusiform rather than quadrate section.

Siphotextularia mestayerae Vella

Siphotextularia mestayerae VELLA, 1957, p. 17, pl. 4, figs. 55-57.

Test elongate, biserial, quite rapidly tapering, base very narrowly rounded, apertural end convex and rounded, section slightly rhomboid because plane of biseriality oblique to peripheral plane, periphery slightly lobulate and broadly rounded. Chambers inflated, about twice as broad as high. Sutures distinct, depressed, oblique. Wall very finely agglutinated, smoothly finished, thin. Aperture nearly interiomarginal, a subvertical, fairly high slit surrounded by thin and fairly high

lip.

Remarks: The chamber shape distinguishes this species from most, while Textularia flintii Cushman is not rhomboid in section, and its aperture is horizontal.

Siphotextularia sp. A

Test elongate, biserial, very slender and gradually but steadily tapering, compressed and quite thin, base pointed, periphery lobulate and rounded. Chambers inflated, globular, as high as broad, appressed. Sutures distinct, depressed, nearly horizontal. Wall very finely agglutinated and smoothly finished. Aperture subterminal, round, on very short fine neck without lip.

Remarks: This species is readily distinguished from both S. catenata and S. rolshauseni Phleger and Parker by its much more slender and delicate appearance.

Siphotextularia sp. B

Test elongate, biserial, about twice as long as broad, faces flattened, base rounded, periphery very broadly rounded. Chambers obscure, just broader than high, not inflated. Sutures oblique, flush, very obscure. Test coarsely agglutinated and roughly finished. Aperture terminal, on short neck with thick walls, crescentic but with rounded corners; terminal position may be due to presence of very large sand grain at inner margin.

Remarks: The large robust rounded test with obscure chambers and sutures is distinctive.

Family VALVULINIDAE Berthelin, 1880

Subfamily VALVULININAE Berthelin, 1880

Genus Clavulina d'Orbigny, 1826

Clavulina pacifica Cushman

Clavulina angularis d'Orbigny. CUSHMAN, 1911, p. 74, figs. 120-122.---CUSHMAN, 1921, p. 155, pl. 31, fig. 3.

Clavulina pacifica CUSHMAN, 1924, p. 22, pl. 6, figs. 7-11.---CUSHMAN, 1932, p. 16, pl. 4, figs. 4,7,9.---BARKER, 1960, p. 98, pl. 48, figs. 22-24.

Test elongate, initially triserial and triangular in section, twisted on axis and

rapidly tapering, angles acute to somewhat carinate; thereafter uniserial, rectilinear, parallel-sided, triangular in section, margins angled but not acute. Chambers in uniserial stage very mildly inflated, not increasing in breadth as added, terminal chamber as high as broad, upper surface convex and rounded. Sutures distinct, very gently depressed, arched upward in middle of faces and excavated, and directed basalward at margins. Wall somewhat rough but heavily cemented and polished. Aperture terminal, round, truncate, without evident neck or tooth.

Remarks: Clavulina angularis has a triangular final chamber, often with concave faces, and a produced terminal apertural neck.

Suborder	SPIRILLININA Hohenegger and Piller, 1975
Family	PATELLINIDAE Rhumbler, 1906
Subfamily	PATELLININAE Rhumbler, 1906
Genus	<u>Patellina</u> Williamson, 1858

Patellina corrugata Williamson

Patellina corrugata WILLIAMSON, 1858, p. 46, pl. 3, figs. 86-89.---CUSHMAN, 1915, p. 9, t.f. 8, pl. 7, fig. 1.---BARKER, 1960, p. 178, pl. 86, figs. 1-7.---MURRAY, 1971, p. 147, pl. 61, figs. 2-5.---LAGOE, 1977, p. 126, pl. 4, figs. 11, 14.---COLE, 1981, p. 99, pl. 19, figs. 62, 63.---WARD AND WEBB, 1986, p. 194, pl. 5, figs. 13, 14.---LOEBLICH AND TAPPAN, 1987, p. 306, pl. 320, figs. 7-14.

Test patelliform, subcircular in outline, very delicate, dorsal side evolute and flaring rapidly from globular proloculus, ventral side concave and involute, periphery very slightly lobulate, acute and carinate. Chambers in adult almost annular, 2 per whorl, very low, embracing, uninflated. Sutures distinct, limbate on dorsal side, obscure ventrally. Wall with numerous radial ridges reflecting internal partitions, connected to peripheral margin but stopping short of umbilical or inner margin, producing characteristic corrugated appearance to entire dorsal surface and outer whorl on ventral side. Aperture opening into highly complex excavated umbilical region.

Remarks: There is but a single broken specimen in the present material, and a somewhat simplified description is thus given. It may more properly belong to

Patellina corrugata Williamson var. formosa Heron-Allen and Earland, in which the dorsal profile is more hyperbolic or concave, and the test flattened.

Suborder MILIOLINA Delage and Hérouard, 1896

Superfamily CORNUSPIRACEA Schultze, 1854

Family CORNUSPIRIDAE Schultze, 1854

Subfamily CORNUSPIRINAE Schultze, 1854

Genus Cornuspira Schultze, 1854

Cornuspira involvens (Reuss)

Operculina involvens REUSS, 1850, p. 370, pl. 46, fig. 20

Cornuspira involvens (Reuss). CUSHMAN, 1917a, p. 25, pl. 1, fig. 2; pl. 2, fig. 2.---CUSHMAN, 1921, p. 389, pl. 77, figs. 3,4.---CUSHMAN, 1932, p. 67, pl. 16, fig. 2.---BARKER, 1960, p. 22, pl. 11, figs. 1-3.

Cyclogyra involvens (Reuss). MURRAY, 1971, p. 53, pl. 18, figs. 1-3.---COLE, 1981, p. 46, pl. 8, fig. 6.---WARD AND WEBB, 1986, p. 181, pl. 1, fig. 11.

Cyclogyra invoivens? (Reuss). LAGOE, 1977, p. 119, pl. 1, fig. 6.

Test planispiral, discoidal, gently biconcave, consisting of globular proloculus followed by single unbroken tubular chamber in 5 or more whorls that overlap significantly. Wall smooth except for irregular constrictions or varices. periphery rounded and spiral suture depressed. Aperture terminal, round, with concave bottom where preceding whorl is overlapped.

Remarks: The lack of ornamentation distinguishes this species from most others in the genus. Operculina carinata Costa has a carinate periphery, while Cornuspira crassisepia Brady has much more numerous whorls, a limbate spiral suture, and truncate periphery.

Family FISCHERINIDAE Millett, 1898

Subfamily NODOBACULARIELLINAE Bogdanovich, 1981

Genus Wiesnerella Cushman, 1933

Wiesnerella auriculata (Egger)

Planispirina auriculata EGGER, 1893, p. 245, pl. 3, figs. 13-15.---CUSHMAN, 1932, p. 72, pl. 16, fig. 6.

Wiesnerella auriculata (Egger). POAG, 1981, p. 88, pl. 53, fig. 4; pl. 54, fig. 4.

Test elongate oval, 1 1/2 times as long as broad, strongly compressed, periphery acute to narrowly rounded, base rounded. Chambers with arrangement initially obscure, ultimately 2 per whorl, rather elongate, with rather sunken faces near periphery. Sutures gently depressed, nearly obscure. Aperture a terminal ovate opening, eccentric with respect to the peripheral plane, with strongly everted or flaring lip, subcircular and flattened.

Remarks: The chamber shape and apertural lip are distinctive.

Family NUBECULARIIDAE Jones, 1875
Subfamily NODOBACULARIINAE Cushman, 1927
Genus Nubeculina Cushman, 1924

Nubeculina divaricata (Brady)

Sagrina divaricata BRADY, 1879, p. 276, pl. 8, figs. 22-24.

Nubeculina divaricata (Brady). CUSHMAN, 1932, p. 48, pl. 11, figs. 5,6.---BARKER, 1960, p. 158, pl. 76, figs. 11-16.

Test elongate, gently tapering, very obscure initial milioline coil followed by uniserial subfusiform to elongate oval chambers, loosely appressed to separated by long stolon-like necks, and sutures not distinct. Wall calcareous imperforate, with extremely coarse sand grains incorporated into and often penetrating wall, in such cases often a very fine porcelaneous film lines the interior surface of the grain; apertural necks without agglutinated material. Aperture terminal, on long slender neck, with furrows reflecting infolding of wall to produce internal longitudinal plates that appear as fine teeth in apertural view, with distinct everted lip at top. A broken specimen reveals the manner of chamber addition, wherein the neck is extended a short distance beyond the lip. The subsequent chamber embraces much of the neck, which becomes thick-walled and polygonal in section. That chamber expands well outside the neck and lip, and within it and near its base is a thin porcelaneous plate, strongly concave upward, but also drawn upward in the middle

where it is pierced by and joined to the extension of the neck beyond the lip.

Remarks: Nubecularia divaricata (Brady) var. advena Cushman has chambers which are always appressed, a short neck, and coarse teeth.

Family OPHTHALMIDIIDAE Wiesner, 1920

Genus Cornuloculina Burbach, 1886

Cornuloculina inconstans (Brady)

Haucrina inconstans BRADY, 1879, p. 168.

Ophthalmidium inconstans (Brady). BRADY, 1884, pl. 12, figs. 5,7,8.

Ophthalmidium inconstans Brady. CUSHMAN, 1917a, p. 28, pl. 3, figs. 1-4.

Ophthalmidium inconstans (Brady). CUSHMAN, 1921, p. 393, pl. 78, figs. 2,3.

Haucrinella inconstans (Brady). BARKER, 1960, p. 24, pl. 12, figs. 5,7,8.

Cornuloculina inconstans (Brady). COLE, 1981, p. 48, pl. 9, fig. 2.---HERMELIN AND SCOTT, 1985, p. 206, pl. 1, fig. 12.

Test planispiral, globular proloculus followed by non-septate tube of 2 or more whorls, chambers thereafter somewhat spiroloculine, approximately half of test circumference, but usually a little more than 2 chambers per whorl in the adult. Surface gently undulose, periphery with ragged keel which forms a flange separating successive whorls. Aperture a compressed terminal slit.

Remarks: Ophthalmidium tumidulum Brady has inflated chambers and a rounded periphery, so that the whorls meet along a suture. The present specimens exhibit only the completion of the non-septate phase, with no spiroloculine chambers.

Superfamily MILIOLACEA Ehrenberg, 1839

Family SPIROLOCULINIDAE Wiesner, 1920

Genus Spiroloculina d'Orbigny, 1826

Spiroloculina antillarum d'Orbigny

Spiroloculina antillarum d'ORBIGNY, 1839a, p. 166, pl. 9, figs. 3,4.---CUSHMAN, 1921, p. 407, pl. 81, fig. 4; not pl. 83, fig. 4.---CUSHMAN, 1932, p. 36, pl. 9, figs. 3-5.---BARKER, 1960, p. 20, pl. 10, fig. 21.---BOLTOVSKOY, 1978, p. 169, pl. 7, fig. 13.

Spiroloculina grata Terquem. CUSHMAN, 1917a, p. 35, pl. 7, figs. 3,4.

Spiroloculina angulata Cushman. BARKER, 1960, p. 20, pl. 10, figs. 16,17 only.

Test eccentric fusiform in outline, base produced and well rounded, apertural end with fairly long cylindrical neck with distinct lip, periphery well rounded. Chambers after large globular proloculus spiroloculine i.e. 2 per whorl, strongly curved and very slightly tapering from base to aperture, apertural end reversed from chamber to chamber, each whorl much larger, particularly in thickness, than preceeding whorl. Sutures deep and distinct. Surface ornamented with longitudinal costae. Aperture terminal, round, at end of neck, with very small simple tooth on inner margin.

Remarks: This species differs from S. grata, in which the chambers are much broader at the base than apertural end and whose asymmetry, end to end, is much more pronounced, and also differs from S. grata Terquem var. angulata Cushman, which has a truncate to angled periphery that is also carinate. The specimen illustrated in Cushman (1921) as pl. 83, fig. 4 has oblique ridges or crenulations on the chambers that run inward and down, rather than longitudinal costae.

Spiroloculina communis Cushman and Todd

Spiroloculina communis CUSHMAN AND TODD, 1944, p. 63, pl. 9, figs. 4,5---
BARKER, 1960, p. 20, pl. 10, figs. 3,4.

Test fusiform, biloculine, base narrowly rounded to pointed, faces strongly excavated, edges concave or excavated with carinate margins. Long axis and line of greatest width are mutually perpendicular. Chambers in few whorls, 3 pairs of chambers prominent, increasing rapidly, especially in thickness, as added. Outer margins of chambers project above inner margins of succeeding chambers, from which they are separated by depressed sutures. Aperture terminal, round, on neck with lip and "T"-shaped tooth at inner margin.

Remarks: The variant described by Cushman and Todd, and also described and illustrated by Barker (1960, p.18, pl. 9, figs. 5,6), with convex chamber edges, was

not seen in the present study. Spiroloculina canaliculata d'Orbigny is too strongly compressed and has too many slowly expanding chambers, S. impressa Terquem has carinate but flat edges, and a narrow aperture with no tooth, and S. depressa d'Orbigny lacks a type description and the type figure is of a specimen with the aperture broken away.

Spiroloculina pusilla Earland

Spiroloculina pusilla EARLAND, 1934, p. 47, pl. 1, figs. 3,4.---BOLTOVSKOY, 1978, p. 169, pl. 7, fig. 15.

Spirophthalmidium pusillum (Earland). BARKER, 1960, p. 20, pl. 10, figs. 9,10.

Ophthalmidium pusillum (Earland). CORLISS, 1979, p. 5, pl. 1, figs. 7,8.---COLE, 1981, p. 48, pl. 9, fig. 1.---HERMELIN AND SCOTT, 1985, p. 214, pl. 1, fig. 10.

Test elongate fusiform, flattened but irregular, periphery rounded, base produced and rounded. Chambers long, narrow and tubular, added in spiroloculine fashion, exactly 2 per whorl, with axes slightly angled with respect to preceding chambers, but still predominately in same plane. Sutures depressed. Aperture terminal, round, on short produced cylindrical neck.

Remarks: Its rounded margin distinguishes the present species from Spiroloculina acutimargo Brady, the type species of Spirophthalmidium Cushman, which has a carinate periphery and intercameral flanges. The distinct spiroloculine arrangement for all the discernible chambers of the present species prevents assignment to Ophthalmidium Kübler, wherein chambers may occupy an entire whorl.

Spiroloculina sp. A

Test elongate, slender fusiform, nearly 3 times as long as broad, strongly flattened, thin lenticular in section, margins acute, base rounded, apertural end with produced neck. Chambers uninflated, thin, sutures depressed but somewhat obscure, due to longitudinal costae. Aperture not observed as neck is broken off.

Remarks: This form is distinguished by its very flat test with costae and acute margins.

Family HAUERINIDAE Schwager, 1876

Subfamily HAUERININAE Schwager, 1876

Genus Hauerina d'Orbigny, 1839

Hauerina complanata Dakin

Hauerina complanata DAKIN, 1906, p. 231, fig. 7.

Test discoidal, compressed, periphery narrowly rounded to subacute, somewhat irregular but essentially circular and entire. Initial small milioline stage is followed by several planispiral whorls, initially with 2 chambers per whorl, but terminating with a full 4. Chambers not too wide, less than 1/4 of test diameter. Sutures quite strongly curved, somewhat oblique, and very gently depressed if at all. Inner whorls obscured by secondary deposits, and surfaces of test flat, not the least concave. Aperture a curved and convex porous trematophore-like plate at end of final chamber.

Remarks: Many other species of this genus have much broader chambers in proportion to the test diameter, while Spiroloculina fragilissima Brady has only 2 chambers per whorl and is much thinner. Hauerina exigua Brady is identical in all respects except for the aperture, which is a terminal compressed slit. It is the type species of the genus Planispirinella Wiesner.

Genus Massilina Schlumberger, 1893

Massilina sp. A

Test somewhat ovate to quadrate in outline, rather flattened but thick, base and apertural end broadly rounded, sides subparallel, periphery well rounded. Chambers initially quinqueloculine, later 2 per whorl in same plane in spiroloculine fashion, "J"-shaped, completely embracing at base, but at apertural end not even close to reaching furthest extremity. Sutures very slightly depressed, wall smooth. Aperture at open end of final chamber, well below apex or maximum length of test, furnished with simple short thick tooth.

Remarks: The rounded periphery, "J"-shaped chambers, and aperture opening

well short of the end of the test are distinctive.

Genus Quinqueloculina d'Orbigny, 1826

Quinqueloculina angulata (Williamson)

Miliolina bicornis (Walker and Jacob) var. angulata WILLIAMSON, 1858, p. 88, pl. 7, fig. 196.

Quinqueloculina bicornis (Walker and Jacob) var. angulata (Williamson). MURRAY, 1971, p. 59, pl. 21, figs. 1-5.

Test fusiform in outline, almost twice as long as broad, base rounded, margins truncate with blunt carinae. Chambers quinqueloculine, quadrate in section, faces very slightly depressed below level of marginal carinae. Sutures rather obscure, very slightly incised between raised chamber margins. Surface with very fine, discontinuous longitudinal striae and scratches or grooves. Aperture terminal, barely produced, quadrate, with simple flat tooth projecting from inner margin.

Remarks: The truncate, bluntly carinate margins, and finely grooved faces, are distinctive.

Quinqueloculina bicostata d'Orbigny

Quinqueloculina bicostata d'ORBIGNY, 1839a, p. 195, pl. 12, figs. 8-10.---
CUSHMAN, 1917a, p. 47, pl. 13, fig. 1.

Quinqueloculina bicostata d'Orbigny forma typica ?POAG, 1981, p. 77, pl. 63, fig. 1; pl. 64, fig. 1.

Test ovate, base eccentrically projected and rounded, periphery and chamber margins with 2 quite closely spaced carinae. Chambers quinqueloculine, may be very gently convex in middle of faces, but overall impression is of concave faces between margins. Surface smooth, sutures virtually undetectable. Aperture terminal, rounded, on short neck but not produced, with simple tooth.

Remarks: Poag's illustrated specimen is not as markedly concave on the faces as is the type or the present material, but is nothing like Q. bicarinata Terquem, which has inflated chambers with markedly convex faces.

Quinqueloculina collumnosa Cushman

Quinqueloculina collumnosa CUSHMAN, 1922b, p. 65, pl. 10, fig. 10.

Quinqueloculina collumnosa Cushman forma excavata POAG, 1981, p. 78, pl. 63, fig. 3; pl. 64, fig. 3.

Test thick and extremely broad fusiform to ovate where nearly as broad as long, both ends produced as asymmetrically rounded points, aperture on neck, margins acute, carinate, usually slightly undulose, while chamber surfaces are concave or excavated. Chambers quinqueloculine, uninflated, increasing not too rapidly in size as added, and of virtually constant breadth top to bottom. Sutures obscure, situated in depressions between previous margins. Wall smooth. Aperture terminal, round, on short neck with flared lip and simple tooth on inner margin, or rarely somewhat ovate without appreciable neck and a longer tooth.

Remarks: The symmetrical, broad outline, carinate and gently undulose margins, and sunken faces are distinctive, and the form is nowhere near as wrinkled and elongate as Quinqueloculina sp. E. The surfaces of Poag's specimens are more strongly excavated.

Quinqueloculina costata Terquem

Quinqueloculina costata TERQUEM, 1878, p. 63, pl. 6, figs. 3-5.

Quinqueloculina costata d'Orbigny. CUSHMAN, 1917a, p. 49, pl. 15, fig. 1.---
CUSHMAN, 1932, p. 20, pl. 5, figs. 6,7.

Test elongate oval in outline, almost twice as long as broad, periphery rounded to slightly angled, base entire and rounded. Chambers quinqueloculine, strongly overlapping and appressed, widest at base, narrow in the middle, then wider again at the apertural end. Sutures distinct but not much depressed. Entire surface of test covered in slightly oblique and twisted costae, not parallel to margins. Aperture terminal, compressed, on very short neck with gently flared lip and simple tooth.

Remarks: The discrepancy in authorship is accounted for by the fact that Q. costata d'Orbigny was judged to be nom. nud. This species differs from both Q. boueana d'Orbigny and Q. crassa d'Orbigny var. subcuneata Cushman which are much more broadly ovate. Serpula bicornis Walker and Jacob. is very poorly described and illustrated, but it appears among other things that the costae are truly

longitudinal.

Quinqueloculina elongata Natland

Quinqueloculina elongata NATLAND, 1938, p. 141, pl. 4, fig. 5.

NOT Quinqueloculina elongata Natland. COLE, 1981, p. 50, pl. 13, fig. 11.---
HERMELIN AND SCOTT, 1985, p. 216, pl. 2, fig. 2.

Test quadrate in outline, between 1 1/2 and 2 times as long as broad, sides parallel, base and apertural end truncate but with rounded corners. Chambers "J"- or "L"-shaped, rather narrow, with angled and carinate margins, the carinae may bifurcate for much of the basal half of later chambers. Sutures gently depressed, somewhat obscure. Aperture terminal, round, with very slight thin produced lip, and well developed tooth.

Remarks: The quadrate outline, carinate margins, and characteristic chamber shape are distinctive. Cole, as well as Hermelin and Scott, referred elongate, smooth forms with rounded periphery to this species. The former specimens are the same as Quinqueloculina sp. B of this paper. The latter reference could conceivably belong to Q. lata, but looks rather elongate and tapering, or Quinqueloculina sp. C, although the position of the aperture would not appear to be near enough terminal. Because of the uncertainty, it has not been reassigned herein.

Quinqueloculina lamarckiana d'Orbigny

Quinqueloculina lamarckiana d'ORBIGNY, 1839a, p. 189, pl. 11, figs. 14,15.---

CUSHMAN, 1921, p. 418, t.f. 22,23, pl. 87, figs. 2,3.---CUSHMAN, 1932, p. 24, pl. 6, fig. 2.---BARKER, 1960, p. 10, pl. 5, fig. 12, not fig. 7.

Test broadly ovate in outline, at most 1 1/2 times as long as broad, thick, irregularly polygonal rather than triangular in section, base rounded to eccentrically angled, not much indented, periphery subacute to acute, not markedly carinate. Chambers neither very broad nor strongly embracing, sutures somewhat indistinct. Aperture terminal, round, with simple tooth, extremity of final chamber in outline an oblique extension of penultimate chamber.

Remarks: This form is frequently less broad than d'Orbigny's type, and never

develops the stout oblique neck figured by him. This species may be distinguished from Q. auberiana d'Orbigny, which is relatively thicker, broader, and more circular in outline, has broader, more strongly embracing chambers, and an aperture which is recessed somewhat from the oral extremity of the test. Barker referred the specimen illustrated in pl. 5, fig. 7 to the present species, but it belongs in Q. venusta as Brady had originally believed.

Quinqueloculina lata Terquem

Quinqueloculina lata TERQUEM, 1876, p. 82, pl. 11, fig. 8.---MURRAY, 1971, p. 63, pl. 23, figs. 1-3.

Test quadrate in outline and rounded triangular in section, over twice as long as broad in some instances, base broadly rounded and apertural end truncate and slightly oblique, periphery rounded. Chambers "L"-shaped, uninflated, completely embracing at base. Sutures nearly flush, rather indistinct, nearly longitudinal. Wall smooth. Aperture terminal, an oval opening without inner marginal wall, furnished with simple tooth projecting from base of penultimate chamber.

Remarks: The quadrate form with flush sutures is distinguished from Q. elongata by its rounded rather than carinate periphery.

Quinqueloculina parkeri (Brady)

Miliolina parkeri BRADY, 1881, p. 46.---BRADY, 1884, pl. 7, fig. 14.

Quinqueloculina parkeri (Brady). CUSHMAN, 1917a, p. 50, pl. 15, fig. 3.---CUSHMAN, 1921, p. 440, pl. 86, fig. 4.---CUSHMAN, 1932, p. 25, pl. 6, figs. 3,4.---BARKER, 1960, p. 14, pl. 7, fig. 14.

Test broadly ovate in outline, quite thick, base rounded, margins acute to angular and very narrow!v rounded. Chambers quinqueloculine, not inflated, characterized by transverse crenulations or ridges which affect the outline as well, and between these ridges are longitudinal costae that are quite fine and closely spaced. Sutures rather indistinct, not much depressed. Aperture apparently quite strongly compressed, slightly produced, with a long thin tooth parallel to the plane of compression.

Remarks: The aperture was broken on the single specimen of the present study. Only certain species of Hauerina are similar, but differ in having much broader, flattened chambers, as well as the multiple aperture characteristic of that genus.

Quinqueloculina pygmaea Reuss

Quinqueloculina pygmaea REUSS, 1850, p. 384, pl. 50, fig. 3.

Quinqueloculina cf. Q. pygmaea Reuss. BOLTOVSKOY, 1978, p. 167, pl. 6, figs. 34-36.

Test elongate, more than twice as long as broad, parallel-sided, somewhat compressed triangular in section, the ends thicker than the middle, periphery rounded, base asymmetrically and broadly rounded. Chambers elongate, not inflated, surface gently undulose to produce distinctive wrinkled appearance to test. Sutures very obscure, nearly flush. Aperture terminal, rounded, on large convex upper surface of chamber, with small tooth and no lip.

Remarks: The rounded periphery and parallel-sided, wrinkled test distinguish this species, although this latter aspect is not discernible on Reuss's type figure. Quinqueloculina tropicalis Cushman differs in having a granular surface, with cemented grains, and also has depressed sutures.

Quinqueloculina reticulata (d'Orbigny)

Triloculina reticulata d'ORBIGNY, 1826, p. 299.

Quinqueloculina reticulata (d'Orbigny). CUSHMAN, 1917a, p. 55, pl. 16, figs. 1,2,3.

NOT? Quinqueloculina reticulata (d'Orbigny). ASANO, 1951, pt. 6, p. 6, figs. 35,36.

Quinqueloculina reticulata d'Orbigny. BARKER, 1960, p. 18, pl. 9, fig. 4.

Test somewhat fusiform in outline, over twice as long as broad, base broken off specimen, periphery rounded. Chambers quinqueloculine, not significantly inflated; sutures obscure. Surface very rough, with reticulation produced by very coarsely pitted surface, pattern not so evident as in other references. Aperture terminal, rounded, on very short but distinct neck, with flattened inner margin and simple tooth.

Remarks: The concept of this species is not well stabilized, there being no type description or figure, and the figure on which it was based being unavailable. Parr erected *Q. pseudoreticulata* which embraced very broad, well rounded forms, with a very neat diamond-grid network of holes between ridges. Cushman's (1917a) pl. 16, fig. 2 is more like that, while his fig. 3 depicts a form which is more costate or striate-looking, with some oblique crenulation. The problems with this species cannot be resolved without re-examination of some form of type material, or redesignation.

Quinqueloculina sawanensis Asano

Quinqueloculina sawanensis ASANO, 1951, pt. 6, p. 6, figs. 40-42.

Test very broadly oval, nearly circular in outline, somewhat irregular pentagonal in section, margins truncate. Chambers quinqueloculine, very broad, strongly embracing and curved, faces on the 4-chambered side usually sunken or concave. Sutures distinct, depressed. Wall with short longitudinal scratches or sharp grooves. Aperture terminal, a compressed ovate opening without neck, with simple long tooth projecting from base of penultimate chamber.

Remarks: The truncate but not carinate periphery, and nearly circular outline, are distinctive.

Quinqueloculina venusta Karrer

Quinqueloculina venusta KARRER, 1868, p. 147, pl. 2, fig. 6.---CUSHMAN, 1917a, p. 45, pl. 11, fig. 1.---CUSHMAN, 1911, p. 420, pl. 91, fig. 2.---BOLTOVSKOY, 1973, p. 167, pl. 6, figs. 32,33.---?CORLISS, 1979, p. 6, pl. 1, figs. 9-11.

Quinqueloculina venusta Karrer?. BARKER, 1960, p. 10, pl. 5, fig. 5.

Quinqueloculina lamarekiana d'Orbigny. BARKER, 1960, p. 10, pl. 5, fig. 7.

Test elliptical in outline, compressed triangular in section, periphery acute to carinate, base broadly and eccentrically rounded, indented slightly up the side of test. Chambers quinqueloculine, arcuate, with slightly undulose convex faces becoming concave just near margins. Sutures rather indistinct. Aperture terminal, round, very slightly but distinctly produced, truncate transverse to test axis, with

simple tooth.

Remarks: The almost perfect elliptical outline, carinate margins, and characteristic chamber surface serve to distinguish this species from most others. Quinqueloculina ungeriana d'Orbigny is also elliptical but somewhat broader in outline, and is also thicker. Its aperture is oblique to the test axis, and the test surface may be rough or ornamented.

Quinqueloculina vulgaris d'Orbigny

Quinqueloculina vulgaris d'ORBIGNY, 1826, p. 302.---CUSHMAN, 1917a, p. 46, pl. 11, fig. 3.---ASANO, 1951, pt. 6, p. 8, figs. 54-56.---COLLE, 1981, p. 50, pl. 8, fig. 7.

Test thick and very broadly ovate, barely broader than high, base produced and slightly rounded, periphery angled to acute, not carinate. Chambers very broad, curved, embracing, slightly convex. Sutures distinct, gently incised to depressed. Wall smooth. Aperture terminal, ovate, with very long and strong simple tooth projectin , from base of penultimate chamber.

Remarks: The very broad, smooth form with angled to acute margins and no neck is distinctive.

Quinqueloculina sp. A

Quinqueloculina cf. gracilis d'Orbigny. CUSHMAN, 1932, p. 23, pl. 5, fig. 12.

Test extremely elongate and slender, 4 times longer than broad, periphery rounded, base strongly produced and rounded. Chambers quinqueloculine, circular in section, very long and narrow. Sutures distinct, depressed, somewhat oblique to test axis, very gently curved. Aperture terminal, on rather long, slender cylindrical neck with lip, and no evident tooth.

Remarks: There are no species quite like this in the Catalogue. There are two species named Q. gracilis, one by Costa and the other by Karrer, but they are both far too broad for the present form. There is a Triloculina gracilis d'Orbigny, but that form was definitely triloculine, and not to be confused with the present form.

Quinqueloculina sp. B

(Plate 2, Figures 11-13)

Quinqueloculina elongata Natland. COLE, 1981, p. 50, pl. 13, fig. 11.

Test elongate, twice as long as broad, essentially parallel-sided, periphery rounded, base rounded to oblique and rounded, apertural end strongly oblique and acute. Chambers quinqueloculine, not inflated, strongly embracing, especially at base, thinning to 1/3 of test width just above midline of test, then wider again as base of penultimate chamber is embraced by apertural end. Sutures distinct, virtually flush, strongly curved and oblique to axis of test. Aperture terminal, round, upper rim oblique to test axis and continuous with basal contour of penultimate chamber, with very rudimentary tooth at inner margin.

Remarks: The reasons for transferring Cole's form from Q. elongata have been given in the discussion for that species. The form of the aperture distinguishes this species from Quinqueloculina sp. C.

Quinqueloculina sp. C

Quinqueloculina oblonga (Montagu). MURRAY, 1971, p. 63, pl. 23, figs. 4-8.

Test elongate, over 2 1/2 times as long as broad, periphery and base very well rounded, as is produced apertural end of final chamber. Chambers 5 in outer whorl, uninflated, increasing rapidly in length but not much in thickness or breadth as added, each face of test with the smallest chamber barely visible. Sutures distinct, almost flush, curved and slightly oblique. Wall smooth. Aperture terminal, on produced convex rounded end of chamber rather than on a neck, having no contact with penultimate chamber, and with simple flat tooth projecting from inner edge.

Remarks: The form of the aperture distinguishes this species from Quinqueloculina sp. B in particular, and the very long, rounded flush form from most others. Vermiculum oblongum Montagu is poorly described and illustrated, but appears to be triloculine, with chambers rather much broader with respect to their length, and a distinct neck, in contrast to the form figured by Murray.

Quinqueloculina sp. D

Test elongate fusiform, may be over twice as long as broad, base rounded, apertural end produced, angles acute, faces sunken to strongly excavated, section triangular with concave sides. Chambers quinqueloculine, increasing rapidly in length more so than in other dimensions, deflated. Sutures very obscure, nearly flush. Wall may be somewhat rough and pitted. Aperture terminal, rounded, on neck or produced chamber extremity with simple lip.

Remarks: The combination of fusiform shape, sharp margins with concave faces, and triangular section is distinctive.

Quinqueloculina? sp. E

Test fusiform in outline, with narrowly rounded ends, flattened and strongly undulose, periphery acute, carinate and undulose. Chambers very thin, evidently but obscurely quinqueloculine, wall so translucent that it is hard to distinguish external from internal whorls. Sutures very obscure, evidently flush, sinuous. Surface strongly wrinkled, may have fine costae or striae, but not universally. Aperture terminal, irregular, with projecting simple tooth.

Remarks: This form is distinct and unique, looking rather like a flattened raisin. The sutures and chambers are so obscure that it cannot be assigned unreservedly to Quinqueloculina.

Subfamily MILIOLINELLINAE Vella, 1957

Genus Pyrgo DeFrance, 1824

Pyrgo depressa (d'Orbigny)

Biloculina depressa d'ORBIGNY, 1826, p. 298.---CUSHMAN, 1917a, p.74, pl. 28, figs. 1,2.---CUSHMAN, 1921, p. 469, t.f. 45-47, pl. 96, fig. 2.

Pyrgo depressa (d'Orbigny). BARKER, 1960, p. 4, pl. 2, figs. 12,16,17; p. 6, pl. 3, figs. 1,2.---MURRAY, 1971, p. 71, pl. 27, figs. 1-4.---BOLTOVSKOY, 1978, p. 167, pl. 6, fig. 25.

Test biloculine, circular or even broader than high in outline, quite strongly compressed, edges drawn out into carinae. Chambers strongly embracing, only outermost pair visible. Apertural neck almost non-existent, aperture flattened,

broader than deep, with variably developed broad bifid tooth.

Remarks: Pyrgo murrhina has a nearly circular aperture on a well-developed neck, an aboral peripheral gap, with or without spines, and is higher than broad.

Pyrgo sarsi has a better developed tooth and is much thicker than the present species.

Pyrgo lucernula (Schwager)

Biloculina lucernula SCHWAGER, 1866, p. 202, pl. 4, figs. 14, 17.---CUSHMAN, 1917a, p. 79, pl. 32, fig. 2.---CUSHMAN, 1921, p. 475, pl. 97, fig. 2; pl. 98, fig. 1.

Pyrgo lucernula (Schwager). BARKER, 1960, p. 4, pl. 2, figs. 10, 11.---BOLTOVSKOY, 1978, p. 167, pl. 6, fig. 29.---COLE, 1981, p. 52, pl. 9, fig. 1.

Pyrgo lucernula (Schwager) HERMELIN AND SCOTT, 1985, p. 216, pl. 2, fig. 5.

Test biloculine, nearly circular in outline, about as thick as broad. Chambers with narrowly rounded margins, strongly embracing to produce a lip or rim around the penultimate chamber, and a concave surface. Rare specimens have a most unusual strong excavation of both chambers along the sides, and the chambers do not embrace to any significant extent; test in these cases is biconcave in section and thicker than broad. Aperture round, on short cylindrical neck, turned toward penultimate chamber, with poorly developed tooth.

Remarks: Biloculina anomala Schlumberger has no apertural neck, nor does B. subsphaerica d'Orbigny. This latter species is also convex throughout, and the periphery is broadly rounded.

Pyrgo murrhina (Schwager)

Biloculina murrhina SCHWAGER, 1866, p. 203, pl. 4, fig. 15.---CUSHMAN, 1917a, p. 75 (as B. murrhyna), pl. 28, fig. 3; pl. 29, fig. 1.

Pyrgo murrhina (Schwager). CUSHMAN, 1932, p. 64, pl. 15, figs. 1-3.---BOLTOVSKOY, 1978, p. 167, pl. 6, fig. 26.---CORLISS, 1979, p. 6, pl. 1, figs. 15-18.

Pyrgo murrhyna (Schwager). BARKER, 1960, p. 4, pl. 2, figs. 10, 11, 15.---BURKE, 1981, pl. 1, fig. 9.

Test biloculine, biconvex and compressed, periphery with wide, thin keel that has a depression or gap at the aboral extremity, often furnished on each side with a

2

Micred

short bordering spine. Chambers strongly embracing, with occasional development of carinate margin to penultimate chamber that is smaller in diameter and raised above the level of the final chamber. Aperture nearly circular, as high as broad, on end of cylindrical neck that traverses keel, opening oblique to plane of keel, with rather small tooth and no surrounding lip.

Remarks: The aboral gap, usually with spines, and the nearly circular aperture serve to distinguish this species.

Pyrgo sarsi (Schlumberger)

Biloculina sarsi SCHLUMBERGER, 1891, p. 553, t.f. 10-12, pl. 9, figs. 55-59.

Biloculina sarsii Schlumberger. CUSHMAN, 1917a, p. 76, not pl. 30, fig. 2.---
CUSHMAN, 1921, p. 471, t.f. 48, pl. 97, fig. 1.

Test biloculine, quite thick, with relatively wide keel that may be irregular, even bifurcate. Penultimate chamber with carinate to almost narrowly rounded margin, chamber excavated between this and final chamber. One very large specimen in this study with single ridge, resembling a wrinkle, running from aboral periphery on dorsal side up about one-fifth of test length toward aperture. Aperture broad, curving around edges of broad, slightly curved tooth.

Remarks: The specimen figured by Cushman (1917) is too rounded, lacks a carinate periphery, and cannot be assigned to this species.

Pyrgo yabei Asano

Pyrgo yabei ASANO, 1936b, p. 621, pl. 33, figs. 1,5.---ASANO, 1951, pt. 6, p. 20, figs. 132,133.

?*Pyrgo williamsoni* (Silvestri). LOEBLICH AND TAPPAN, 1953, p. 48 (*paris*), pl. 6, figs. 2,4, not 1,3.---MURRAY, 1971, p. 71, pl. 27, figs. 5-7.---LAGOE, 1977, p. 119, pl. 1, fig. 14.---COLE, 1981, p. 54, pl. 9, fig. 7.

Test elongate and almost teardrop-shaped in outline, twice as long and nearly as thick as broad, tapering from somewhat truncate apertural end to broader and broadly rounded base, periphery acute and sinuate, peripheral plane concave toward face of test with aperture, and is thereby sinuous in side view. Chambers very thick and inflated, strongly embracing, biloculine although pre-penultimate chamber

evidently quinqueloculine and visible at one side of penultimate chamber in rare specimens. Sutures distinct, limbate. Wall smooth. Aperture terminal, slightly oblique to end of test, oval with broad, thin, bifid tooth.

Remarks: This form is distinguished from Biloculina elongata d'Orbigny, which is more tumid, has well rounded margins, and lacks both the sinuate suture and the embrace of the chamber at the base. Biloculina williamsoni Silvestri is distinctly broad ovate in outline, not even 1 1/2 times as long as broad, and not tapering. The two figured specimens of Loeblich and Tappan excluded from synonymy do belong to this latter species, while the other two match the present form very well. Their discussion and description suggest the possibility that the present form represents immature P. williamsoni. Murray's forms are not so nearly acute, but agree well in other respects, while Lagoe's form, while definitely not P. williamsoni as originally described and illustrated, cannot be referred with certainty to the present form without a side view. For the moment the present material is left in Asano's species as there is nothing matching Silvestri's.

Pyrge sp. A

Test ovate in outline, base rounded, apertural end produced, face with final chamber more strongly convex than the other, periphery with very broad, thin, undulose and ragged keel. Chambers biloculine, circular in outline. Juveniles with slightly raised, fairly broad ridge running from neck to base. Suture flush, separating broad final chamber from keel of penultimate chamber, which is continuous surface, slightly excavated and undulose on inferior face. Aperture on long hemicylindrical neck, embraced by keel, with hint of lip as a flared end which is not thickened, no evident tooth.

Remarks: It has a very broad, thin keel without basal notch or paired spines as in P. murrhina, while P. depressa has neither this kind of neck, nor as broad a keel.

Pyrge spp.

This name or label is used for juvenile embracing biloculine forms which

clearly belong to this genus, but have not developed sufficiently to reveal the characteristics of the mature form necessary to identify and distinguish species.

Genus Pyrgoella Cushman and E.M. White, 1936

Pyrgoella globula (Bornemann)

Biloculina globulus BORNEMANN, 1855, p. 349, pl. 19, fig. 3.---CUSHMAN, 1917a, p. 78, pl. 31, fig. 2.---CUSHMAN, 1921, p. 474, not pl. 95, fig. 2.

Biloculina elongata d'Orbigny. CUSHMAN, 1921, pl. 95, fig. 4 only.

Pyrgo globula Bornemann. CUSHMAN, 1932, p. 65, pl. 15, figs. 6-8.

Test subspherical, slightly ovate and may be very gently compressed. Chambers biloculine, inflated, very strongly embracing such that penultimate chamber is restricted to 1/3 of circumference near apertural end. Suture distinct, barely depressed, running from basal corners of aperture in an elliptical loop, occasionally with some trace of previous aperture. Aperture under hooded projection, a small arch that may have 2 tiny teeth, a triangular flap, or neither feature.

Remarks: The extreme case whereby the aperture consists of only 2 slits in a "V" pattern is not observed. It appears that the captions for Cushman's (1921) pl. 95, figs. 2 and 4 were switched. Biloculina irregularis d'Orbigny is quite strongly compressed though broadly rounded, and the suture passes well below the aperture. Biloculina sphaera d'Orbigny is spherical, with an even less apparent penultimate chamber, and a less clearly developed aperture.

Genus Triloculina d'Orbigny, 1826

Triloculina sp. cf. T. terquemiana (Brady)

Miliolina terquemiana BRADY, 1884, p. 166, pl. 114, fig. 1.

Triloculina terquemiana (Brady). CUSHMAN, 1917a, p. 72, pl. 27, fig. 2.---ASANO, 1951, pt. 6, p. 17, figs. 112,113.---BARKER, 1960, p. 234, pl. 114, fig. 1.

Test triloculine, trihedral, triangular in section, margins carinate, peripheral face of final chamber not as broad as those of other chambers; test, exclusive of neck, a bit longer than broad, base somewhat rounded. Chambers not inflated, but faces convex. Sutures distinct, notched or incised rather than depressed. Surface

with closely spaced longitudinal striae rather than costae. Aperture terminal, round, on cylindrical neck with two angles to it, a slight flared lip, and tooth projecting from the inner border.

Remarks: The type and synonymous forms have no neck, but instead a truncate apertural end which does not project beyond the base of the penultimate chamber, and a long tooth in a compressed opening. This form is distinguished by its carinate angles and fine striae.

Triloculina tricarinata d'Orbigny

Triloculina tricarinata d'ORBIGNY, 1826, p. 299.---CUSHMAN, 1917a, p. 66, t.f. 32, pl. 25, figs. 1,2.---CUSHMAN, 1921, p. 454, not t.f. 35,36.---CUSHMAN, 1932, p. 59, pl. 13, fig. 3.---BARKER, 1960, p. 6, pl. 3, fig. 17.---HERMELIN AND SCOTT, 1985, p. 218, pl. 2, fig. 7.

NOT Triloculina tricarinata d'Orbigny. POAG, 1981, p. 84, pl. 57, fig. 3; pl. 58, fig. 3.

Test triloculine, slightly higher than broad, base and apertural end narrowly rounded to subacute, nearly rhomboid in outline, triangular in section. Large faces of chambers essentially flat to very gently convex, margins of test acute to carinate. Sutures distinct, nearly flush. Aperture with tooth plate, apparently long and simple rather than broad and bifid.

Remarks: The present species may be distinguished from the following similar species. Triloculina affinis d'Orbigny has strongly convex chamber faces and gently angled test margins, and T. trihedra Loeblich and Tappan has subacute angles and broadly rounded extremities, producing a nearly circular outline. Triloculina tricarinata var. convexa Cushman differs in having rotund, inflated sides, and Miliolites trigonula Lamarck is well rounded in cross section. The specimens illustrated by Poag as T. tricarinata are circular in outline and have strongly convex sides.

Triloculina sp. A

Test elongate, more than twice as long as broad, triangular in section and angles acute, greatest width slightly below midline, base well rounded but not

broadly so. Chambers triloculine, with very gently convex faces but not inflated. Sutures just barely depressed, and surface very slightly concave between sutures and margins. Aperture terminal, round, with simple or notched tooth, final chamber with end slightly produced and eccentric, turned in toward axis of test.

Remarks: This species is distinguished from most others by the combination of a very elongate test, triangular section with acute margins, and the gently convex faces. Triloculina angularis d'Orbigny is elongate, but not quite twice as long as broad, has an acute if not apiculate base, and a truncate rather than produced termination to the final chamber.

Genus Triloculinella Riccio, 1950

Triloculinella australis (Parr)
(Plate 2, Figures 8-10)

Quinqueloculina procera (Goës). CUSHMAN, 1921, p. 421, pl. 88, fig. 3.

Quinqueloculina australis PARR, 1932, p. 7, pl. 1, fig. 8.

Miliolinella (?) australis (Parr). BARKER, 1960, p. 10, pl. 5, figs. 10, 11.

Test circular in outline, somewhat compressed, periphery usually angled, narrowly rounded to subacute, base with penultimate apertural rim projecting. Chambers quinqueloculine, crescentic, subtriangular in section, increasing very little in height as added. Sutures rather indistinct, not depressed. Aperture a semicircular arch with flared lip, oblique to peripheral plane rather than perpendicular, almost filled by thin, high semicircular flap projecting from periphery just anterior to arch.

Remarks: Cushman's form should not be referred to Miliolina procera Goes, which is not so circular in outline, has a flattened base with depressed suture, and is nearly rounded in section, with rounded periphery. The aperture is a much more subdued feature in that species as well.

Triloculinella circularis (Bornemann)

Triloculina circularis BORNEMANN, 1855, p. 349, pl. 19, fig. 4.---CUSHMAN, 1917a, p. 67, pl. 25, fig. 4; pl. 26, fig. 1.---CUSHMAN, 1921, p. 462, pl. 92, figs. 1, 2.---CUSHMAN, 1932, p. 52, pl. 11, fig. 11.

?Miliolinella subrotunda (Montagu). BARKER, 1960, p. 10, pl. 5, figs. 13,14.---
MURRAY, 1971, p. 73, pl. 28, figs. 5,6.

Miliolinella circularis (Bornemann). COLE, 1981, p. 56, pl. 13, fig. 10.---POAG, 1981,
p. 72, pl. 59, fig. 3; pl. 60, fig. 3.

Test subcircular in outline, skewed or irregular, periphery broadly rounded, base may be very slightly indented and may be marked by preceeding apertural lip. Chambers cryptoquineloculine, only 3 visible, quite broad, inflated, may increase substantially in thickness as added to produce thick subtriangular section. Sutures gently sigmoid, oblique, variably depressed in adult stage. Aperture a terminal arch oblique to peripheral plane, with flared but not thickened lip, and flap projecting upward from base of penultimate chamber.

Remarks: This form lacks a planispiral stage and does not belong in Miliolinella Wiesner. The subcircular outline and strongly inflated chambers distinguish this species from most others. Vermiculum subrotundum Montagu exhibits no skewing or asymmetry, the final and penultimate chambers are subequal, and there is no hint of the apertural complexity that characterizes the present species.

Triloculinella elongata (Kruit)

Miliolinella circularis (Bornemann) var. elongata KRUIT, 1955, p. 110, pl. 1, fig. 15.-
--MURRAY, 1971, p. 73, pl. 28, figs. 1-4.

Test somewhat elongate and skewed ovate to teardrop-shaped, periphery and base very well rounded. Chambers cryptoquineloculine, 3 visible in outer whorl, very broad and bulbous near base, narrowing rapidly and curved toward apertural end, which is thin. Sutures distinct, not much depressed, strongly curved and oblique to test axis. Aperture an arch, with a very faint flared lip, and flap projecting upward well in front of aperture.

Remarks: The slightly elongate, strongly skewed test with oblique sutures distinguishes this species from other related forms. This species was not found in either the microfilm or the fiche versions of the Catalogue at Carleton University.

Triloculinella sp. A

Test very broad fusiform, not even 1 1/2 times as long as broad, apertural and basal ends produced, the former acute and the latter narrowly rounded and often quite rugose. Periphery unusual in that final chamber has broad truncate to excavated margin with sharp carinae on the angles, while the preceeding chambers are either acute with a single carina, or the penultimate may have a lesser developed second carina that rarely runs the full chamber length; periphery usually, but not universally, undulose. Chambers quinqueloculine, increasing substantially in size, especially thickness, in latter stages, faces flat to gently sunken. Sutures obscure, nearly flush. Wall rough, somewhat glassy rather than porcelaneous. Aperture terminal, a large oval to semicircular opening, bordered by very slightly produced chamber end with gently flared rim, which curves down to penultimate chamber, bulk of opening covered by very thin semicircular flap that is connected to, but not a smooth extension of, the keel of penultimate chamber.

Remarks: The form of the keel is apparently unique within the genus.

Subfamily SIGMOINITINAE Luczkowska, 1974

Genus Sigmoilina Schlumberger, 1887

Sigmoilina sigmoidea (Brady)

Planispirina sigmoidea BRADY, 1884, p. 197, t.f. 5, pl. 2, figs. 1-3.

Sigmoilina sigmoidea (Brady). CUSHMAN, 1917a, p. 61, pl. 24, figs. 2,3.

Nummoloculina contraria (d'Orbigny), juv. BARKER, 1960, p. 4, pl. 2, figs. 1-3.

Test broad and skewed fusiform in outline, both ends produced and narrowly rounded, eccentric to the side of the penultimate chamber, whose outline describes a low bell curve, while profile of final chamber is almost semicircular; test lenticular in section, angles acute. Chambers added 2 per whorl, in sigmoid series when viewed down axis, each chamber producing broad thin flaps which embrace virtually all but penultimate chamber, such that test is opaque white with 2 translucent marginal areas, the opaque and translucent regions separated clearly by a line marking the

position of the previous periphery; sutures otherwise totally indistinct. Aperture terminal, rounded, with thickened rim, and short blunt tooth projecting from inner margin.

Remarks: Sigmoilinita sigmoidea (Brady) var. compressa Cushman is nearly circular in outline, compressed, and lacks pointed ends. Barker's assignment appears erroneous, for Biloculina contraria d'Orbigny is circular in outline, with an evidently rounded periphery, and no produced ends to the chambers.

Genus Sigmoilinita Seiglie, 1965

Sigmoilinita asperula (Karrer)

Spiroloculina asperula KARRER, 1868, p. 136, pl. 1, fig. 10.---BOLTOVSKOY, 1978, p. 169, pl. 7, fig. 4.

Massilina alveoliniformis Millett. CUSHMAN, 1932, p. 30, pl. 8, fig. 3.

Ammomassilina alveoliniformis (Millett). BARKER, 1960, p. 16, pl. 8, figs. 11,13,14.

Test fusiform to broadly fusiform in outline, flattened with inner whorls projecting slightly, especially penultimate one, periphery rounded, base produced and narrowly rounded. Chambers long, narrow, initially added in evolute sigmoiline series, later planispiral, 2 per whorl, protruding at base. Sutures distinct, depressed. Wall porcelaneous but rough, with much fine elastic material included. Aperture terminal, round, on short produced cylindrical neck, tooth not apparent in present specimens.

Remarks: Massilina alveoliniformis Millett is identical to the present species in all respects except for its aperture, which is terminal, radiate or cribrate, and obscure. For this reason Cushman's and Barker's forms should be referred to the present species. Miliolina alveoliniformis Brady has a spiral chamber arrangement that produces a broadly rounded triangular section to the test, and also has a terminal multiple aperture. Spiroloculina arenaria Brady differs in having fewer, broader chambers, and in being completely flattened.

Sigmoilinita tenuis (Czjzek)

Quinqueloculina tenuis CZJZEK, 1848, p. 149, pl. 13, figs. 31-34.

"Sigmoilina" tenuis (Czjzek). BARKER, 1960, p. 20, pl. 10, figs. 7,8,11.

Test fusiform in outline, flattened, periphery rounded and both ends projecting but rounded. Chambers elongate, tubular, arched, added in evolute sigmoiline series, almost becoming planispiral, 2 per whorl. Sutures distinct, depressed. Wall calcareous, imperforate, but incorporating very minor amounts of clastic material. Aperture terminal, round, on short stout neck, no tooth evident.

Remarks: This species differs from the previous one in being much smoother and flattened. The sigmoiline chamber arrangement is not apparent in Czjzek's type figures, and the type description is in German. Spiroloculina tenuissima Reuss is remarkably similar, but Czjzek's species has priority, and if anything a better developed apertural neck, matching the present material more closely.

Subfamily SIGMOILOPSINAE Vella, 1957

Genus Sigmoilopsis Finlay, 1939

Sigmoilopsis schlumbergeri (Silvestri)

Sigmoilina schlumbergeri SILVESTRI, 1904, p. 267, p. 481, t.f. 6, p. 482, t.f. 7, pl. 7, figs. 12-14.---BOLTOVSKOY, 1978, p. 167, pl. 7, figs. 5,6.

Sigmoilopsis schlumbergeri (Silvestri). BARKER, 1960, p. 16, pl. 8, figs. 1-4.---HERMELIN AND SCOTT, 1985, p. 217, pl. 2, fig. 6.---BELANGER AND BERGGREN, 1986, p. 331, pl. 1, fig. 5.

Test quinqueloculine, angular-ovate in outline with rounded margins. Chambers essentially uninflated, sutures rather indistinct. Wall porcelaneous with much fairly coarse agglutinated material. Aperture terminal, round, produced on porcelaneous neck, tooth not apparent in most cases.

Remarks: The wall structure, outline, and indistinct sutures serve to characterize this species.

Subfamily TUBINELLINAE Rhumbler, 1906

Genus Articulina d'Orbigny, 1826

Articulina fijiensis Cushman

Articulina fijiensis CUSHMAN, 1944a. p. 15, pl. 4, figs. 1-6.

Test elongate, gently arcuate. Initial quinqueloculine portion ovate, base somewhat truncate and irregular, with gently inflated chambers and surface with several sharp costae. Thereafter several uniserial chambers may be added, distinctly but not strongly compressed, greatest width near base, narrowing then constricted below flared and reflexed apertural lip. Sutures distinct, depressed, curved and convex upward. Uniserial chambers ornamented with numerous strong costae, many of which anastomose or are inserted between others of greater extent, terminating near base of chamber but projecting slightly toward base of test. Aperture compressed ovate, with flared bordering lip.

Remarks: The uniserial portion is never found attached to the quinqueloculine stage in the present study. Nevertheless, the compression of the uniserial stage prevents confusion with Nodobacularia Rhumbler. Articulina lineata is more strongly compressed with much broader chambers, as is Vertebralina cassis d'Orbigny. Articulina sagra d'Orbigny is similar, but the chamber outline is much more complex, like a hurricane lamp, and the costae terminate against heavy limbate sutures. Articulina pacifica Cushman has a strongly projecting lip at the base of the test, while A. sulcata Reuss has a more broadly oval quinqueloculine stage and more numerous and finer costae.

Articulina lineata Brady

Articulina lineata BRADY, 1884, p. 183, pl. 12, figs. 19-21.---CUSHMAN, 1932, p. 47, pl. 11, figs. 1,2.---BARKER, 1960, p. 24, pl. 12, figs. 19-21.

Test flattened, thin and spatulate, with early quinqueloculine stage and one or two rectilinear chambers, periphery acute and carinate where costae coincide with it, base rounded but with slight projection of previous apertural lip. Chambers broad and flat, but still significantly higher than broad. Sutures obscure. Surface with numerous fairly fine longitudinal costae. Aperture a strongly compressed slit, with thickened lip slightly broader than rest of chamber.

Remarks: The rectilinear stage is not present on the single specimen of the

present study. This strongly flattened form needs to be distinguished from Vertebralina cassis d'Orbigny, in which the chambers are nearly as broad as long, and V. striata d'Orbigny, in which the uniserial chambers in particular are much broader than high.

Superfamily SORITACEA Ehrenberg, 1839

Family PENEROPLIDAE Schultze, 1854

Genus Peneroplis de Montfort, 1808

Peneroplis pertusus (Forskål)

Nautilus pertusus FORSKÅL, 1775, p. 125.

Peneroplis pertusus (Forskål). CUSHMAN, 1917a, p. 86, pl. 36, fig. 1; pl. 37, figs. 1,2,6.---BARKER, 1960, p. 26, pl. 13, figs. 16,17,23.

Test planispiral, compressed, somewhat lenticular, evolute, periphery angled but neither acute nor carinate, slightly lobulate. Chambers more than 12 in final whorl, increasing gradually in size as added, latest formed very gently inflated if at all, and may show very weak tendency to uncoil. Sutures limbate, quite strongly curved, flush with possible exception of a few, these not necessarily the last formed. Surface between sutures with numerous fine closely spaced longitudinal costae. Aperture multiple, a number of pores on apertural face, which has smooth, slightly inflated borders.

Remarks: This costate species with non-carinate periphery is distinguished from Nautilus planulatus vars Fichtel and Moll. which have strongly flattened and rapidly flaring chambers, and from N. (Lituus) arietinus Batsch, which is generally considered to have a well developed rectilinear uncoiling stage. The type description and figures of Batsch embrace far too many forms, many of which clearly belong to other species.

Family SORITIDAE Ehrenberg, 1839

Subfamily SORITINAE Ehrenberg, 1839

Genus Sorites Ehrenberg, 1839

Sorites marginalis (Lamarck)

Orbulites marginalis LAMARCK, 1816, p. 196.

Orbitolites marginalis (Lamarck). CUSHMAN, 1917a, p. 92 t.f. 47, pl. 38, figs. 1,2.

Sorites marginalis (Lamarck). CUSHMAN, 1932, p. 64.---BARKER, 1960, p. 30, pl. 15, figs. 1-3,5.

Test discoidal, flattened, large globular proloculus followed by one long unbroken coiled chamber, thereafter a very obscure peneropline series, finally bulk of test is series of increasingly embracing annular chambers, not increasing much in height as added, which eventually encircle entire test. Chambers subdivided into numerous small chamberlets which look somewhat like bubbles. Periphery initially mildly lobulate, later entire, truncate with rounded margins. Aperture multiple, a single row of peripheral pores.

Remarks: This species is distinguished from Praesorites orbitolitoides Hofker, which has a very well developed and obvious peneropline stage of a few whorls, the chambers flaring quite rapidly as added. It should be noted that the present species has no type figure, and only the most rudimentary description that mentions it is flat, with a porous periphery.

Suborder LAGENINA Delage and Hérouard, 1896

Superfamily NODOSARIACEA Ehrenberg, 1838

Family NODOSARIIDAE Ehrenberg, 1838

Subfamily NODOSARIINAE Ehrenberg, 1838

Genus Dentalina Risso, 1826

Dentalina deceptoria (Schwager)

Nodosaria deceptoria SCHWAGER, 1866, p. 212, pl. 5, fig. 30.---ASANO, 1951, pt. 15, p. 22, fig. 98.

Test elongate but stout, uniserial, barely arcuate, base broadly rounded and apiculate. Chambers few, globular proloculus followed by 2 chambers of diminishing diameter, the first broader than high, all subsequent chambers higher than broad and increasingly so as added, and final few chambers also increase in

diameter, and are ellipsoidal. Sutures subhorizontal and depressed throughout, increasingly so and broader as formed. Surface with approximately 15 to 20 fairly heavy, high longitudinal costae, constricted but continuous across sutures. Aperture terminal, very slightly produced, radiate.

Remarks: Both Nodosaria subscalaris Cushman and N. subscalaris Cushman var. pauci-costata Cushman have costate apertural necks, and are thereby distinguished from this species. Nautilus raphanus Linnaeus tapers strongly to an acute base, and its chambers are only slightly inflated.

Dentalina spirostriolata (Cushman)

Nodosaria spirostriolata CUSHMAN, 1917b, p. 656.---CUSHMAN, 1921, p. 212, pl. 38, fig. 4.

Test elongate, uniserial, barely arcuate, base rounded. Chambers slightly ellipsoidal, not globular, inflated and increasing very gradually in size as added, or rarely with second chamber smaller than proloculus and succeeding one. Sutures distinct, depressed but not sharply so, limbate. Surface with numerous (40 or more) fine costae, sublongitudinal to distinctly spiral or oblique on a few chambers, constricted at sutures. Apertural end rounded, with small, very slightly projecting radiate aperture.

Remarks: Dentalina subperversa has lower chambers and longitudinal costae, while Nodosaria perversa Schwager, in addition to its different aperture, has more elongate chambers and longitudinal costae.

Dentalina subperversa (Cushman)

Nodosaria subperversa CUSHMAN, 1917b, p. 655.---CUSHMAN, 1921, p. 208, pl. 37, fig. 3.

Test elongate, uniserial, somewhat irregularly contorted rather than arcuate, base rounded. Proloculus subspherical and larger than subsequent chamber, chambers thereafter squat subglobular and strongly appressed, broader than high, strongly inflated. Sutures distinct, depressed, rather sinuate. Surface with numerous fine longitudinal costae, completely constricted at sutures, and becoming more faint

with growth, barely apparent on final chamber. Aperture terminal, radiate, on rounded upper extremity.

Remarks: The fine costae and strongly inflated chambers distinguish this species from most, while D. spirostriolata is more nearly rectilinear, has higher chambers, and frequently oblique to spiral costae.

Dentalina? sulcata (Nilsson)

Nodosaria sulcata NILSSON, 1826, p. 341.---NILSSON, 1827, pl. 9, fig. 19.

Dentalina sulcata (Nilsson). BROTZEN, 1937, p. 74, t.f. 6, pl. 2, figs. 8-16.

?Nodosaria sulcata Nilsson. ?BOLTOVSKOY, 1978, p. 162, pl. 4, fig. 37.

Nodosaria fusiformis Silvestri. ?BOLTOVSKOY, 1978, p. 162, pl. 4, fig. 39.

Test elongate, uniserial and arcuate, quite strongly tapering, base acute and presumably aculeate. Chambers initially broader than high, uninflated, eventually gently inflated and subglobular, increasing quite rapidly in diameter as added. Sutures initially obscure, limbate, flush and slightly oblique, later gently depressed. Surface covered in numerous fine sublongitudinal costae, 40 or more in adult, initially fewer in number and oblique to axis of test, with additional costae inserted with growth and eventually becoming longitudinal, in the adult very gently constricted at sutures, with alternate costae discontinuous across them. Aperture terminal, apparently rounded with a heavy lip.

Remarks: At least the final chamber is broken off the single specimen, so apertural details are determined from the uppermost preserved chamber. According to Loeblich and Tappan (1987), Dentalina should have a radiate aperture. The present species superficially looks more like Mesodentalina Norling, but that genus is Lower Jurassic. Nodosaria fusiformis has much more elongate chambers that are virtually uninflated, and the form Boltovskoy referred to that species is tentatively transferred. Likewise, the form he assigned to the present species does not taper much, is not arcuate, and the chambers are inflated throughout, and thus may not be referable to the present species. There are two closely similar forms that need to be

distinguished. Nodosaria vertebralis (Batsch) var. albatrossi Cushman has fewer, more plate-like costae that are in no way inserted or oblique, nor are they constricted at the sutures, while N. flintii Cushman has far too few, too high plate-like costae, and the chambers are relatively higher.

Genus Laevidentalina Loeblich and Tappan, 1986

Laevidentalina sp. cf. L. frobisherensis
(Loeblich and Tappan)

Dentalina frobisherensis LOEBLICH AND TAPPAN, 1953, p. 55, pl. 10, figs. 1-9.---
COLE, 1981, p. 60, pl. 18, fig. 6.

NOT Dentalina cf. D. frobisherensis Loeblich and Tappan. LAGOE, 1977, p. 121, pl. 3, fig. 2.

Test elongate, uniserial, slender, arcuate. Chambers as high as or higher than broad, not inflated. Sutures slightly oblique, flush. Aperture terminal, radiate.

Remarks: The single broken specimen lacks the proloculus, initial chamber shape, and terminal stage necessary for positive identification. This species is one of the few with flush sutures and higher than broad chambers.

Laevidentalina ittai (Loeblich and Tappan)

Nodosaria calomorpha Reuss. CUSHMAN, 1913a, p. 48, pl. 25, fig. 6.---BARKER, 1960, p. 128, pl. 61, figs. 23-27.---COLE, 1981, p. 57, pl. 17, fig. 46.

Dentalina ittai LOEBLICH AND TAPPAN, 1953, p. 56, pl. 10, figs. 10-12.---COLE, 1981, p. 60, pl. 18, fig. 8.

Test elongate, uniserial, slender, gently arcuate, base rounded. Chambers subelliptical in outline, generally slightly broader toward the base, distinctly but not strongly overlapping, final few may decrease slightly in size. Sutures distinct, depressed, straight and horizontal. Wall completely hyaline and smooth, embraced apertural ends of earlier chambers clearly visible. Aperture terminal, central, radiate.

Remarks: Nodosaria (Nodosaria) calomorpha Reuss is completely rectilinear, usually basally apiculate, and the terminal chamber is distinctly pyriform rather than prolate spheroidal. The proloculus is also distinctly larger in diameter than the

subsequent chambers. It is not clear why Cole referred apparently identical arcuate forms to the two different species.

Laevidentalina mucronata (Neugeboren)

Dentalina mucronata NEUGEBOREN, 1856, p. 83, pl. 3, figs. 8-11.

Nodosaria mucronata (Neugeboren). CUSHMAN, 1913a, p. 56, pl. 25, fig. 2; pl. 27, figs. 5-7; not pl. 24, fig. 3; not pl. 35, fig. 6.

Test elongate, uniserial, not particularly slender, base acute, initially tapering rapidly and gently curved, thereafter increasing slowly in breadth, nearly parallel-sided and slightly arcuate in the opposite direction, greatest breadth near the top. Chambers 7 or more, broader than high throughout, only final one inflated at all. Sutures distinct, flush, strongly oblique. Aperture terminal, produced to inner margin, radiate.

Remarks: This species is much slimmer than *Nodosaria intorta* Dervieux and its chambers occupy a much smaller proportion of the test length. *Nodosaria communis* d'Orbigny has depressed sutures throughout, and the proloculus is larger than the succeeding chambers. *Dentalina roemeri* Neugeboren does not have a reversal in the curvature, and the base is rounded. Some of the specimens referred by Cushman to this species do not belong because they are too short, with strongly embracing chambers that are too few in number, horizontal to subhorizontal sutures, and no tendency to be arcuate.

Laevidentalina neugeboreni (Schwager)

Nodosaria neugeboreni SCHWAGER, 1866, p. 232, pl. 6, fig. 67.

Nodosaria inornata (d'Orbigny) var. *bradyensis* DERVIEUX, 1894, p. 610, pl. 5, figs. 30,31.

Nodosaria communis d'Orbigny. CUSHMAN, 1921, p. 192, pl. 34, fig. 7.

Dentalina neugeboreni (Schwager). CUSHMAN, 1933d, p. 11, pl. 3, figs. 2,3.

Dentalina communis d'Orbigny. BARKER, 1960, p. 130, pl. 62, figs. 21,22.---
BOLTOVSKOY, 1978, p. 157, pl. 3, fig. 23.

Dentalina inornata (d'Orbigny) var. *bradyensis* (Dervieux). BARKER, 1960, p. 130, pl. 62, figs. 19,20.

Dentalina communis (d'Orbigny). WARD AND WEBB, 1986, p. 183, pl. 1, fig. 6.

Test elongate, uniserial, slender and arcuate, base acute to apiculate. Chambers 7 or more, initially slightly broader than high, later as high as broad or slightly higher, and becoming very gently inflated. Sutures distinct, strongly oblique, flush becoming very gently depressed. Wall smooth, hyaline. Apertural end produced, aperture terminal and radiate.

Remarks: The oblique sutures which are flush, becoming depressed, and the transition in chamber shape distinguish this species. Nodosaria (Dentalina) communis d'Orbigny has depressed sutures throughout, and the chambers are always broader than high. Dervieux's species/subspecies is, at least on the basis of the type description and figures, completely indistinguishable from Schwager's. The same applies to Barker's illustrated specimens, and it seems likely that the two are synonymous, Schwager's species having priority. The present species is often so hyaline that the embraced chamber surfaces are not detectable, but the absence of an entosolenian tube means that these are not some species of Phlegeria Loeblich and Tappan.

Laevidentalina pauperata (d'Orbigny)

Dentalina pauperata d'ORBIGNY, 1846. p. 46, pl. 1, figs. 57,58.---LAGOE, 1977, p. 121, pl. 2, fig. 6.---COLE, 1981, p. 6. pl. 18, fig. 9.

Dentalina plebeia Reuss. BARKER, 1960, p. 132, pl. 63, fig. 2.

Test stout, uniserial, subcylindrical and very slightly arcuate, base with single coarse, blunt spine. Chambers few, large, as high as broad, not inflated, proloculus barely greater in diameter than successive chambers. Sutures obscure, flush, subhorizontal. Aperture produced, eccentric, radiate.

Remarks: It is possible that not enough chambers were present to display the inflation with depressed sutures that was observed by d'Orbigny in the adult stage. Dentalina plebeia Reuss has many more chambers, at least 12, and is more strongly arcuate and tapering. In addition, the chambers are initially broader than high.

Laevidentalina subemaciata (Parr)

Nodosaria consobrina d'Orbigny var. emaciata Reuss. CUSHMAN, 1921, p. 195 (pars), pl. 35, fig. 1; not pl. 34, fig. 8.

Dentalina subemaciata PARR, 1950, p. 329, pl. 12, fig. 1.

Dentalina subemaciata Parr?. BARKER, 1960, p. 130, pl. 62, figs. 25,26.

Test elongate, large, uniserial, arcuate and gently tapering, base rounded. Large globular proloculus followed by uninflated chambers almost twice as broad as high and smaller in diameter, chambers thereafter increasingly broad and proportionately higher, very slightly inflated. Sutures distinct, heavily limbate, straight and initially horizontal, later slightly oblique and very slightly depressed. Aperture terminal, eccentric, radiate.

Remarks: Dentalina plebeia Reuss is remarkably similar, differing only in having a small, apiculate proloculus. This may be the microspheric form, and Parr's species the megalospheric, although it should be noted that both rounded and bluntly pointed bases were embraced in Parr's type description. The two species could be synonymous, in which case plebeia would have priority. Dentalina emaciata Reuss has chambers higher than broad throughout, and almost all sutures are depressed, which accounts for the reassignment herein of some of Cushman's (1921) forms. The same criteria serve to distinguish D. baggi Galloway and Wissler.

Laevidentalina sp. A

Test uniserial, arcuate, consisting of 3 chambers. Proloculus twice as high as broad, almost parallel-sided, with weakly apiculate base; second chamber subspherical, twice as broad as proloculus, and third chamber elongate oval, twice as high as broad, inflated, almost 1 1/2 times broader than middle chamber, and greatest breadth well below midline of chamber. Sutures distinct, depressed, straight. Aperture terminal, produced, radiate.

Remarks: The single specimen looks like an aberrant form, the only remote possibility being Nodosaria subtertenuata Schwager, which has elongate inflated

ellipsoidal chambers.

Genus Nodosaria Lamarck, 1812

Nodosaria spp.

Test elongate, uniserial, rectilinear, essentially cylindrical, base rounded. Chambers somewhat ellipsoidal, elongate and barely inflated, quite strongly appressed. Sutures straight, barely depressed, slightly limbate. Aperture terminal, radiate.

Remarks: This name embraces a collection of relatively featureless fragments.

Genus Pyramidulina Fornasini, 1894

Pyramidulina doliolaris (Parr)

Nodosaria doliolaris PARR, 1950, p. 330, pl. 12, fig. 2.

Nodosaria cf. N. doliolaris Parr. LAGOE, 1977, p. 121, pl. 2, fig. 5.

"Nodosaria" cf. doliolaris Parr. McCULLOCH, 1977, p. 237, pl. 103, fig. 8.

Test small, elongate, uniserial, rectilinear to very slightly arcuate, base rounded, occasionally with trace of basal spine where costae meet. Chambers barrel-shaped, higher than broad, barely inflated, decreasing in diameter as added from large ellipsoidal proloculus. Sutures depressed, horizontal. Surface with about 10 fairly high thin longitudinal costae, interrupted at sutures, but aligned from chamber to chamber. Costae pass at apertural end into low rim or rather thick, short neck, aperture terminal and round.

Remarks: The barrel-shaped chambers, decreasing in diameter as added, and high, thin costae are distinctive.

Subfamily LINGULININAE Loeblich and Tappan, 1961

Genus Neolingulina McCulloch, 1977

Neolingulina vicioensis McCulloch

Lingulina glandigena (Schwager). CUSHMAN, 1933d, p. 10, pl. 2, fig. 9.

Neolingulina vicioensis McCULLOCH, 1977, p. 22, pl. 49, fig. 8.

Neolingulina krebsi McCULLOCH, 1977, p. 23, pl. 49, fig. 44.

Test elongate, uniserial, compressed, base and periphery rounded. Chambers alternating in style, first as broad as long and somewhat inflated or thicker, then longer than broad, more parallel-sided and compressed, which produces a lobulate outline independent of the sutures, which are slightly undulose and not much depressed. Aperture a terminal ovate opening in the plane of compression.

Remarks: Cushman did not provide a synonymy for his form, and it was not possible to determine the genus under which Schwager's species was described. It differs slightly from the present form in that there appears to be a steady increase in chamber width and thickness with growth, and the chamber height is greater than the breadth. Lingulina vitrea Heron-Allen and Earland has a consistent, if barely perceptible in the megalospheric form, increase in chamber size with growth, it has no peripheral lobulation, and has slight excavation of the test surface along the median line. It would appear from McCulloch's figures and description that both N. vicjoensis, which is the juvenile form, and N. krebsi, which is the adult form and also lobulate despite the description, belong to the same species. The former species is retained because it is the type for the genus and the alternation in chamber form is explicit in the type description. It is recommended that N. krebsi be suppressed.

Family VAGINULINIDAE Reuss, 1860

Subfamily LENTICULININAE Chapman, Parr, and Collins, 1934

Genus Lenticulina Lamarck, 1804

Lenticulina angulata (Reuss)

Robulina angulata REUSS, 1851b, p. 154, pl. 8, fig. 6.

Lenticulina angulata (Reuss). COLE, 1981, p. 67, pl. 13, fig. 12.

Test small, planispiral, somewhat lenticular, wholly involute and neither umbonate nor umbilicate, periphery acute and carinate, keel not projecting, outline somewhat rounded in juvenile to distinctly angled in adult. Proloculus teardrop-shaped, chambers subsequently triangular, uninflated, increasing steadily in size as added. Sutures distinct, flush, limbate, radial and slightly curved. Apertural face

narrow, with rounded margins; aperture radiate, at peripheral angle.

Remarks: The thin test with angular outline is distinctive.

Lenticulina calcar (Linnaeus)

"*Nautilus minimus non umbilicatus*" GUALTIERI, 1742, pl. 19, fig. C only.

Nautilus calcar LINNAEUS, 1758, p. 709 (pars).

Cristellaria calcar (Linnaeus). CUSHMAN, 1913a, p. 72, pl. 32, fig. 4.---CUSHMAN, 1921, p. 231, not pl. 45, fig. 2.

Robulus calcar (Linnaeus). CUSHMAN, 1933d, p. 7, pl. 2, fig. 3.

Lenticulina calcar (Linnaeus). BARKER, 1960, p. 146, pl. 70, figs. 9-12.

Test planispiral, lenticular, biumbonate and quite thick. Chambers usually 6 in adult whorl, triangular in outline. Sutures limbate, flush, straight and tangential to umbos. Periphery carinate, keel moderately thin and broad, with spines, usually broken and roughly one per chamber, may be at suture or chamber. Aperture at peripheral angle, radiate with robuline slit on apertural face, which is a broad to narrow triangle with carinate margins.

Remarks: Other species, as well as *Nautilus calcar* Linné vars. Fichtel and Moll (1798), have curved and/or limbate beaded sutures. This latter feature characterizes Cushman's (1921) illustrated specimen, which is therefore excluded from synonymy. *Cristellaria formosa* Cushman has many more (11 to 13) chambers per whorl, while *C. denticulifera* Cushman has irregular longitudinal costae on the earlier formed chambers, and a denticulate rather than sparsely spinose keel.

Lenticulina cultrata (de Montfort)

Robulus cultratus de MONTFORT, 1808, p. 215, p. 214 t.f.

Cristellaria cultrata (Montfort). CUSHMAN, 1913a, p. 64, pl. 29, fig. 4.

Test planispiral, lenticular, biumbonate with very large umbos. Chambers usually 6 or 7 in adult whorl, triangular in outline. Sutures flush, straight, tangential to umbos, not limbate. Periphery acute; as successive chambers added, preceeding ones acquire thin narrow keel that overlaps existing keel, producing a

broad keel with strongly curved, faint traces of previous limit of keel. Aperture at peripheral angle, radiate with robuline slit on apertural face, which has strongly carinate margins.

Remarks: De Montfort's type figure shows a form with the slightest curve to the sutures, and not as large umbos as either the present specimens or Cushman's. Robulina limbosa Reuss is more evolute, with a tendency to uncoil, visible inner whorls, and curved sutures. Lenticulites rotulata Lamarck is non-umbonate and lacks a wide keel.

Lenticulina gibba (d'Orbigny)

Cristellaria gibba d'ORBIGNY, 1839a, p. 40, pl. 7, figs. 20,21.

Robulus gibbus (d'Orbigny). CUSHMAN, 1933d, p. 6, pl. 2, figs. 2,6,7.

Lenticulina gibba (d'Orbigny). BARKER, 1960, p. 144, pl. 69, figs. 8,9.---WARD AND WEBB, 1986, p. 183, pl. 10, fig. 2.

Test planispiral, involute, compressed but thick, outline somewhat teardrop-shaped, not circular. Chambers 8 or so in adult whorl, increasing fairly rapidly in height as added, but rather low and broad. Sutures limbate, flush, distinctly but gently curved, meeting at eccentric point that is non-umbilicate, may be irregularly umbonate. Periphery acute, with non-projecting carina at beginning of final whorl. Aperture at peripheral angle, radiate with robuline slit; apertural face high and narrow, sunken between inflated and rounded borders.

Remarks: The absence of a broad, thin keel distinguishes this species from other elongate forms with many chambers. Cristellaria reniformis d'Orbigny also differs in having depressed sutures.

Lenticulina larva (Stache)

Cristellaria (Cristellaria) larva STACHE, 1865, p. 232, pl. 23, fig. 11.

Robulus larvus (Stache). CUSHMAN, 1933d, p. 4, pl. 1, fig. 7.

Test planispiral, compressed with somewhat flattened central areas, not so much uncoiling as evolute, with inner whorls completely visible. Chambers 9 or so in

adult whorl, only very slightly inflated; umbilical extremities of earlier chambers in outer whorl constricted then expanded, club-shaped, later chambers curved quadrangular, exhibiting tendency to linear uncoiling mode. Sutures gently curved and oblique to inner whorls, only very slightly depressed between last few chambers. Inner whorls covered by nearly flush expanse of clear shell material. Aperture at peripheral angle, produced, broad, and radiate; apertural face convex in side view, meeting periphery in a smooth transition, with rounded margins.

Remarks: This species is distinguished from most by its evolute coiling, well developed spiral suture, and curved sutures. Both Cristellaria (Robulina) articulata Reuss and Cristellaria convergens Bornemann are uncoiling, but the former is umbilicate, and the latter is not evolute, and its sutures are radial.

Lenticulina orbicularis (d'Orbigny)

Robulina orbicularis d'ORBIGNY, 1826, p. 288, pl. 15, figs. 8,9.

Cristellaria orbicularis (d'Orbigny). CUSHMAN, 1913a, p. 67, pl. 36, fig. 5, ?not fig. 4.

Robulus vortex (Fichtel and Moll). CUSHMAN, 1933d, p. 5, pl. 2, fig. 1.

Robulus orbicularis (d'Orbigny)? BARKER, 1960, p. 144, pl. 69, fig. 17.

Test planispiral, lenticular, fairly thick and involute, with small irregular umbo at inner junction of sutures. Chambers 8 or more in outer whorl, quite strongly curved and rather narrow. Sutures limbate, flush and strongly curved. Periphery with distinct narrow acute keel. Aperture at peripheral angle, radiate with robuline slit; apertural face with carinate margins.

Remarks: The specimen illustrated by Cushman (1913a) as pl. 36, fig. 4 has a large umbo and barely over 5 chambers in the outer whorl, and probably should not be referred to this species. Nautilus vortex Fichtel and Moll lacks an umbo, has more chambers per whorl, much more strongly curved sutures, and an acute periphery without a keel of any appreciable width. Cushman's (1933d) specimen exhibits none of these features and should be referred to the present species.

Lenticulina spp.

Test planispiral, consisting of globular proloculus and 1 or 2 triangular chambers, with radiate aperture at peripheral angle. Periphery generally non-lobulate and somewhat acute to carinate.

Remarks: This includes what must be regarded as juvenile specimens of the genus which have not developed to the extent that they can be referred to particular species. This almost certainly includes Polymorphina pliocaena Silvestri, and Robulus pliocaenicus [sic] (Silvestri) in Barker (1960, p. 144, pl. 69, fig. 5).

Genus Saracenaria Defrance, 1824

Saracenaria moresiana Howe and Wallace

Saracenaria moresiana HOWE AND WALLACE, 1932, p. 42, pl. 2, fig. 8.

Test planispiral, quite strongly coiled and exhibiting little if any tendency to uncoil, periphery angled but very narrowly rounded, non-lobulate. Chambers low and broad, increasing fairly rapidly in size and particularly thickness as added, producing inflated broad triangular apertural face, not quite as broad as high, whose lower edge is still in contact with initial part of outer whorl. Sutures distinct, flush, curved gently backward. Aperture at peripheral angle, radiate.

Remarks: This species is distinguished by its flush sutures, rapid increase in thickness, and no apparent tendency to uncoil.

Saracenaria saratogana Howe and Wallace

Cristellaria italica (Defrance). CUSHMAN, 1913a, p. 78, pl. 33, fig. 3---CUSHMAN, 1921, p. 252, pl. 51, fig. 2.

Saracenaria saratogana HOWE AND WALLACE, 1932, p. 40.

Saracenaria italica Defrance. BARKER, 1960, p. 144, pl. 68, figs. 17, 18, 20-23.

Test elongate, initially planispiral, later uncoiling, triangular in section, periphery initially acute, later narrowly rounded. Chambers low and broad, increasing quite rapidly in size as added. Sutures flush, and previous radiate apertures remain clearly visible at the periphery. Lateral test surfaces and surface

between initial coil and apertural face gently concave, while apertural face an equilateral triangle in outline, with well-rounded margins.

Remarks: S. italica was described by DeFrance as having two rows of chambers and no trace of an aperture, and illustrated as a completely triangular form. There appears to be no sound basis for referring the present form to that species. Howe and Wallace intended their forms to differ from C. italica (DeFrance), sensu Cushman (paper not cited herein), in lacking a robuline slit, as does the present form. This apertural character is not regarded as of specific significance, and so forms referred by Cushman to the species italica are instead referred herein to saratogana.

Subfamily MARGINULININAE Wedekind, 1937

Genus Amphicoryna Schlumberger, 1881

Amphicoryna hispida (d'Orbigny)

Nodosaria (Nodosaire) hirsuta d'ORBIGNY, 1826, p. 252.

Nodosaria hispida d'ORBIGNY, 1846, p. 35, pl. 1, figs. 24,25.

Nodosaria hirsuta d'Orbigny. CUSHMAN, 1921, p. 213, pl. 38, figs. 5,6.

Amphicoryna hirsuta (d'Orbigny). BARKER, 1960, p. 132, pl. 63, figs. 12-16, not figs. 10,11.

Test elongate, uniserial, may be gently arcuate. Proloculus globular, larger than succeeding chamber, remaining chambers globular, initially appressed, later separated by long, thin necks. Sutures straight and depressed initially, later virtually non-existent. Surfaces of chambers and necks covered in coarse sharp spines. Aperture apparently terminal, radiate, on long neck.

Remarks: There were no intact specimens in the present material, and so the aperture! characteristics are derived from the literature. The present material is presumed to represent the megalospheric generation, as the microspheric form has an initial astacolone coil. Nodosaria hirsuta had neither a type description nor a type figure, and was placed in the synonymy of N. hispida by d'Orbigny. The

former species cannot be given priority as it was nom. nud. Nodosaria papillosa Silvestri has strongly overlapping chambers throughout, even though it also has a very long apertural neck. The specimens of Barker's pl. 63, figs. 10 and 11 should probably be referred to the latter species.

Amphicoryna sp. A

Test somewhat elongate, compressed especially in initial stages, rhomboid in outline, base projecting ventrally and apiculate, dorsal margin almost entire, inner or ventral margin somewhat lobulate. Chambers low and broad, initially uninflated and in astacoline coil, later quite strongly inflated and very strongly oblique, without much increase in breadth as added, but increasing in height and inflation. Sutures distinct, straight, oblique, flush becoming depressed. Aperture terminal, rounded, on slightly tapering neck at dorsal angle of test.

Remarks: Any radiate portion the aperture may have had has been broken off. This species differs from Nodosariopsis bradii Silvestri, which is relatively uncompressed, has a circular section, and chambers that soon are as high as or higher than broad.

Genus Astacolus de Montfort, 1808

Astacolus crepidulus (Fichtel and Moll)

Nautilus crepidula FICHTEL AND MOLL, 1798, p. 107, pl. 19, figs. g-i.

NOT Cristellaria crepidula (Fichtel and Moll). CUSHMAN, 1921, p. 248, pl. 50, figs. 4,5.

Astacolus crepidulus (Fichtel and Moll). BARKER, 1960, p. 142, pl. 67, fig. 20; pl. 68, figs. 1,2 (as A. crepidula).---?MURRAY, 1971, p. 77, pl. 29, figs. 5,6.---BOLTOVSKOY, 1978, p. 152, pl. 1, fig. 11.---ROGL AND HANSEN, 1984, p. 66, t.f. 27, pl. 26, figs. 1,2.

Test elongate, arcuate and tapering, strongly flattened, periphery rounded, base very narrowly rounded and outline non-lobulate. Chambers added in arcuate uniserial fashion, without initial coil, low, broad and curved, not inflated, higher on dorsal margin. Sutures distinct, slightly sigmoid, flush. Aperture at well produced dorsal angle, radiate.

Remarks: The flush sutures serve to distinguish this species from Cristellaria insolita Schwager, wherein the sutures are depressed and more strongly sigmoid. The specimen illustrated by Cushman (1921) has sutures far too strongly depressed and a very lobulate inner margin, while the final few sutures of Murray's illustrated specimen are slightly depressed, but possibly not enough to warrant assignment to another species.

Genus Hemirobulina Stache, 1864

Hemirobulina glabra (d'Orbigny)

Marginulina glabra d'ORBIGNY, 1826, p. 259.---CUSHMAN, 1913a, p. 79, pl. 23, fig. 3.---ASANO, 1951, pt. 15, p. 16, fig. 80.---PATTERSON, 1986a, p. 150, pl. 31, fig. 11.

NOT Marginulina glabra (d'Orbigny). CUSHMAN, 1921, p. 254, pl. 41, fig. 1.

Test elongate, uniserial, nearly circular in section, gently arcuate with initial portion coiled. Chambers in present specimen 3, barely inflated, and barely increasing in diameter as added. Sutures distinct, oblique, very gently depressed on the concave margin. Aperture terminal, radiate, at peripheral angle on convex side.

Remarks: The elongate, gently curved test, with very slightly depressed sutures is distinguished from H. obesa, in which the strongly inflated chambers increase rapidly in size. Cushman (1921) illustrated a form with acute ends and strongly inflated, rapidly increasing chambers that is referred herein to Hemirobulina? sp. A.

Hemirobulina obesa (Cushman)

Marginulina glabra d'Orbigny var. obesa CUSHMAN, 1923, p. 128, pl. 37, fig. 1.

Marginulina obesa Cushman. BARKER, 1960, p. 136, pl. 65, figs. 5,6.

Test stout, somewhat ovate to subfusiform in outline, rounded in section. Chambers initially in compact planispiral coil of 3 to 4 chambers, thereafter 1 or 2 uncoiling chambers, quite strongly embracing and tumid, a bit higher than broad. Sutures distinct, gently depressed, slightly oblique, in shape of inverted "V" toward aperture on convex or dorsal margin. Aperture terminal, radiate, produced at dorsal margin.

Remarks: Marginulina glabra is an elongate, almost slender, and strongly arcuate form, and is completely distinct from the present species.

Hemirobulina? sp. A

Marginulina glabra d'Orbigny. CUSHMAN, 1921, p. 254, pl. 41, fig. 1.

Test uniserial, consisting in both specimens of but 2 chambers, the test being elongate and somewhat fusiform, circular in section, base acute and slightly apiculate, apertural end also acute, on opposite side of test. Chambers long ovate, quite strongly overlapping, inflated, increasing substantially in size. Sutures distinct, depressed, oblique. Aperture terminal, a radiate cone or acute projection, on straighter, less convex margin.

Remarks: This form is characterized by its smooth test with acute ends and inflated chambers. There are insufficient chambers in the specimens to place them with certainty in this uncoiling genus, but the overall appearance, with asymmetry of the test with respect to the convexity of the outline, suggests this genus.

Cushman's reference has already been discussed under H. glabra.

Subfamily VAGINULININAE Reuss, 1860

Genus Vaginulina d'Orbigny, 1826

Vaginulina pauciloculata Cushman and Gray

Vaginulina advena Cushman var. pauciloculata CUSHMAN AND GRAY, 1946, p. 15, pl. 3, fig. 15.

Vaginulina (?) cf. advena pauciloculata Cushman and Gray. McCULLOCH, 1977, p. 11, pl. 96, figs. 16,21,22.

Test elongate, uniserial, consisting in this instance of just proloculus and succeeding chamber, base rounded, test compressed slightly. Proloculus compressed globular, next chamber greater in diameter and elongate pyriform, strongly produced toward long apertural neck at the convex margin. Single suture gently depressed, strongly oblique. Surface with weak, slightly oblique, longitudinal costae, which seem to be weaker on chamber surface and stronger at periphery, some run up neck. Aperture terminal, round.

Remarks: The costate test with few chambers and a very long, slender neck is distinctive.

Vaginulina subelegans Parr

Vaginulina subelegans PARR, 1950, p. 326, pl. 11, fig. 20.

NOT Vaginulina subelegans Parr?. BARKER, 1960, p. 140, pl. 66, fig. 15.

Dentalina subarcuata (Montagu). MURRAY, 1971, p. 79, pl. 30, figs. 4,5.

Test elongate, uniserial, gently compressed and very slightly arcuate. Proloculus globular, thick, with single basal spine, followed by a few (3 in present material) compressed but inflated chambers, thinner than proloculus, very little change in height or breadth as added, wall smooth. Sutures strongly oblique, depressed, very slightly limbate, test strongly lobulate in both side and edge views. Aperture quite strongly produced at peripheral angle, radiate.

Remarks: The present specimen agrees very well with Parr's species. Parr included Vaginulina elegans d'Orbigny of Cushman (1933d) in synonymy, but those forms differed in many respects, and are herein referred to Vaginulina sp. A. The forms Barker referred to the present species are too smooth in outline, without depressed or strongly oblique sutures, taper too strongly, and have a small unornamented proloculus. Murray's specimen, apart from lacking a basal spine, is an excellent match for Parr's species. Nautilus subarcuatus Montagu is delicate, strongly tapering and arcuate, with constricted sutures and subglobular to pyriform chambers.

Vaginulina sp. A

Vaginulina legumen (Linnaeus) var. elegans d'Orbigny. CUSHMAN, 1921, p. 258, pl. 41, fig. 4.

Vaginulina elegans d'Orbigny. CUSHMAN, 1933d, p. 16, pl. 3, figs. 9,10.

Test elongate, uniserial, arcuate and quite strongly compressed, periphery rounded and base with blunt broken spine at convex margin. Proloculus slightly thicker than rest of test, chambers thereafter at least twice as broad as high,

increasing so slowly in size as added that test barely tapers; no inflation evident in side view, but edge view has slightly lobulate profile. Sutures heavily limbate, nearly flush, gently curved and oblique. Surface completely smooth. Aperture radiate, at concave marginal angle.

Remarks: Vaginulina elegans differs in having heavy raised limbate sutures. Vaginulina bradyi Cushman and Vaginulinopsis sublegumen Parr have much broader chambers, especially in the former species, which also tapers more strongly. The present species is identical to Vaginulina legumen (Linnaeus) var. arquata Brady except this latter species is curved strongly and in the opposite sense, i.e. the aperture is at the convex margin and the basal spine at the concave one.

Subfamily SPIROLINGULININAE Loeblich and Tappan, 1986

Genus Spirolingulina Sellier de Civrieux and Dessauvage, 1965

Spirolingulina strigosa (McCulloch)

Neolenticulina (?) strigosa McCULLOCH, 1977, p. 9, pl. 94, fig. 8; pl. 96, fig. 39.

Test elongate, arcuate and compressed, periphery rounded. Chambers planispiral and initially coiled for a few chambers, later uncoiling but not rectilinear, broader than high, asymmetrically arched, slightly inflated. Sutures distinct, depressed, asymmetrically arched and oblique, higher and more widely spaced on convex side of test; on concave inner margin reaching back quite strongly toward initial coil. Aperture terminal, ovate, surrounded by extremely fine lip.

Remarks: The genus Neolenticulina McCulloch has acute margins and an unusual multiple aperture that superficially appears radiate, and so this species does not belong in that genus. Lingulinopsis carlofortensis Bornemann has much less asymmetrical sutures which do not extend in the slightest toward the initial coil.

Spirolingulina? sp. A

Test elongate, arcuate, very slightly compressed. Chambers uncoiling throughout. uniserial, initially broader than high, later as high as broad or more, not

much inflated. Sutures distinct, oblique, barely depressed. Aperture a barely compressed terminal oval, with very fine lip.

Remarks: There is but one specimen of this form.

Family LAGENIDAE Reuss, 1862

Genus Hyalinonetrion Patterson and Richardson, 1987

Hyalinonetrion napolitanum (Boltovskoy and de Kahn)

Amphorina elongata SEGUENZA, 1862b, p. 51, pl. 1, fig. 34.

Lagena napolitanum BOLTOVSKOY AND de KAHN, 1982, p. 437, pl. 10, figs. 9, 10.

Test elongate pyriform, circular in section, chamber exclusive of neck almost 4 times as long as broad, base rounded but with spine which is broken. Tapering chamber passes smoothly to slender neck, which is broken. Wall smooth. Aperture terminal, presumed round and without entosolenian tube.

Remarks: The elongate slender chamber distinguishes this species from H. vulgaris. The form was renamed by Boltovskoy and de Kahn to avoid confusion with Miliola elongata Ehrenberg.

Hyalinonetrion vulgaris (Williamson)

Lagena vulgaris WILLIAMSON, 1858, p. 3, pl. 1, fig. 5.

Lagena vulgaris vulgaris Williamson. BOLTOVSKOY AND de KAHN, 1982, p. 440, pl. 11, fig. 15.

Test teardrop-shaped, circular in section, chamber about twice as long as broad, base rounded with fine apical structure. Wall smooth, test tapers smoothly to elongate slender neck, which is broken, without entosolenian tube.

Remarks: This species is more ellipsoidal or stout than H. napolitanum, while Vermiculum laeve Montagu is shorter and has a much more stout neck than the present species.

Genus Lagena Walker and Jacob, 1798

Lagena alticostata Cushman

Lagena sulcata var. alticostata CUSHMAN, 1913a, p. 23, pl. 9, fig. 5.

Lagena striata (d'Orbigny). CUSHMAN, 1933d, p. 32, pl. 8, fig. 13, not fig. 11.

Test unilocular, pyriform, base rounded with apical spine, apertural neck long and slender at least in distal portion. Test ornamented, usually with 6, but rarely with 5 high thin costae that run from apical spine well up apertural neck, forming convex flanges. Between these are inserted 2 or 3 costae which originate at base of test, of which 1 (the central if 3 are developed) terminates at the base of the neck, while the other(s) is (are) shorter.

Remarks: Ovulina elegantissima Bornemann has the same pattern of costae, but is apparently truncate at the base and has a shorter, stout neck in contrast to the present species. Oolina striata d'Orbigny is characterized by a long slender neck without prominent raised costae, hence Cushman's (1933d) pl. 8, fig. 13 should be referred to the present species, while his fig. 11 represents L. striata.

Lagena interrupta Williamson

Lagena striata (Montagu) var. interrupta WILLIAMSON, 1848, p. 14, pl. 1, fig. 7.

Lagena striata (d'Orbigny) var. interrupta Williamson. CUSHMAN, 1933d, p. 33, pl. 8, fig. 4.

Lagena interrupta Williamson. MURRAY, 1971, p. 83, pl. 32, figs. 1-5.

Lagena spp. BELANGER AND BERGGREN, 1986, p. 331 (pars), pl. 1, fig. 6, not 7,8.

Test unilocular, subglobular to oval, with distinct long slender neck. Test covered with very fine costae, many of which run from base of neck to a point near base of test, where there are one or more rings of short spines. There are also numerous costae which terminate well above this point, and also fail to extend to the base of the neck. Base furnished with single prominent tubular apical spine. Neck evidently ornamented with spiral costa.

Remarks: The basal spine observed in the present material was not present in either the types or Murray's specimens, and the neck of Murray's forms was characterized by a twisted hexagonal pattern. The specimen illustrated by Belanger and Berggren in pl. 1, fig. 6 has many fewer costae, but is otherwise closely similar

to the present forms.

Lagena meridionalis Wiesner

Lagena gracilis Williamson var. meridionalis WIESNER, 1931, p. 117, pl. 18, fig. 211

Lagena meridionalis Wiesner. LOEBLICH AND TAPPAN, 1953, p. 62, pl. 12, fig. 1.---
BARKER, 1960, p. 119, pl. 58, fig. 19.---BOLTOVSKOY AND de KAHN, 1982,
p. 437, pl. 10, figs. 4, 23.---PATTERSON, 1986a, p. 61, pl. 7, figs. 13-15.

Lagena gracilis Williamson. ?BARKER, 1960, p. 119, pl. 58, fig. 23 only.

NOT? Lagena cf. L. meridionalis Wiesner. WARD AND WEBB, 1986, p. 183, pl. 2, fig. 11.

Test with chamber very elongate ellipsoidal to teardrop-shaped, surface with many strong costae, several fusing at base to produce tapering spine, at apertural end alternate costae pass up onto slender, tapering neck, and are wide and thin at the transition. Some specimens with a few very short costae interspersed at greatest breadth of test, which is usually below midline. Aperture terminal, round, on slender neck, may have thickened lip.

Remarks: The alternation of costae passing up onto the neck is a major distinguishing feature, as is the apical spine, but the chamber shape is highly variable. It looks much like Lagena axiformis Matthes, which is highly variable, but that species may have slightly fewer costae, and is entosolenian. Loeblich and Tappan included Lagena gracilis Williamson var. of Cushman, 1913 (p. 25, pl. 8, fig. 7) in synonymy, but that form has flaring plate-like costae on the neck that are independent of the chamber costae. Lagena gracilis Williamson is elongate and fusiform, and for that reason Barker's pl. 58, fig. 23 is referred herein to the present species. Ward and Webb's specimen is tentatively excluded because it does not apparently exhibit the alternation of costae passing onto the neck. There appears, rather, to be a fusing of costae before the apertural and basal extremities.

Lagena plumigera Brady

Lagena plumigera BRADY, 1881, p. 62.---BRADY, 1884, pl. 58, figs. 25-27.---
CUSHMAN, 1913a, p. 25, pl. 12, fig. 4.---BARKER, 1960, p. 120, pl. 58, figs. 25-27.

Test unilocular, pyriform in outline but chamber essentially globular, neck very long and slender. Surface ornamented with 8 longitudinal costae that originate well up on neck and run to a point close to the base, increasing in height toward base and provided with tubuli below midpoint of chamber, projecting progressively more toward base, producing distinctive fringed appearance to base of test. Base also provided with apical spine which projects below acute lower margin of costae. Neck lacks lip, is apparently strongly angular in section.

Remarks: The fringed appearance of the base, caused by tubulated costae, is distinctive.

Lagena sesquistriata Bagg

Lagena sesquistriata BAGG, 1912, p. 50, pl. 13, figs. 12-14.---BOLTOVSKOY AND de KAHN, 1982, p. 439, pl. 10, figs. 32,33.

Test elongate teardrop shaped, circular in section, greatest breadth toward base, which is rounded. Surface with 7 to 9 high plate-like costae which meet at the base, and run up onto base of long thin neck, at end of which is terminal round aperture.

Remarks: The test shape and low number of plate-like costae distinguish this species. Lagena hexacostata McCulloch is similar, but is parallel-sided, and may have only a short neck.

Lagena spiralis Brady

Lagena spiralis BRADY, 1884, p. 468, pl. 114, fig. 9.---CUSHMAN, 1933d, p. 30, pl. 7, figs. 15,16.

Lagena? spiralis Brady. BARKER, 1960, p. 236, pl. 114, fig. 9.

Test unilocular, subglobose to somewhat elongate, base rounded, neck produced. Surface ornamented with 7 longitudinal costae which meet at the base, then are spirally twisted as they run up the test, executing approximately 1/4 turn, thence running vertically onto and up the neck; costae are perforated, perforations not penetrating test wall. No entosolenian tube detected.

Remarks: The absence of an entosolenian tube forces placement of this species

in Lagena rather than Cushmanina, but the perforate costae would suggest this latter genus. It may be that specimens with an entosolenian tube may eventually be discovered, causing reassignment.

Lagena spirata Bandy

Lagena sulcata (Walker and Jacob) var. spirata BANDY, 1949, p. 57, pl. 7, fig. 18.

Lagena laevis (Montagu) variants. BARKER, 1960, p. 118, pl. 57, fig. 23 only.

Test slightly pyriform, circular in section, base rounded. Surface covered by fine sharp closely spaced costae which for the most part run from the base to the neck, whence a few spiral up the long, slender, slightly tapering neck at a very oblique angle. Aperture terminal, round.

Remarks: This species is completely distinctive.

Lagena substriata Williamson

Lagena substriata WILLIAMSON, 1848, p. 15, pl. 2, fig. 12.---MURRAY, 1971, p. 87, pl. 34, figs. 1-4.---BOLTOVSKOY AND de KAHN, 1982, p. 439, pl. 11, figs. 7,8.

Lagena striata (d'Orbigny) var. substriata Williamson. CUSHMAN, 1913a, p. 20, pl. 8, figs. 1-3.

Test very elongate teardrop shaped, chamber nearly parallel-sided for much of its length, base produced into caudal protrusion, chamber tapers to elongate slender neck, with clear tapering base. Whole of chamber covered with fine longitudinal striae rather than costae, disappearing on tapered base of neck. Aperture terminal, round.

Remarks: The present specimen is rather more elongate and slender than Williamson's type, and is suggestive of Procerolagena. Based on the more typical members of this species, it is left for the present in Lagena. The fine striae are distinctive, while Oolina striata d'Orbigny has a globular chamber.

Lagena sulcata (Walker and Jacob)

Serpula (Lagena) sulcata WALKER AND JACOB, 1798, p. 634, pl. 14, fig. 5.

Lagena sulcata (Walker and Jacob). CUSHMAN, 1913a, p. 22, ?pl. 9, fig. 2.---BARKER, 1960, p. 118, pl. 57, figs. 33,34.---MURRAY, 1971, p. 87, pl. 34, figs. 5-8.

Lagena sulcata var. apiculata CUSHMAN, 1913a, p. 23, pl. 9, figs. 3,4.

Lagena sulcata var. spicata CUSHMAN AND McCULLOCH, 1950, p. 360, pl. 48, figs. 3-7.

Test unilocular, globular, with rather slender elongate neck which may have a lip. Surface ornamented with several fairly high, sharp costae (on average 16-18) that run from the base of the neck, which has no collar, to the base of the test, where they coalesce in a small circular plug which may be produced into an apical spine. Rarely individual costae may bifurcate. Aperture terminal and round.

Remarks: The form which Cushman (1913a) designated as a subspecies on the basis of its apical spine is not separated herein as a distinct form for the simple reason that such a fine apical spine may not be preserved. Cushman and McCulloch's subspecies is simply a new name for the same form, the name change being required as a different form had already been named apiculata. The specimen illustrated by Cushman (1913a) in pl. 9, fig. 2 is definitely not typical, and may not even be referable to this species. It has a few costae that are more prominent and project basalward at the lower chamber margin.

Lagena sp. A

Test unilocular, elongate oval to pyriform, chamber oval, neck conical, with distinct basal shoulder and indentation of test outline, base rounded. Surface ornamented with several orders of longitudinal costae; first order costae are actually six very closely spaced pairs that run the length of test, to the aperture, and produce a distinctly hexagonal cross-section to test when viewed from aperture. Between these pairs of first order costae are second order costae which run right up to the aperture, but do not extend quite to the base. There may then be a third order of longitudinal costae which are essentially restricted to the middle portion of the test, and are not as high or prominent as the first two orders.

Remarks: This species bears a superficial resemblance to Lagena gracilis var. of Cushman (1913a, pl. 8, fig. 7) and L. gracilis of Barker (1960, pl. 58, fig. 22), but

the six pairs of very closely spaced costae that mark the angles of the test serve above all to distinguish the present species.

Genus Procerolagena Puri, 1954

Procerolagena gracilis (Williamson)

Lagena gracilis WILLIAMSON, 1848, p. 13, pl. 1, fig. 5.---CUSHMAN, 1913a, p. 24 (pars), not pl. 8, figs. 5,6.---BARKER, 1960, p. 119, pl. 58, figs. 2,8,9 only.---MURRAY, 1971, p. 81, pl. 31, figs. 4-6.

NOT Lagena gracilis Williamson. CUSHMAN, 1933d, p. 33, pl. 8, figs. 5-7.---BUCHNER, 1940, p. 426, pl. 4, figs. 62, 63.---ASANO, 1951, pt. 15, p. 30, fig. 133.---BOLTOVSKOY AND de KAHN, 1982, p. 436, pl. 9, figs. 20-22.---WARD AND WEBB, 1986, p. 183, pl. 2, figs. 2-4.

Lagena mollis Cushman. BOLTOVSKOY AND de KAHN, 1982, p. 437, pl. 10, fig. 5.

Test extremely elongate fusiform, slender, circular in section, greatest breadth usually slightly below midline. Surface with many (12 or more) strong longitudinal costae which fuse and are produced as a long tapering basal spine, and also run well up long slender tapering neck. Aperture terminal, round, no lip observed in present material.

Remarks: Lagena distoma Parker and Jones is elongate and parallel-sided for most of its length, before tapering rapidly to open tubular endings at both ends of the test. Lagena gracillima (Seguenza) var. mollis Cushman has a greater disparity between the longer apertural neck and shorter basal spine, and has extremely fine costae or striae. All forms or specimens ruled out of the present synonymy are either of the right shape but have too few and too plate-like costae, or are too globose or broad in outline.

Genus Pygmacoseistron Patterson and Richardson, 1987

Pygmacoseistron hispidum Reuss

Lagena hispida REUSS, 1863, p. 335, pl. 6, figs. 77-79.---CUSHMAN, 1913a, p. 13, pl. 4, figs. 4,5; pl. 5, fig. 1.---BARKER, 1960, p. 116, pl. 57, figs. 1-4.

Lagena hispidula Cushman. ?BARKER, 1960, pl. 56, fig. 13.

Test unilocular, globular to pyriform, base rounded, with fairly long stout neck and distinct phialine lip. Surface of chamber and most of neck quite strongly

hispid.

Remarks: Lagena aspera Reuss has much coarser ornament, while L. gibbera Buchner is essentially smooth except for very coarse spines or rugosities on the neck. Pygmaeoseistrion hispidulum is more finely hispid and has a distinctly different shape, being subcylindrical, with subparallel sides, a strong shoulder, and very long, slender neck. Because of its globular test without shoulders, the specimen figured in Barker as pl. 56, fig. 13 is tentatively referred herein to the present species.

Pygmaeoseistrion hispidulum Cushman

Lagena hispidula CUSHMAN, 1913a, p. 14, pl. 5, figs. 2,3.---BARKER, 1960, p. 114, pl. 56, figs. 10,11, ?not 13.

Test unilocular, somewhat elongate, subcylindrical, almost parallel-sided and with distinct rounded shoulders. Surface of test very finely hispid, as is neck, which is very elongate and slender.

Remarks: The distinction of this species has already been discussed under P. hispidum. A specimen from sample NOVA-A 32G may have an entosolenian tube, which would place this species in Pristinosceptrella Patterson and Richardson.

Pygmaeoseistrion nebulosum (Cushman)

Lagena laevis (Montagu) var. nebulosa CUSHMAN, 1923, p. 29, pl. 5, figs. 4,5.

Lagena nebulosa Cushman. BARKER, 1960, p. 114, pl. 56, fig. 12.---COLE, 1981, p. 65, pl. 18, fig. 21.---BOLTOVSKOY AND de KAHN, 1982, p. 437, pl. 10, figs. 11,12.

Test rather long ellipsoidal, chamber just over twice as long as broad, parallel-sided, base rounded with distinct caudal bump or short spine, upper chamber surface distinct from neck and rapidly tapering but not quite shouldered. Wall smooth, neck long and slender, smoothly joined to body, with terminal round aperture.

Remarks: This species is distinguished from P. hispidulum by its smooth wall, from Pygmaeoseistrion sp. A by its long slender neck, and from others by its chamber shape.

Pygmacoscistrion sp. A

Test ellipsoidal to barrel-shaped, sides parallel, a bit more than twice as long as broad, base rounded and may be apiculate, wall smooth. Aperture terminal, round, on very short distinct neck with phialine lip.

Remarks: The chamber shape distinguishes this species from most, while the neck differs from those of both P. nebulosum and P. hispidulum, which is also hispid.

Pygmacoscistrion sp. B

Lagena sp. aff. laevis (Montagu). BARKER, 1960, p. 116, pl.56, fig. 14.

Test unilocular, globular, may have apical spine. Surface smooth, not hispid. Aperture terminal, round, on end of elongate, distinct neck with tapering stages and no smooth transition with chamber, furnished with phialine lip. No entosolenian tube observed.

Remarks: Vermiculum globosum Montagu lacks a neck, V. laevis Montagu is teardrop-shaped and the neck produced rather than distinct, and P. hispidum is of course hispid.

Family POLYMORPHINIDAE d'Orbigny, 1839

Subfamily POLYMORPHININAE d'Orbigny, 1839

Genus Globulina d'Orbigny, 1839

Globulina inaequalis Reuss

Globulina inaequalis REUSS, 1850, p. 377, pl. 48, fig. 9.---BARKER, 1960, p. 148, pl. 71, fig. 13.

Test, except for final chamber, skewed ovate, with subacute extremities, thick but compressed. Chambers in polymorphine arrangement, virtually uninflated, quite strongly embracing, last pair about 3/4 of test, several visible on each side, not obviously biserial. Sutures distinct, slightly depressed, oblique and essentially straight. Aperture terminal, radiate. Added to this is single large subglobular chamber, overlapping upper 1/4 to 1/3 of test on one side of periphery, and long

enough, exclusive of neck, to be nearly 1/2 of test length. This chamber provided with long cylindrical neck and very rough lip, whole of chamber hispid, neck sparsely so.

Remarks: The skewed test with subacute ends distinguishes this species. The abberant final chamber is not thought to distinguish a new species, but rather to be an expression of the tendency in polymorphinids to fistulose development of the final chamber.

Genus Polymorphina d'Orbigny, 1826

Polymorphina inflata (Reuss)

Globulina inflata REUSS, 1851a, p. 81, pl. 6, fig. 45.

Test ovate, compressed and oval in section, base rounded and greatest width just above midline. Chambers 2 per whorl, clearly biserial, very strongly embracing and uninflated, over 3/4 of test length, but as many as 3 pairs clearly visible per side. Sutures distinct, flush, concave down, somewhat subhorizontal higher up, but finally strongly oblique at the base. Aperture terminal, radiate, with no evidence of entosolenian tube.

Remarks: Globulina depressa d'Orbigny is very strongly compressed, the main suture subhorizontal, and the chambers disposed at a great angle to the test axis, while G. aequalis d'Orbigny has more nearly straight, oblique sutures that are very slightly depressed.

Polymorphina minima (Bornemann)

Globulina minima BORNEMANN, 1855, p. 344, pl. 17, fig. 3.

Test slightly skewed, broad fusiform in outline, nearly circular in section, base acute to apiculate. Chambers 2 per whorl, not quite 180° apart, fairly strongly embracing, over 3/4 of test length, 3 visible on one side, 4 on the other. Sutures distinct, flush, strongly oblique to subvertical, concave downward throughout. Aperture terminal, radiate, without entosolenian tube.

Remarks: Polymorphina (Globulina) minuta Roemer is more strongly

compressed, and the chambers are much less embracing, the final pair being just over half the test length.

Genus Pyrulina d'Orbigny, 1839

Pyrulina angusta (Egger)

Polymorphina (Globulina) angusta EGGER, 1857, p. 290, pl. 13, figs. 13-15.

NOT Polymorphina angusta Egger. CUSHMAN, 1913a, p. 86, pl. 39, fig. 6.

NOT Pyrulina angusta (Egger). BARKER, 1960, p. 150, pl. 72, figs. 1-3.

Test elongate and somewhat fusiform in outline, nearly parallel-sided for middle portion, tapering asymmetrically to same side at both ends, which are pointed, test distinctly compressed. Chambers added in planes 120° apart, uninflated, strongly embracing, reaching close to but not all the way to base. Sutures distinct, flush, strongly oblique and gently sigmoid or curved. Aperture terminal, radiate.

Remarks: This species is distinguished by its chamber arrangement, shape, and flush sutures from most species. It differs from Laryngosigma invecta, which is entosolenian and resorbs embraced surfaces. Both Cushman's (1913a) and Barker's references have been transferred thereto.

Pyrulina extensa (Cushman)

Polymorphina longicolis Karrer. CUSHMAN, 1913a, p. 90, pl. 41, figs. 1-3.

Polymorphina extensa CUSHMAN, 1923, p. 156, pl. 41, figs. 7,8.

Pyrulina extensa (Cushman). CUSHMAN, 1933d, p. 39, pl. 9, fig. 12.---BARKER, 1960, p. 152, pl. 73, figs. 18,19.

Test fusiform, base acute. Chambers arranged in series approximately 120° apart, distinctly 3 per whorl, later 2 per whorl only. Sutures essentially flush, except for that at base of very slightly inflated final chamber. Surface finely hispid throughout, even neck, and final chamber more densely covered. Aperture terminal, round, produced on neck, lip not preserved on present specimens.

Remarks: Polymorphina longicolis is teardrop-shaped, with a rounded base,

produced apertural end with radiate aperture, and a smooth surface.

Subfamily RAMULININAE Brady, 1884

Genus Ramulina T.R. Jones, 1875

Ramulina goesi Rzehak

Nodosaria radícula var. monile "Aulostoma-Form" GOËS, 1882, pl. 1, fig. 7 (fide Rzehak, 1895).

Ramulina goesi RZEHAKE, 1895, p. 223.

Specimen consists of a single chamber, ellipsoidal to elongate pyriform in outline and circular in section, with a long broken tube greater in length and of about 1/2 diameter projecting from one end and defining test axis, and from the other end project two short broken tubes of lesser diameter, symmetrically disposed about axis and at an angle of about 60° to each other. Wall smooth. Aperture presumed to be round openings at ends of tubes.

Remarks: This species is distinguished from most others of the genus by its completely smooth walls, and from the Cretaceous R. laevis Rupert-Jones, which is characterized by an irregular series of swellings and curved connections, rather than straight tubes between distinct chambers.

Family ELLIPSOLAGENIDAE A. Silvestri, 1923

Subfamily OOLININAE Loeblich and Tappan, 1961

Genus Buchnerina R.W. Jones, 1984

Buchnerina bradii (Silvestri)

Fissurina bradii SILVESTRI, 1902, p. 147.

Lagena orbignyana (Seguenza). CUSHMAN, 1913a, p. 42, pl. 19, fig. 1.---CUSHMAN, 1933d, p. 26, pl. 6, figs. 7,8, not 11.

Fissurina bradii Silvestri. BARKER, 1960, p. 124, pl. 59, fig. 24.

Fissurina orbignyana Seguenza. BARKER, 1960, pl. 59, fig. 26.

Test unilocular, not much compressed, chamber circular but test outline pyriform due to produced neck. Test furnished with main peripheral keel extending right up neck to apertural lip, with two supplementary marginal keels that are lesser

in diameter than peripheral keel, and well removed from it, producing a truncate periphery with projecting keel. Surface of test otherwise smooth.

Remarks: Fissurina orbignyana is circular in outline, with a broad, arcuate apertural neck with acute corners, and its peripheral keel is prominent, while the two marginal keels are very close to it and barely greater in diameter than the chamber. Thus the specimens referred by Cushman and Barker to this latter species belong in the present one. Specimens referred to E. orbignyana Seguenza vars. by Barker (pl. 59, figs. 18,20) do not have an apertural view and thus cannot be transferred, while the specimen illustrated by Cushman (1933d) in pl. 6, fig. 11 has too complex a keel system to be transferred to E. bradii. Fissurina cucullata Silvestri has 3 broad but very closely spaced keels, and the faces have broad tapering extensions of the peripheral bands and barely inflated chambers. Lagena orbignyana var. coronata Sidebottom has a broad opaque band on each face, and thus differs from the present species.

Buchnerina castrensis (Schwager)

Lagena castrensis SCHWAGER, 1866, p. 208, pl. 5, fig. 22.

Test unilocular, compressed, somewhat pyriform in outline, neck quite stout and strongly produced. Test furnished with a peripheral keel that adheres closely to outline, and two adjacent keels that are slightly smaller in extent and well removed from peripheral keel, producing strongly truncate margin with projecting keel. Base with single apical spine, and surface of chamber covered with pustules or rugosities.

Remarks: This species differs from E. bradii in having rugosities on the chamber surface, and it differs from the remarkably similar L. orbignyana var. caribaea Cushman, which has a granular rather than rugose test surface.

Buchnerina sp. cf. B. curvicostata (Sidebottom)

Lagena orbignyana (Seguenza) var. curvicostata SIDEBOTTOM, 1912, p. 417, pl. 19, fig. 20.

Test pyriform in outline, with ovate, inflated but compressed chamber, and a

stout, angular neck with flared, convex upward lip. Periphery rounded with a rather broad thin keel, and each face with a narrower, rounded keel which is removed from and well inboard of peripheral keel; 3 keels not continuous around base, but are interrupted by a gap, and the lateral keels curve in to meet the central keel, which produces 2 contiguous grooves from each lateral margin which do not meet at base. Central keel forms a flange up to base of lip, while lateral ones run in to the costae or ridges that produce the angles of the neck. Aperture terminal, slightly ovate, entosolenian tube presumed.

Remarks: This species is distinguished from related forms by the manner in which the 3 keels fuse before reaching the base. Sidebottom (1912, p. 417) described ornament that "is a series of grooves, which are mostly bent as they approach the border and are sometimes irregular", and also noted that he had but a single specimen. The type figure is not helpful in illuminating this latter feature, so the present form is tentatively assigned to this species on the basis of its keels.

Buchnerina iberica Jones

Buchnerina iberica JONES, 1984, p. 104, pl. 2, figs. 4-6.

Buchnerina sp. 1. ?JONES, 1984, p. 105, pl. 2, figs. 7-9.

Test pyriform, strongly compressed, faces rather flattened, chamber nearly circular in outline, with stout tapering neck, rounded base. Periphery truncate, with broad thin keel in middle which embraces neck, which gives typical 3-keeled appearance; from periphery a plane surface passes onto chamber, which is also encircled by a raised rounded ridge which is joined at the base of the neck by 2 closely spaced costae which run to the top of neck, so that it is in effect a 5-keeled form. Aperture terminal, broken in present specimen, presumed rounded and entosolenian.

Remarks: The 5 complete keels are distinctive, and not to be confused with the 3 keels plus irregular ridges of *B. semiconcentrica*. It appears there is little if any real difference between Jones's two forms, the latter supposedly being smaller and

having a longer neck.

Buchnerina lacunata (Burrows and Holland)

Lagena lacunata BURROWS AND HOLLAND, 1895, p. 205, pl. 7, fig. 12.

Lagena orbignyana (Seguenza), var. lacunata Burrows and Holland. CUSHMAN, 1913a, p. 43, pl. 20, fig. 1.---CUSHMAN, 1933d, p. 27, pl. 7, figs. 1-5,8.

Fissurina lacunata (Burrows and Holland). BARKER, 1960, p. 124, pl. 60 figs. 1,2.

Test unilocular, compressed, pyriform in outline. Single large thin peripheral keel runs up to end of apertural neck which is quite large and stout, this keel bordered by 2 keels of lesser diameter, well-spaced from peripheral keel to produce somewhat truncate margin with projecting keel; keels interrupted at base of test. Chamber faces covered by series of vertically oriented and aligned shallow, ellipsoidal pits.

Remarks: The surface ornament of ellipsoidal pits is distinctive.

Buchnerina semiconcentrica (Cushman)

Lagena orbignyana (Seguenza) var. semiconcentrica CUSHMAN, 1933b, p. 10, pl. 1, fig. 22.

Test ellipsoidal in outline, quite strongly compressed with rather flattened faces, and a presumed stout produced neck. Periphery with a fairly broad thin keel, and then each face with a well rounded, thick keel well removed from and inboard of periphery, these latter keels thinning and disappearing before closing at base of neck, peripheral keel presumed to form flange for at least lower part of neck. Faces with at least one rounded thick ridge, concentric to periphery, that forms anything from a complete closed oval to basal ridge.

Remarks: This species is distinguished from others of Buchnerina by its irregular concentric ridges on the faces, especially as compared to Lagena orbignyana (Seguenza) var. concentrica Sidebottom, which has several concentric and complete costae on each face.

Buchnerina sp. A

Test elongate pyriform in outline, chamber ovate, 1 1/2 times as long as broad,

inflated, with rounded periphery and base, and furnished with stout neck of about 1/4 chamber length. Periphery with fairly broad, thin keel, and 2 rounded supplementary keels on margins of faces, these latter not quite continuous around base, but rather joining main keel to produce caudal structure, and at base of neck meeting 2 very closely spaced, nearly fused costae which run up the neck. Surface of faces with very coarse perforations in no evident pattern. Aperture terminal, ovate, with fairly wide sharp lip, and short free entosolenian tube.

Remarks: This species is distinguished from B. lacunata, which has a sculpture of elliptical pits or depressions, rather than coarse perforations.

Genus Cushmanina R.W. Jones, 1984

Cushmanina desmophora (Jones)

Lagena vulgaris var. desmophora JONES, 1874, p. 54, pl. 19, figs. 23,24.

Lagena desmophora Rymer-Jones. CUSHMAN, 1913a, p. 27, pl. 12, fig. 5; pl. 13, fig. 3.---?CUSHMAN, 1933d, p. 29, pl. 7, figs. 11-14.

Oolina desmophora (Rymer-Jones). BARKER, 1960, p. 120, pl. 58, figs. 42,43.

Test unilocular, pyriform, chamber almost globular, base essentially rounded, neck long and slender, distinctly tapering. Ornament consists of longitudinal costae, 6 in present specimens, that are thick and flattened, with 4 or more circular perforations which do not penetrate test wall, first one just above chamber midpoint, remainder running toward base. Costae fuse at base and run partway up neck, which is smaller in diameter and clearer above these costae. Between these costae are finer costae which originate below the neck, bifurcate almost immediately, reunite toward the base whereupon they bifurcate again, joining the large perforate costae at the fourth perforation. Entosolenian tube not observed in the present study, but is common to all other descriptions of this form.

Remarks: As found in the literature, this species is quite variable as to the character of the finer costae and also the test shape, which (see Cushman, 1933d, all figured specimens) may be elongate, parallel-sided, and bent to one side. Lagena torquata Brady has crossbars joining the costae to produce a reticulate appearance,

while C. striatopunctata has costae whose bases are pierced on either side by foramina.

Cushmanina sp. cf. C. striatopunctata (Parker and Jones)

Lagena sulcata Walker and Jacob var. striatopunctata PARKER AND JONES, 1865, p. 350, pl. 13, figs. 25-27.

Oolina striatopunctata (Parker and Jones). BARKER, 1960, p. 120, pl. 58, figs. 37,40.

Lagena striato-punctata Parker and Jones. BOLTOVSKOY AND de KAHN, 1982, p. 439, pl. 11, fig. 6.

Cushmanina striatopunctata (Parker and Jones). LOEBLICH AND TAPPAN, 1987, p. 426, pl. 462, figs. 7-10.

Test elongate pyriform, greatest breadth near midline of chamber, base rounded, with apical spine. Neck long and slender, aperture terminal, rounded, with thickened rim, presumed entosolenian. Numerous strong costae run from base to top of chamber, whence at least alternate ones run up neck almost halfway; costae with distinct perforations in single rows along each side of costae at their base.

Remarks: The ornament and style of perforations is distinctive, but in the type and most specimens included in synonymy, there is no apparent continuity of costae onto the neck, nor costae of varying lengths.

Cushmanina sp. A

Test with globular pyriform chamber, as broad as long, with distinct ornament. Wall evidently finely perforate and frosted, base with tapering produced perforate area passing rapidly to thick, hyaline tapering spine, extremely long, about 1 1/2 times chamber length; apertural end produced, upper portion hyaline, as is tapering apertural neck, which is broken. Arising within this imperforate produced apertural end are some 24 very low costae, which become higher and are thin passing down to a point about 1/5 of the way from base, where their greatest extent or height is reached. Within the limits of the perforate portion of the chamber, the costae are pierced by fine tubuli and are very ragged or serrate, and at their basal extremity these tubuli are often retrally directed and inwardly curved tubes or spines of

significant length. Between these retral spines and the central basal spine, the surface of the test is hispid. Aperture presumed terminal, round, and entosolenian.

Remarks: This spectacular form is unique, represented by a single specimen.

Cushmanina sp. B

Test elongate flask-shaped, circular in section, greatest breadth 1/3 from base, about midline of ellipsoidal main part of chamber, above which is a smaller portion marked by distinct constriction; base rounded, with caudal thickening. Wall distinctly perforate throughout. Surface with 20 high, thin, plate-like costae alternating between 2 styles; first is slightly thinner, lower, stopping some distance before base, and becoming quite low crossing constriction to upper chamber part, where they terminate; second is quite high and a bit thick, with distinct, widely spaced perforations in the fashion of C. desmophora which do not penetrate the test, these costae reach closer to base than other kind, and their lower extremities are produced as flat, bladed spines, while toward the apertural end they pass beyond the chamber onto the neck as fairly broad, thin ragged keels, eventually becoming much reduced to absent for the balance of the long slender neck. Aperture terminal, round, without evident lip, presumed entosolenian.

Remarks: This form is distinguished by the alternation of perforate and simple costae, and basal projecting spines rather than fused caudal structure.

Cushmanina sp. C

Test with ellipsoidal chamber, circular in section, with long, slender neck about 2/3 of chamber length, with thickened lip. Surface with about 8 or 9 irregular perforate rugose costae that are sublongitudinal, but curve obliquely to horizontally across the top and bottom, crossing each other irregularly, while some continue as flanges up the neck. Base with a few transverse loops with no apparent pattern. Aperture terminal, round, with entosolenian tube.

Remarks: This form superficially resembles Lagena spiralis, but has no apparent pattern to the costae.

Genus Exsculptina Patterson and Richardson, 1987

Exsculptina georgii (Buchner)

Lagena Georgii BUCHNER, 1940, p. 443, pl. 6, figs. 95-97.

Test very short pyriform, broader than long, base rounded, apertural end slightly produced, truncate. Surface distinctively ornamented, with 15 apparent costae which, rather than being raised features, are the remnant ridges between radial excavations that extend $2/3$ of way from base, with rounded upper terminations; these ridges produced retrally as spines at their lower extremity, which is $1/3$ from base, to produce a fringe. Entire test surface below this fringe covered in coarse polygonal, predominantly pentagonal, raised reticulations of comparable dimensions to the width of the excavations. Aperture terminal, round, in middle of large collar or ring, presumed entosolenian.

Remarks: The pyriform shape, radial excavations with rounded upper terminations, and reticulate basal network are all characteristic of the genus, though the relative proportions of the three areas of the test may vary from species to species. Buchner's type figures showed slight depressions between radial ridges on the otherwise smooth upper surface, but these were not observed herein. Lagena exsculpta Brady lacks the coarse reticular mesh, and the excavations extend only as far as the midline.

Exsculptina sidebottomi (Earland)

Lagena intermedia SIDEBOTTOM, 1912, p. 390, pl. 17, figs. 1-3.---CUSHMAN, 1913a, p. 29, pl. 13, fig. 4.

Lagena sidebottomi EARLAND, 1934, p. 161, pl. 7, fig. 23.---BARKER, 1960, p. 118, pl. 57, fig. 20.

Test unilocular, pyriform, base subrounded, apertural end produced but not distinct. Greatest diameter near base; below this line are several grooves, with rounded upper terminations, radiating from a basal ring, within which test is irregularly ornamented. In present study this consists of fine elongate hispid ornament, but other descriptions mention reticulations and other irregular ornament.

Aperture terminal, radiate, apparently entosolenian.

Remarks: This species is distinguished from Lagena exsculpta Brady, which has grooves radiating from the base without an inner ornamented ring, and from L. crenata Parker and Jones, which has a flattened base, long neck with spiral ornament, and a central smooth convex region inside the radiating basal furrows.

Genus Favulina Patterson and Richardson, 1987

Favulina hexagona (Williamson)

Entosolenia squamosa (Montagu) var. γ. hexagona WILLIAMSON, 1848, p. 20, pl. 2, fig. 23.

Lagena hexagona (Williamson). CUSHMAN, 1913a, p. 17, pl. 6, figs. 2,3.

Lagena hexagona (Williamson) forma typica BUCHNER, 1940, p. 433, pl. 5, fig. 74.

Lagena hexagona (Williamson) forma alata BUCHNER, 1940, p. 433, pl. 5, fig. 77.

Entosolenia hexagona Williamson. ASANO, 1951, pt. 15, p. 35, fig. 151.

Oolina hexagona (Williamson). BARKER, 1960, p. 120, pl. 58, figs. 32,33.---

MURRAY, 1971, p. 93, pl. 37, figs. 1-3.---LAGOE, 1977, p. 122, pl. 2, fig. 13.---

COLE, 1981, p. 76, pl. 19, fig. 9.---HERMELIN AND SCOTT, 1985, p. 214, pl. 2, fig. 10.

Favulina hexagona (Williamson). PATTERSON, 1986a, p. 73, pl. 10, figs. 12,13.

Test nearly globose but distinctly pyriform due to slightly produced apertural end, base rounded. Whole of test covered with coarse reticulations formed by high, thin plate-like ridges, most frequently hexagonal but often irregularly polygonal to accommodate test geometry, usually in some loose vertical alignment with horizontal top and bottom surfaces. Aperture terminal, round, usually bordered by lip or thickened collar, but one specimen with additional short thin neck; entosolenian.

Remarks: The hexagonal ornament is dominant, with no suggestion of costae as in E. melo or its junior synonym Entosolenia squamosa (Montagu) var. scalariformis Williamson. Vermiculum squamosum Montagu has convex-upward fish-scale ornament. Lagena montagui Silvestri has much finer ornament with heavier plates, very randomly oriented, and Lagena geometrica Reuss has finer ornament and a well developed pyriform shape due to the long produced apertural end, and has a

radiate aperture.

Favulina melo d'Orbigny

Oolina melo d'ORBIGNY, 1839c, p. 51, pl. 7, figs. 13,14.---BARKER, 1960, p. 120, pl. 58, figs. 29,31,28, not 30---MURRAY, 1971, p. 93, pl. 37, figs. 4-6.---LAGOE, 1977, p.122, pl. 2, figs.1,16.---HERMELIN AND SCOTT, 1985, p. 214, pl. 2, fig. 11.

Oolina squamosa (Montagu). MURRAY, 1971, p. 95, pl. 38, figs. 1-3.

Test unilocular, pyriform, base rounded, aperture produced on very short neck on somewhat obscure collar, entosolenian tube not observed. Ornament consists of numerous closely spaced costae running length of test, connected by crossbars to produce vertical rows of a reticulate pattern that is offset.

Remarks: Favulina hexagona lacks obvious vertical alignment of reticulations by costae, and Lagena montagui Silvestri is distinguished by irregular or non-oriented subhexagonal ornament. Lagena geometrica Reuss is characterized by vertical rows of true hexagons laid on their sides (axes horizontal), while Vermiculum squamosum Montagu is characterized by ornament with the appearance of fish scales. Hence some of Murray's specimens should be transferred from that species, while Barker's pl. 58, fig. 28 probably should be referred to that species. The form illustrated by Barker in pl. 58, fig. 30 appears to have much too coarse a reticulation and should probably be referred to Entosolenia squamosa (Montagu) var. scalariformis Williamson.

Genus Galwavella Patterson and Pettis, 1986

Galwavella trigonoelliptica (Balkwill and Millett)

Lagena trigono-elliptica BALKWILL AND MILLETT, 1884, p. 81,87, pl. 3, fig. 8 (on p. 87 as L. marginata var. trigono-elliptica).

Galwavella trigonoelliptica (Balkwill and Millett). PATTERSON AND PETTIS, 1986, p. 74, figs. 1-4.

Fissurina cf. E. trigonmarginata (Parker and Jones). WARD AND WEBB, 1986, p. 185, pl. 2, fig. 6.

Test short elliptical in outline, not quite 1 1/2 times as long as broad, triangular in section with more or less flat faces, each of the three margins with a

distinct, single, simple keel, thin and reasonably broad, which all meet at the base without apical spine, and at the apertural end join slightly thickened lip. Wall smooth. Aperture terminal, triangular, with long, free, fairly straight entosolenian tube.

Remarks: This species differs from the many related species of Balkwill and Millett by its shape, and the fact that its carinae are simple and thin. Lagena trigono-marginata Parker and Jones, though not in either version of the Catalogue at Carleton University, would appear from the work of other authors to be almost globose, with strongly convex faces and some form of blunt, thick carinae. Ward and Webb's form is thus transferred herein to the present species.

Genus Heteromorphina R.W. Jones, 1984

Heteromorphina collaris (Cushman)

Lagena collaris CUSHMAN, 1913a, p. 10, pl. 1, fig. 2.

Oolina heteromorpha PARR, 1950, p. 304, pl. 8, fig. 6.

Heteromorphina heteromorpha (Parr). JONES, 1984, p. 98,99, pl. 1, fig. 2.

NOT Heteromorphina heteromorpha (Parr). PATTERSON, 1986a, p. 96, pl. 15, figs. 8,9.

Test elongate ellipsoidal to gently teardrop-shaped, over twice as long as broad, greatest breadth about 1/3 from base, section circular, base rounded with faint apical ring. Apertural end of main chamber surmounted by small stout chamberlet comprising 1/6 to 1/7 of test length and of lesser diameter than upper chamber extremity, but tapering with same contour as rest of test, and with slightly truncate top. Chamberlet separated from main chamber by strongly incised transverse suture, wall smooth. Aperture terminal, round, furnished with entosolenian tube which extends a very short distance into main chamber.

Remarks: Cushman (1913a, p. 10) explicitly referred to the chamberlet, calling it a "separate cavity", while Parr (1950, p. 304) referred to a rounded mass of clear shell material. Examination of the type figures shows these two species to be

synonymous, with Cushman's having priority. For this reason the genotype for Heteromorphina R.W. Jones should be Lagena collaris Cushman. Patterson's form differs from the present species in having a chamberlet that comprises fully 3/8 of the test length, and pointed extremities. It has been named H. amplivestibulata n. sp. by Clark (in press, b).

Heteromorphina sp. A

Test very elongate teardrop-shaped, over 3 times as long as broad, circular in section, greatest diameter about 1/3 from base; profile convex from there down to base, and gently so for the next 1/3 up, but the remainder to the aperture has a concave profile. Base rounded with apical structure of a small ring or produced spine base, wall smooth or with very faint, fine striae on lower part. Upper 1/4 of test is rather slender, tapering apertural chamberlet, separated by transverse depressed suture from main chamber. Aperture terminal and round, with short entosolenian tube passing through short imperforate inner collar into chamberlet, and from base of chamberlet another short straight tube passes into main chamber, the 2 tubes not apparently connected.

Remarks: The contour of the test and the elongate acute chamberlet distinguish this species from both H. collaris and Heteromorphina sp. B.

Heteromorphina sp. B

Test pyriform, circular in section, about twice as long as broad, tapering to narrow but not produced apertural end, base rounded with gently produced caudal bump. Principal chamber rather strongly inflated, as is chamberlet which is 1/3 of test length, the two joined at a rather broad, depressed, limbate suture. Aperture terminal, round, presumed entosolenian.

Remarks: This species differs from H. collaris in possessing a proportionately much larger chamberlet and limbate suture, and from Heteromorphina sp. A in having a much less strongly produced apertural end.

Genus Homalohedra Patterson and Richardson, 1987

Homalohedra anastocostata Patterson

Homalohedra anastocostata PATTERSON, 1986a, p. 97, pl. 17, figs. 8-11.

Test elongate pyriform to ellipsoidal, circular in section, surface with very unusual costate pattern, whereby the general pattern is for costae to be longitudinal and parallel for slightly over half of test length, centered on midline, thence rapidly converging to join adjacent costa on one side toward the top, and on the other side toward the base, producing a zigzag pattern transverse to test axis; from these fusions single costae continue toward either extremity, and may form sharp flanges or corners on the apertural neck, fusing with the base of short, tapering, thickened lip, or may not be on neck at all, and as for the basal extremity, these fused costae, or in rare cases the more numerous costae, will run to the base, joining a raised polygonal ring. Aperture terminal, round, entosolenian.

Remarks: This species has yet to be validated by publication. As a general rule, the costae on Patterson's types exhibited nothing like the clear pattern of the present material, although there are rare exceptions to the pattern within individual specimens that would suggest some randomness is to be expected within the species.

Homalohedra apiopleura (Loeblich and Tappan)

Lagena acuticosta Reuss. CUSHMAN, 1913a, p. 23, pl. 8, fig. 9, not 10; pl. 23, fig. 2.--CUSHMAN, 1933d, p. 34, pl. 8, figs. 9?, 10, 12.---BUCHNER, 1940, p. 429, pl. 4, figs. 68, 69.

Lagena apiopleura LOEBLICH AND TAPPAN, 1953, p. 59, pl. 10, figs. 14, 15.

Lagena sp. nov.? BARKER, 1960, p. 119, pl. 58, fig. 21.

Oolina apiopleura (Loeblich and Tappan). LAGOE, 1977, p. 121, pl. 2, fig. 14, not 11.

Oolina apiopleura Loeblich and Tappan. BOLTOVSKOY AND de KAHN, 1982, p. 441, pl. 12, figs. 1-3.

Lagena acuticosta Reuss f. typica ?BOLTOVSKOY AND de KAHN, 1982, p. 433, pl. 8, figs. 12-15.

Homalohedra apiopleura (Loeblich and Tappan). PATTERSON, 1986a, p. 98, pl. 17, figs. 6, 7.

Test ovate to pyriform, circular in section, base rounded but with a raised

ring, whence arise quite widely spaced longitudinal costae which join a smooth, gently raised collar which tapers to the neck. Aperture terminal, round, presumed entosolenian, on short straight neck.

Remarks: Lagena acuticosta Reuss is globular, and the costae meet at the base of the neck, without a smooth collar. There is also no apparent basal ring in that species. Cushman (1913a, pl. 8, fig. 10) illustrated a form with three stacked, progressively diminishing collars, the basal most with a scalloped edge, and Lagoe (pl. 2, fig. 11) illustrated a form with serrate costae that project rather than unite basally, and run up to the apertural extremity of the neck. Neither of these should be referred to the present species. Although Barker asserted that the type figure of the species indicated incipient hexagonal or reticular ornament, this is just the effect of the excavation of the test surface below the collar. It is impossible to tell why Boltovskoy and de Kahn placed externally identical forms in two separate species, unless the latter was for specimens without detectable entosolenian tubes.

Homalohedra polykamptarion Patterson

Lagena acuticosta Reuss, f. brevipostica (Bandy). BOLTOVSKOY AND de KAHN, 1982, p. 433, pl. 8, fig. 16.

Homalohedra polykamptarion PATTERSON, 1986a, p. 104, pl. 19, figs. 4-7.

Test globular, base with raised polygonal ring whence arise 9 rather low, widely spaced costae which run onto base of neck, which on present specimen is broken, but would otherwise presumably be long and tapering, with a terminal round aperture and entosolenian tube.

Remarks: Lagena acuticosta Reuss var. brevipostica Bandy is a Cretaceous form, long ovate pyriform, with costae fusing into a very subtle smooth surface that tapers into the neck. For this reason, the form of Boltovskoy and de Kahn is transferred. The present species has yet to be validated by publication. It is presumed to differ from Lagena costata (Williamson) var. polygonata Cushman principally on the lack of a neck in this latter species, assuming it has not simply

broken off, and also the absence of a raised basal polygonal ring. Although Patterson (1986a) asserted that the present species has a greater number of costae, the type figures for both species show eight.

Homalohedra stelligera (Brady)

Lagena stelligera BRADY, 1881, p. 60. --- BRADY, 1884, pl. 57, figs. 35,36. --- CUSHMAN, 1913a, p. 26, pl. 12, fig. 3. --- BARKER, 1960, p. 119, pl. 57, figs. 35,36.

Homalohedra stelligera (Brady). PATTERSON, 1986a, p. 105, pl. 19, figs. 1-3.

Test unilocular, pyriform, base with fairly deep rim or collar some 1/4 to 1/3 of test diameter. Rim in rare instances smooth, more typically furnished with 8 to 12 costae that may be merely buttresses, or even run 1/3 of way up test. Produced apertural end with heavy imperforate cone, pierced by entosolenian tube which is often preserved, aperture round.

Remarks: Brady's type description and 1884 amplification indicate that the entosolenian tube is not always observed, that the test is often asymmetrical, and that it frequently looks like the terminal chamber of some nodosarian. The similar Oolina clavata d'Orbigny is fusiform, with an apical spine and very long, thin neck. Dentalina guttifera d'Orbigny is composed of an arcuate series of chambers much like this species in shape, but the aperture presumably was radiate, although it was not explicitly described. The basal ring on H. stelligera does not have the ragged appearance that would be expected if it were the fragment of a larger form. The description of this genus in Loeblich and Tappan (1987) indicates that the ribs merge into a ring-like collar just below the apertural neck, but this was evidently based on the anticipated type description of the genus by Patterson and Richardson, which ultimately said that "costae...may or may not extend to small, round aperture" (Patterson and Richardson, 1988, p. 251).

Homalohedra sp. A

Lagena sulcata laevicostata Cushman and Gray. ?BOLTOVSKOY AND de KAHN, 1982, p. 440, pl. 11, fig. 12.

Test with pyriform chamber, circular in section, having long, slender basal tube of as much as 2/3 chamber length, and an extremely long, slender apertural neck, up to 1 1/2 times the length of the chamber. Test ornamented with 10 or 12 sharp costae which originate where basal tube meets chamber, or even as thin flanges to tube; half of, or alternate costae, pass up to or just beyond midline of chamber, remainder become broad and thin as they pass up onto neck, going approximately but not quite halfway to aperture, and forming flanges. Aperture terminal, round, with short free entosolenian tube.

Remarks: This species is evidently very closely related to H. stelligera, from which it differs in its stronger development of costae, and their style of alternation. It resembles the specimen of Boltovskoy and de Kahn, which in the single side view would appear to have a basal tube, neck possibly broken off beyond the costae, and alternate costae terminating well short of the neck. It is impossible to determine the presence of an entosolenian tube. The species to which they referred this form has a globular chamber with high, plate-like costae, some of which go up the neck, but the remainder go to the base of same, without true alternation. In addition, the base has no tube, nor is there any entosolenian tube.

Genus Lagnea Popescu, 1983

Lagnea sp. cf. L. costata (Brady)

Lagnea auriculata (Brady) var. costata BRADY, 1881, p. 61.---BRADY, 1884, pl. 60, fig. 38.---CUSHMAN, 1913a, p. 32, pl. 14, fig. 2.---CUSHMAN, 1933d, p. 23, pl. 6, fig. 2.

Fissurina auriculata (Brady) var. costata (Brady). BARKER, 1960, p. 127, pl. 60, fig. 38.

Test unilocular, pyriform, chamber circular in outline, aperture in wide produced conical neck, with entosolenian tube. Base with two loops, one on each lateral margin, widest and almost rounded nearest base, where joined together by very narrow keel, tapering, as they pass up to widest point of chamber, to an acute opening. Lower portion of chamber furnished with numerous longitudinal costae.

Remarks: The present forms differ from those figured by Brady and others, whose specimens are carinate right up to the aperture, which is on a tubular neck, and have costae running the length of the chamber. In addition, their specimens have a spinose keel joining the basal loops. It is not unusual to have this kind of variation in the development of ornament within a species of Lagnea, and so the present forms are tentatively referred to this subspecies.

Lagnea formosa (Schwager)

Lagnea formosa SCHWAGER, 1866, p. 206, pl. 4, fig. 19; pl. 7, fig. 1.---CUSHMAN, 1913a, p. 41, pl. 11, fig. 6.---CUSHMAN, 1933d, p. 25, pl. 6, figs. 6,9,10.

Lagnea formosa Schwager var. comata BRADY, 1884, p. 480, pl. 60, fig. 22.---CUSHMAN, 1913a, p. 41, pl. 11, fig. 8.

Lagnea formosa Schwager var. favosa BRADY, 1884, p. 480, pl. 60, fig. 21.---CUSHMAN, 1913a, p. 41, pl. 11, fig. 7.

Fissurina formosa (Schwager) var. comata (Brady). BARKER, 1960, p. 126, pl. 60, fig. 22.

Fissurina formosa (Schwager) var. favosa (Brady). BARKER, 1960, p. 126, pl. 60, fig. 21.

Fissurina sp. nov. BARKER, 1960, p. 126, pl. 60, figs. 18,19.

Test unilocular, elongate pyriform or teardrop-shaped in outline, chamber oval, with elongate slender neck, often with thickening at apertural end. Predominant ornament consists of a marginal keel, originating well up the apertural neck, which splits into 2 closely spaced wide keels, usually before the level of the chamber is reached. These parallel keels are separated by radiating straight partitions that are limbate, producing contiguous square openings between keels. Keels rejoined near base by somewhat circular, often broken or abbreviated loop which is extension of rather large tubular projection of chamber base. Peripheral keels may be supplemented at junction with chamber by narrow keels which may completely encircle chamber, or merely encircle lower half, tapering to nothing as they pass up the test. Independent of presence or absence of supplementary keels, surface of chamber may be smooth, wholly striate with longitudinal or somewhat

anastomosing fine costae, or have short costae only where neck and basal tube meet peripheral keels.

Remarks: There has been some confusion in the literature, arising primarily from some of Cushman's descriptions in which the keels are said to be traversed by tubuli. Schwager's Latin type description, translated, reads "border itself consisting of two lamellae separated by means of quite closely/densely spaced, straight, radiating fillets" (Schwager, 1866, p. 206). It is the limbate nature of these fillets or partitions that produces the appearance of tubuli. The character of the keels in Lagnea formosa serves to distinguish it from the species Lagena sublagenoides Cushman, E. subformosa Parr, and L. tubulifera Brady, as well as their subspecies, all of which have single keels traversed by tubuli which are circular in section. The present species is highly variable in terms of ornament, and it appears to be fruitless to distinguish several subspecies. Schwager did not observe a basal cleft or tube, which Barker apparently felt was sufficient cause to erect a new species, although he did not do so himself. It is probably an effect of the variability of this species.

Lagena lagenoides (Williamson)

Entosolenia marginata (Montagu) var. lagenoides WILLIAMSON, 1858, p. 11, pl. 1, figs. 25,26.

Lagena tubulifera BRADY, 1881, p. 61.

Lagena lagenoides (Williamson). BRADY, 1884, pl. 60, figs. 6,7,9,12 only.---
CUSHMAN, 1913a, p. 39, pl. 16, fig. 2.---CUSHMAN, 1933d, p. 24, pl. 6, figs. 3-5.

Fissurina lagenoides (Williamson). BARKER, 1960, p. 124, pl. 60, figs. 6,7,9,12.

Test elongate pyriform in outline, chamber compressed ellipsoidal with smooth faces and long slender neck which may exceed 1/2 chamber length. Ornament highly variable, consisting of some form of thin keel which has appreciable to great breadth, embracing the neck, and has something on the order of 6 tubuli per side, which may be radial to somewhat basally directed. Base may have continuous keel, or have large quadrate caudal tube whose corners are extended as costae which run

onto base of chamber, and whence arise secondary fine inclined carinae encircling the chamber. Neck may have a pair of costae running down onto upper surface of chamber. Aperture terminal, essentially round, with long, straight, free entosolenian tube.

Remarks: The simple keel with true tubuli distinguishes this species from most, while it lacks the longitudinal costae of Lagnea tenuistriata. The great range of shape, style of keel and neck, and basal ornament, may indicate that several species have been lumped under the one name. In the present study there are not enough specimens to even attempt a revision of this form, but it is recommended.

Lagnea semisculpta (Parr)

Lagnea auriculata substriata BRADY, 1881, p. 61.

Lagnea alveolata substriata Brady. BRADY, 1884, pl. 60, fig. 34.---CUSHMAN, 1913a, p. 34, pl. 18, fig. 5.

Fissurina alveolata (Brady) var. semisculpta PARR, 1950, p. 307.---BARKER, 1960, p. 127, pl. 60, fig. 34.

Fissurina alveolata semisculpta Parr. BOLTOVSKOY AND de KAHN, 1982, p. 421 (pars), pl. 1, figs. 7,8, not 9,10.

Test unilocular, ovate-pyriform to almost trigonal in outline, chamber essentially circular, neck fairly long and slender. Wide thin keel runs from aperture to near midpoint, where it becomes narrow, running to basal loops, one on each side of peripheral keel, and one such pair on each margin of test, all 6 resultant basally projecting flanges being ragged. Pairs of loops separated at the base by a transverse emarginate section. Surface of test covered in fine longitudinal costae that are more heavily developed on lower and upper chamber surfaces, while being faint to absent on middle portion of chamber. Entosolenian tube very short.

Remarks: Brady originally described this form as a subspecies of L. auriculata, before reassigning it to L. alveolata, a species he erected in 1884 to take into account the different styles of basal loops. Parr proposed the new subspecific or variety name semisculpta because Williamson already had erected a species L. substriata.

The present form properly belongs in Lagnea, and for this reason only figures 7 and 8 of Boltovskoy and de Kahn belong here, while figures 9 and 10 are referred herein to Palliolatella variabilis. It may be that the transfer of the species to a different genus would permit the reinstatement of Brady's original name for the species.

Lagnea subauriculata (Jones)

Lagnea auriculata BRADY, 1881, p. 61 (pars).---BRADY, 1884, pl. 60, fig. 33 only.

Fissurina auriculata (Brady) var. duplicata (Sidebottom). BARKER, 1960, p. 127, pl. 60, fig. 33.

Solenina subauriculata JONES, 1984, p. 123, pl. 5, figs. 16,17.

Test very elongate pyriform in outline, about 2 1/2 times as long as broad, chamber ovate, inflated but compressed, 1 1/2 times as long as broad, greatest breadth 1/3 from base, surface smooth. Base furnished with coarse apical spine and 2 compressed loops formed by high, thin rims, from whose outer extremities arises a very thin, fairly broad hyaline keel which follows the chamber contour, then becomes wider as it embraces the very long, slender, tapering neck, terminating at the thickened lip. Aperture terminal, round, with short, free entosolenian tube.

Remarks: The basal ornament is like that of E. auriculata, but the form of the test places this in a different genus and species. It is distinguished from Lagnea costata by its smooth surface, and from L. tenuistriata by its auriculate base, non-tubulated keel, and smooth chamber. Brady explicitly placed this form in Lagnea auriculata, with 2 basal loops, and it was not included in the synonymy of Lagnea auriculata Brady var. duplicata Sidebottom, which has 4 separate basal loops, in pairs. However, Cushman (1933d) did just that, while illustrating a legitimate keeled form with 4 basal loops as this latter subspecies. Barker unfortunately followed that error in his work.

Lagnea tenuistriata (Brady)

Lagnea tubulifera Brady var. tenuistriata BRADY, 1881, p. 61.

Lagnea lagenoides (Williamson) var. tenuistriata BRADY, 1884, pl. 60, fig. 11 only.---

CUSHMAN, 1913a, p. 39, pl. 16, fig. 3.

Fissurina lagenoides tenuistriata (Brady). BARKER, 1960, p. 126, pl. 60, fig. 11.

Test unilocular, elongate pyriform in outline, not much compressed, neck fairly long and slender. Whole of test furnished with thin keel containing about 6 widely spaced large tubuli per side, keel modified at base to form quadrate opening, whence 2 costae run up chamber surface to join other distinct, fine longitudinal costae, some of which are of a lesser extent than others. Central costa on each face runs as a flange well up the neck, perpendicular to the peripheral keel.

Remarks: The tubuli are widely spaced as opposed to those on Lagena sublagenoides var. striatula Cushman, and the nature of the keel serves to distinguish the present species from Lagena formosa and its subspecies. Lagena tubulifera Brady is a junior synonym of Entosolenia marginata var. lagenoides Williamson.

Genus Oolina d'Orbigny, 1839

Oolina botula (Matthes)

Lagena botula MATTHES, 1939, p. 65, pl. 4, fig. 36.

Lagena Fornasinii BUCHNER, 1940, p. 529, pl. 26, figs. 548, 549.

Test elongate ellipsoidal, asymmetrical and somewhat cucumber-shaped, about 3 times as long as broad, both ends rounded and section circular. Wall smooth, base with faint caudal structure. Aperture terminal, round to subfissurine, oriented toward the less convex side of test, with short free entosolenian tube.

Remarks: It is distinguished from Parafissurina felsinea by its apertural characteristics and greater thickness. The species of Matthes and Buchner appear to be synonymous, with the former having priority. Although that species lacked a type figure from the less convex side, and the tube was not so clearly illustrated, the two seem to be identical and match the present specimens very well.

Oolina emaciata (Reuss)

Lagena emaciata REUSS, 1863, p. 319, pl. 1, fig. 9.

Test elongate teardrop-shaped, with circular section and rounded base, tapering to pointed apertural end. Wall smooth. Aperture terminal, radiate, with entosolenian tube.

Remarks: The shape, absence of surface sculpture, and radiate aperture serve to distinguish this species.

Qolina exilis (Fornasini)

Lagena clavata (d'Orbigny) var. exilis FORNASINI, 1895, p. [1], t.f. [1].

Lagena felsinea (Fornasini). CUSHMAN, 1913a, p. 10, pl. 4, fig. 1.

Qolina felsinea (Fornasini). BARKER, 1960, p. 114, pl. 56, fig. 4.---BOLTOVSKOY AND de KAHN, 1982, p. 442, pl. 12, figs. 10,11.

Test elongate subfusiform, but gently arched and rather wider toward base, which is rounded and furnished with anything from a small apical bump to a long spine. Wall smooth. Aperture terminal, round, on short stout imperforate neck, with free entosolenian tube.

Remarks: The slightly arched test with apiculate base and terminal round aperture is distinctive, and should not be confused with Lagena felsinea Fornasini, which is in fact a Parafissurina.

Qolina globosa (Montagu)

Vermiculum globosum MONTAGU, 1803, p. 523.

Lagena globosa (Montagu). CUSHMAN, 1913a, p. 3, pl. 4, fig. 2.---CUSHMAN, 1933d, p. 20, pl. 4, fig. 10.

Qolina globosa (Montagu). BARKER, 1960, p. 114, pl. 56, figs. 1-3.

Test unilocular, globular to subglobular, may have apical spine, surface otherwise smooth. Aperture terminal, radiate or round and with entosolenian tube, on very slightly produced end of test, no true neck developed.

Remarks: This species is distinguished from V. laeve Montagu, which is much more elongate, teardrop-shaped, and has a produced neck.

Qolina lineata (Williamson)

Entosolenia lineata WILLIAMSON, 1848, p. 18, pl. 2, fig. 18.

Lagena lineata (Williamson). CUSHMAN, 1933d, p. 35, pl. 9, figs. 3,4.---BUCHNER, 1940, p. 442, pl. 6, figs. 92-94.

Test ovate, circular in section, typically with some caudal projection or blunt apical spine, apertural end either rounded to blunt conical with clear collar, or tapering somewhat to a fairly long neck. Surface with very low and faint striae which stop short of hyaline apertural region. Aperture terminal, round, with free straight entosolenian tube less than 1/2 of chamber length.

Remarks: The chamber shape with faint striae is distinctive. The great variability in apertural characteristics suggests that more than one species may be represented here.

Oolina ovum (Ehrenberg)

Miliola ovum EHRENBURG, 1843, p. 166.

Lagena ovum (Ehrenberg). CUSHMAN, 1913a, p. 5, pl. 2, fig. 2.

Oolina ovum (Ehrenberg). BARKER, 1960, p. 114, pl. 56, fig. 5.

Test unilocular, ellipsoidal, slightly more than twice as long as broad, nearly parallel-sided but with a distinct taper toward apertural end, and usually with slight asymmetry and curvature to test. Both ends rounded, base often with very short fine ring, within which wall may be absent. Aperture terminal, round, with extremely short entosolenian tube.

Remarks: This short ellipsoidal form with smooth wall is distinctive, and appears to have been stabilized as a species by usage, as there were no type figures. Were it not for the presence of an entosolenian tube, it might be reasonable to assign these to Laevidentalina ittai, as representing individual chambers which have no base because they had overlapped others in a series. However, this latter species fails to exhibit a flange at the base of each chamber where it overlaps the preceding one.

Oolina punctulata (Sidebottom)

Lagena apiculata (Reuss) var. punctulata SIDEBOTTOM, 1912, p. 382, pl. 14, figs. 21-23.

Heteromorphina punctulata (Sidebottom). JONES, 1984, p. 99, pl. 1, fig. 4.

Test subfusiform, over three times as long as broad, circular in section, greatest breadth about 1/3 from base, tapering to rounded ends, base usually the more broadly rounded, often the whole test with some asymmetry or flexure in side view. Wall with numerous evenly scattered very coarse perforations in hyaline wall, except for imperforate short collar, which is pierced by rather short, straight, free entosolenian tube; aperture round.

Remarks: The subfusiform shape with extremely coarse perforations is unique. This species has no apertural chamberlet, and clearly does not belong in Heteromorphina.

Oolina saccula (Fornasini)

Lagena acuta (Reuss) var. sacculus FORNASINI, 1901, p. 49, t.f. 3.

Oolina globosa proluxa McCULLOCH, 1977, p. 80, pl. 56, fig. 23.

Test teardrop-shaped, circular in section, between 1 1/2 and 2 times as long as broad, base rounded but with caudal projection or ring, apertural end somewhat rounded to narrowly truncate. Wall smooth. Aperture terminal, round, with imperforate inner collar, straight free entosolenian tube.

Remarks: The test length distinguishes this form from O. globosa, which is shorter, and from other species which are proportionately longer, while the round aperture distinguishes it from other species of similar shape.

Oolina setosa (Earland)

Lagena globosa (Montagu) var. setosa EARLAND, 1934, p. 150, pl. 6, fig. 52.

Oolina globosa (Montagu) var. setosa (Earland). BARKER, 1960, p. 116, pl. 56, figs. 33-35.

Oolina globosa (Montagu) f. setosa (Earland). BOLTOVSKOY AND de KAHN, 1982, p. 442, pl. 12, fig. 19.

Oolina setosa Earland. PATTERSON, 1986a, p. 114, pl. 22, figs. 1-4.

Test globular to slightly pyriform, circular in section, base rounded, apertural end slightly produced. Base furnished with several fine short spines covering a

circular area, usually with one being truly apical in position. Aperture terminal, round, with slightly thickened collar, entosolenian tube not observed but presumed.

Remarks: This basally spinose species differs from Lagena globosa (Montagu) var. spinulosa Reuss, which has a fairly long, thick, tapering neck.

Qolina sp. A

Test elongate, nearly ellipsoidal, nearly 3 times as long as broad, greatest diameter about 1/4 from base, which is rounded and may have some faint caudal structure, test tapers to nearly truncate apertural end. Wall smooth. Aperture terminal, round, with free straight entosolenian tube a bit more than 1/4 of test length.

Remarks: The combination of smooth walls and distinct taper toward the aperture is characteristic.

Qolina sp. B

Test elongate cylindrical, between 3 and 4 times as long as broad, apertural end rounded, base more or less rounded, but may have small excentric dimple on side toward which aperture is skewed. Wall smooth. Aperture terminal to barely eccentric, round, with entosolenian tube which in the type runs straight for about 1/5 of test length, then is corkscrew-shaped and reaches inner chamber wall.

Remarks: This species is similar to Lagena botelliformis Brady, but that form is strongly curved.

Qolina sp. C

Test ovate in outline, not quite twice as long as broad, both ends rounded but with faintly produced extremities, apical and apertural. Wall smooth. Aperture terminal, round, with entosolenian tube, and surrounded by very short protruding upper test surface, not a neck or collar as such.

Remarks: Q. lineata bears extremely fine longitudinal striae, of which there is no trace on the present form.

Genus Vasicostella Patterson and Richardson, 1987

Vasicostella sp. A

winged variety of Fissurina sulcata (Walker and Jacob). BARKER, 1960, p. 127, pl. 60, figs. 35, 37, not 36.

Fissurina sp. 4 JONES, 1984, p. 116, pl. 4, fig. 9.

Test unilocular, not much compressed, ovate in outline, base somewhat angled to rounded, apertural end somewhat angled. Aperture terminal, round, in a produced tubular neck, with lip and entosolenian tube. Entire periphery furnished with wide thin keel that merges with imperforate apertural lip. Keel pierced on each margin by a wide but strongly compressed tubule whose upper edge is just below widest portion of test. Normally both margins pierced, but occasionally just one may be. Chamber covered on each face by some 5 or more strong costae that originate well up apertural neck and run usually to base of keel, not just base of chamber, occasionally exhibiting bifurcation or insertion of less extensive costae. Rare specimens with face of chamber completely encircled by outermost costa.

Remarks: The tubuli, usually one per margin, are distinctive, but were not apparent in the specimens placed in synonymy. It may be that those specimens were an extreme development of the absence of tubuli, which has been noted in the description. The form wherein the outer costa encircles the chamber face is similar to F. clathrata (Brady) in Barker, 1960, p. 124, pl. 60, fig. 4. However, Lagena clathrata lacks a tubular apertural neck, having instead a crescentic neck or lip. This species is assigned to the present genus on the basis of its coarse costae, as opposed to the fine striae or ribs which characterize Lagena. This latter genus often has a tubulated keel, however, and the present species may represent a transition between the two genera.

Vasicostella sp. B

Test elongate, subfusiform, very slightly compressed, about 2 1/2 times as long as broad, greatest breadth about 1/3 from base, which is rounded. Surface with 6 high, thin, plate-like costae which originate at common point on base and run up

test to embrace long, slim neck which is $1/6$ test length, forming gently convex flanges continuous with chamber outline and joining base of distinct thick imperforate lip. Lip surrounds round terminal aperture, which is furnished with free, straight entosolenian tube, almost half of chamber length, with flared lower end. Test with distinct bilateral rather than radial 6-fold symmetry; spacing between costae is not uniform, instead one opposed pair lies on the periphery, and the other 4 are situated, 2 per face, closer to the peripheral costae than to each other, so that central smooth area on each face is broader than the 2 lateral ones.

Remarks: This form is unique.

Vasicostella sp. C

Test with ellipsoidal chamber, virtually circular in section, with thin, moderately broad peripheral carina that is produced as long, flat, acute basal spine, $1/3$ chamber length or more, and also embraces lower half of neck, which is about $1/4$ of chamber length, to form flanges. Each face with 3 irregularly developed and spaced plate-like costae of lesser breadth than carinae, joining it at the base, and passing up to neck when completely developed. Neck with tapering opaque lip surrounding terminal round aperture, entosolenian tube presumed but not observed.

Remarks: This form is readily distinguished by its fat inflated test drawn out to both extremities by the spine and neck. It is barely distinguishable as a non-circular form, but the discrepancy between the keel and costae is unmistakable though subtle.

Subfamily ELLIPSOLAGENINAE A. Silvestri, 1923

Genus Fissurina Reuss, 1850

Fissurina aligera McCulloch

Fissurina aligera McCULLOCH, 1977, p. 89, pl. 58, fig. 29.

Fissurina aligera caudimarginata McCULLOCH, 1977, p. 89, pl. 58, fig. 28.

Fissurina aligera inornata McCULLOCH, 1977, p. 90, pl. 58, fig. 30.

Test somewhat pyriform in outline, chamber circular, compressed but thick.

Aperture terminal, in slit between large convex lips, entosolenian tube presumed but not observed. From lips, a carina develops on periphery, narrow and acute, but about 1/3 toward base flares almost tangentially to become very broad and thin, typically quite ragged. Wall may have, on each face, 2 fine long semicircular opaque bands just inboard from carina.

Remarks: This species differs from others, especially E. marginata, by the keel which does not become appreciably broad until well removed from apertural end, but then becomes broad, thin, and frequently ragged. McCulloch's three forms appear to be synonymous, reflecting highly variable keel development. The species name aligera is chosen because it means "wing-bearer", which describes the form well. The name inornata is not desirable, as it could be confused with Fissurina orbignyana Seguenza subsp. inornata Neagu, although this latter form properly belongs in Buchnerina.

Fissurina alveolata (Brady)

Lagena alveolata BRADY, 1884, p. 487, pl. 60, figs. 30,32.---CUSHMAN, 1913a, p. 33, pl. 18, fig. 1.---CUSHMAN, 1933d, p. 21, pl. 4, fig. 17.

Fissurina alveolata (Brady). BARKER, 1960, p. 127, pl. 60, figs. 30,32.

Test unilocular, pyriform in outline, compressed, margins narrowly rounded to subacute. Surface smooth, base with a central peripheral and two lateral keels that produce 4 adjacent basal loops separated only by the central keel and an apical depression or transverse keel. Depression when present may have a fine short ring in the middle. Neck may be distinct, produced and carinate, aperture with entosolenian tube.

Remarks: Other forms with 4 basal loops are ornamented, or, in the case of auriculata var. duplicata Sidebottom, the four loops are not contiguous, there being a distinct separation between them all, especially in the peripheral plane.

Fissurina apiculata Reuss

Fissurina apiculata REUSS, 1863, p. 339, pl. 6, fig. 85.

Lagena laevigata (Reuss) var. labiata BUCHNER, 1940, p. 476, pl. 12, figs. 201-207.

Fissurina labiosa McCULLOCH, 1977, p. 111, pl. 59, figs. 14, 16-19.

Fissurina cf. E. apiculata Reuss. BOLTOVSKOY AND de KAHN, 1982, p. 423, pl. 1, figs. 16-18.

Fissurina laevigata Reuss f. labiata (Buchner). BOLTOVSKOY AND de KAHN, 1982, p. 427, pl. 4, figs. 13-16.

Test elongate teardrop-shaped, barely 2 to over 2 1/2 times as long as broad, compressed, periphery rounded and emarginate, greatest breadth about 1/3 from base, which is well rounded and furnished with anything from an opaque caudal spot to a true spine or rounded projection. Wall smooth, hyaline, except for frequent development of 4 very short and thin, slightly curved opaque lines, one near each lateral margin on both faces at point of greatest breadth. Aperture terminal, opening into very narrow but broad and deep slit that occupies full extent of acutely conical to more commonly broad and rounded subquadrate lips, the lower edges of which are excavated by 2 concave scallops, whose intersection coincides with the location in face view of the straight entosolenian tube, which is almost half the chamber length and may have 2 fine prongs at its lower end.

Remarks: The present specimens do not exhibit quite the range of Buchner's or McCulloch's, which are believed to be synonymous with the present species. None of the forms in the literature appears to have the very fine opaque lines on the chamber wall. The elongate teardrop shape distinguishes this species from most, the large lips from E. improcera, and the compressed section from both Lagena robusta Buchner and Fissurina fissurosecula Patterson, which are circular in section.

Fissurina auriculata (Brady)

Lagena auriculata BRADY, 1881, p. 61.---BRADY, 1884, pl. 60, fig. 29 only.

Fissurina auriculata (Brady). BARKER, 1960, p. 126, pl. 60, fig. 29.

Test unilocular, somewhat elongate, pyriform in outline, gently compressed and sides not reflexed, periphery rounded. Base with 2 oval loops, one on each margin, centered on the periphery, surface otherwise smooth. Aperture with

entosolenian tube.

Remarks: The 2 simple basal loops and smooth surface distinguish this species.

Fissurina clariplana McCulloch

Lagena fasciata (Egger). BUCHNER, 1940, p. 479, p¹ 14, figs. 262-265.

Fissurina clariplana McCULLOCH, 1977, p. 95, pl. 58, fig. 17.

Test ovate in outline, almost 1 1/2 times longer than broad, greatest breadth just below midline, well compressed, base rounded with caudal ornament. Periphery broad, truncate, but very slightly rounded, just inboard of which each face has a distinct narrow opaque band running almost from base to a point just below apertural lips, for a total of 4. Aperture terminal, round and small, opening into narrow slit which occupies full extent of paired broad curved lips, furnished with short, straight entosolenian tube which is slightly flared at base.

Remarks: Buchner referred this form to Oolina fasciata Egger, but that species is neither so ovate nor so compressed, and it has a stout neck with gently flared lip. McCulloch had many closely similar species, all illustrated on the same plate, that are too numerous to discuss in detail. The closest is F. evolutiformis, which has relatively stronger chamber inflation compared to keel thickness, and a slightly more rounded keel than the present species. It is likely that the two forms are conspecific, but the current species matches the present material more closely.

Fissurina crawleyi McCulloch

Fissurina crawleyi McCULLOCH, 1977, p. 98, pl. 64, fig. 26.

Test elongate quadrate in outline, just over twice as long as broad, compressed, base barely rounded, nearly truncate, apiculate, margins taper in toward aperture about 1/4 from top. Periphery may be slightly angled, particularly in basalward part, and have imperforate carina, but no distinct keel. Aperture terminal, in distinct tapering cellar incised at its base, a compressed slit with free entosolenian tube almost 1/3 chamber length.

Remarks: This is barely distinguishable from Lagenosolenia asubtilis

McCulloch, which has a short neck with flared lip and fine carinal flanges. The two may not represent distinct species.

Fissurina curvituba Parr

Fissurina curvituba PARR, 1950, p. 311, pl. 9, fig. 2.

Test ovate-trigonal in outline, greatest breadth very near base, which is somewhat truncate, test strongly compressed. Periphery with single, simple narrow keel, may be interrupted by caudal spine which does not protrude; keel becomes slightly broader toward apertural end, then curves up and outward to meet broad flared convex apertural lips that are also thickened with respect to plane of compression. Aperture a terminal compressed slit, passing to entosolenian tube which appears to attach to one wall, rather short and curved.

Remarks: The ovate-trigonal outline, simple keel, and protruding low, broad lips that are distinct from the keel serve to distinguish this species.

Fissurina dublini McCulloch

Fissurina dublini McCULLOCH, 1977, p. 102, pl. 62, fig. 8.

Test ovate in outline, very little to much longer than broad, greatest breadth below middle, quite strongly compressed. Periphery with acute, fairly thick and narrow keel, bordered on either side and continuous with imperforate bands that are raised slightly above chamber surface, producing a fine ridge and a pseudo-tricarinate appearance. Surface with extremely fine striae or costae on lower half, radiating from middle of base, may not be discernible in some specimens. Aperture terminal, within slit between very low, broad lips that are continuous with keel and not appreciably produced.

Remarks: The entire ovate outline without protruding lips or collar, fine basal striae, and pseudo-tricarinate rather than unimarginate periphery are distinctive.

Fissurina erudita McCulloch

Fissurina erudita McCULLOCH, 1977, p. 103, pl. 65, fig. 29.

Test with very nearly circular chamber, slightly longer than broad,

compressed, with rounded imperforate periphery. Base rounded, with slight caudal inflation. Aperture round, between high, broad, and well rounded lips, opening into fissurine slit, and presumably with entosolenian tube.

Remarks: This species is characterized by its rounded but imperforate periphery, circular to ovate chamber, and large "battle-axe" lips. It differs from E. bombayensis McCulloch which is distinctly tapering ovate.

Fissurina fimbriata (Brady)

Lagena fimbriata BRADY, 1881, p. 61.---BRADY, 1884, pl. 60, figs. 26-28.---CUSHMAN, 1913a, p. 30, pl. 14, fig. 8.

Lagena fimbriata Brady var. occlusa SIDEBOTTOM, 1912, p. 423, pl. 20, figs. 27,28.

Fissurina fimbriata (Brady). BARKER, 1960, p. 126, pl. 60, figs. 26-28.

Fissurina fimbriata (Brady) f. occlusa (Sidebottom). BOLTOVSKOY AND de KAHN, 1982, p. 425, pl. 3, figs. 15-17.

Test unilocular, highly variable, ranging from compressed and trigonal to pyriform in outline, which is the most typical form, to barely compressed and almost circular in outline, to the least common form, which is somewhat flat and shaped like a pumpkin-seed. Base ornamented in the two more typical forms with a fairly wide, delicate oval looped wing that is traversed by fine tubuli, producing a basal fringe that is anywhere from almost slit-like, in the more typical form, to nearly circular at the other extreme. In the compressed pumpkin-seed forms the fringe tapers toward the base and is nearly closed on itself. Aperture compressed to rounded, with entosolenian tube.

Remarks: Included within the range of this species in the present study, and fully linked by intermediate forms, are specimens with the basal loop nearly closed on itself, the which character was the basis for Sidebottom's subspecies. It is not possible to distinguish that form on any consistent and reliable basis.

Fissurina gravata McCulloch

Fissurina gravata McCULLOCH, 1977, p. 108, pl. 62, fig. 21.

Test pyriform in outline, strongly compressed but thick, surfaces somewhat

inflated to gently sunken. Periphery with 2 keels, more or less symmetrically disposed, that encircle entire test and merge with apertural lips, the keels having significant breadth and lapping well onto chamber surface, which is thus very slightly depressed under the keels' inner margins; periphery excavated between keels, neither convex nor rounded. Aperture terminal, in slit between heavy convex imperforate lips, presumed entosolenian.

Remarks: The two keels without a central keel are rather distinctive, in combination with the extent to which they lap onto the chamber surface, and the typical convex fissurine lips.

Fissurina improcera McCulloch

Fissurina quadritranslucens improcera McCULLOCH, 1977, p. 125, pl. 65, fig. 25.

Test elongate, ovate, twice as long as broad or more, compressed, greatest breadth just below midline, periphery rounded and emarginate, base rounded and usually with subtle caudal structure. Wall smooth, hyaline, in rare cases with 4 narrow opaque bands parallel to outline, one at each margin of each face. Aperture terminal, oval, without lips, furnished with straight entosolenian tube of about 1/3 chamber length, having prongs at open end.

Remarks: This species differs from E. apiculata principally in its lack of well developed lips, and from Lagena diaphana Buchner by the distinct thickening of the wall in the apertural area of this latter species. E. quadritranslucens McCulloch is distinctly elongate quadrate and parallel-sided in outline, the which shape is not observed in the present material.

Fissurina kerguelensis Parr

Lagena staphyllearia (Schwager). CUSHMAN, 1913a, p. 31, pl. 17, fig. 3.

Fissurina kerguelensis PARR, 1950, p. 305, pl. 8, fig. 7.---BARKER, 1960, p. 122, pl. 59, figs. 8-11.

NOT Fissurina kerguelensis Parr. HERMELIN AND SCOTT, 1985, p. 208, pl. 2, fig. 12.

Test unilocular, nearly circular to trigonal or rarely pyriform in outline,

compressed. Periphery with thick, narrow keel, with 3 variably developed basal spines, one apical and the other two lateral and symmetrically disposed. Aperture terminal, slitlike, barely produced in arcuate, thickened neck that is often excavated at the base except where entosolenian tube passes to interior of chamber.

Remarks: Fissurina staphyllearia Schwager is barely compressed and has non-carinate, well rounded margins. The specimen illustrated by Hermelin and Scott clearly shows the elongate, low, eccentric hooded aperture and 4 basal spines characteristic of Parafissurina arctica.

Fissurina laevigata Reuss

Fissurina laevigata REUSS, 1850, p. 366, pl. 46, fig. 1.

Lagena acuta (Reuss). ?CUSHMAN, 1913a, p. 6, pl. 38, fig. 6.

NOT Lagena laevigata (Reuss) forma typica BUCHNER, 1940, p. 474, pl. 13, figs. 239-244.

Fissurina laevigata Reuss, f. typica BOLTOVSKOY AND de KAHN, 1982, p. 426, pl. 4, figs. 10-12.

Test teardrop-shaped in outline, not quite 1 1/2 times as long as broad, compressed, base well rounded, usually with subtle rounded caudal structure, periphery angled but not truly carinate, apertural end smoothly produced. Aperture terminal, an ovate slit in heavy, imperforate, compressed conical neck.

Remarks: Buchner's specimens should not be referred to this species because they are truly oval in outline, with their greatest breadth at the midline. Fissurina acuta Reuss is apiculate, and much more elongate, up to twice as long as broad. It seems that most of the present specimens fall somewhere between the two extremes represented by the type figures of these species, as does that illustrated by Cushman (1913a), which is only tentatively placed in synonymy because it exhibits in detail a circular chamber with very thick walls.

Fissurina longifimbriata McCulloch

Fissurina longifimbriata McCULLOCH, 1977, p. 114, pl. 57, fig. 7.

Test broad ovate to pyriform in outline but chamber circular, well compressed,

greatest breadth barely below midline, base rounded with produced rounded opaque caudal area. Periphery rounded, with distinct fine imperforate band, no keel except where it passes to apertural collar. Surface smooth, except near base, where each face has a short opaque bulge, comparable in size to caudal bulge, but distinctly removed from it, convex downward and parallel to base. Aperture a terminal, oval slit in fairly broad but low imperforate compressed collar of 1/2 test breadth.

Remarks: There is nothing else like this species, whose name implies some form of fimbriate structure, although there is nothing of the kind, nor was there in the type.

Fissurina marginata (Walker and Boys)

Serpula (Lagena) marginata WALKER AND BOYS, 1784, p. 2, pl. 1, fig. 7 (*vide* Cushman, 1913a).

Lagena marginata Walker and Boys. CUSHMAN, 1913a, p. 37, pl. 22, figs. 1-7.

Lagena marginata (Montagu). CUSHMAN, 1933d, p. 17, pl. 4, figs. 9,11,12,14-16; pl. 5, figs. 2,4,6,8,9.

Fissurina marginata (Montagu). LOEBLICH AND TAPPAN, 1953, p. 77, pl. 14, figs. 6-9.---WARD AND WEBB, 1986, p. 185, pl. 3, fig. 11, not fig. 9.

Test unilocular, rounded in outline, quite strongly inflated, surrounded in its entirety by a fairly wide to narrow keel, quite thin, merging smoothly at the oral extremity with a thickened arcuate apertural neck. Aperture slitlike, with entosolenian tube.

Remarks: This species is distinguished from most similar single-keeled forms, which are pyriform to quadrate in outline, by its circular outline. The lack of any peripheral spines serves to distinguish it from E. kerguelenensis and L. marginata spinifera Earland. Lagenosolenia incomposita (= Lagena crebra Matthes) is too highly variable with respect to outline, extent and regularity of keel, form of apertural neck, and presence of basal spine. Vermiculium marginatum Montagu (the which species name was replaced by Entosolenia submarginata Boomgart, 1949, on account of the priority of Walker and Boys's species) is pyriform in outline, with a stout

conical neck, and thus Loeblich and Tappan's forms, which are circular, belong in the present species. It may be that the specimens illustrated by Cushnian (1933d) in pl. 4, figs. 14-16 and pl. 5, fig. 2 have too elongate and narrow a neck for this species. The specimen illustrated in Ward and Webb (1986) as pl. 3, fig. 9 has a non-produced slit-like aperture, nearly the breadth of the test, which splits the keel.

Fissurina mennellae (Buchner)

Lagena Mennellae BUCHNER, 1940, p. 458, pl. 9, figs. 148-151.

Test circular in outline, strongly compressed, periphery with narrow acute keel that is furnished, below the midline, with many fine spines, typically 8 or more, with no apparent pattern. Aperture terminal, between 2 small lips that form a slightly truncate to produced profile, entosolenian tube presumed.

Remarks: The small compressed circular test with many fine spines is thereby distinguished from *E. nummiformis*, which lacks spines, and *E. kerguelensis*, which is much thicker, has a broader keel, and a distinct pattern of 3 spines, one of which is apical.

Fissurina nudiformis McCulloch

Fissurina nudiformis McCULLOCH, 1977, p. 118, pl. 59, figs. 1-5.

Test pyriform in outline, thick but distinctly compressed, periphery and base well rounded. Each lateral margin on both faces with a very fine, long, curved opaque line, parallel to periphery, stopping short of apertural lips and base. Aperture terminal, opening into slit between thick convex imperforate lips or collar, with short, free, straight entosolenian tube.

Remarks: The form of the test, combined with the 4 fine opaque lines, is distinctive.

Fissurina nummiformis (Buchner)

Lagena nummiformis BUCHNER, 1940, p. 457, pl. 8, figs. 135-138.

Test circular in outline, compressed, surrounded by fairly thick, rather narrow keel, base may have caudal projection. Apertural lips usually slightly produced and

of appreciable breadth, truncate, containing terminal fissurine aperture, with entosolenian tube.

Remarks: This circular compressed species with distinctly carinate periphery is distinguished from Lagena eburnia Buchner with great difficulty, but this latter species evidently shows no caudal projection, the apertural end is more smoothly integrated into the test outline, and the slit is not so broad.

Fissurina ovata Seguenza

Fissurina (Fissurine) ovata SEGUENZA, 1862b, p. 62, pl. 2, fig. 9.

Fissurina ovata Seguenza. BOLTOVSKOY AND de KAHN, 1982, p. 428, pl. 5, fig. 21.

Test pyriform to teardrop-shaped in outline, compressed, with acute carinate periphery, rounded base, and produced apertural end with some form of imperforate collar or neck. Aperture a terminal slit, with entosolenian tube.

Remarks: This species is a bit of a catch-all, with subtle differences in style of apertural collar, base, and development of the keel.

Fissurina sp. cf. F. paula McCulloch

Fissurina paula McCULLOCH, 1977, p. 120, pl. 58, fig. 5.

Test ovate in outline, not much longer than broad, compressed, periphery rounded, base rounded, and apertural end very slightly truncate. Wall hyaline except for 2 large opaque patches, one on each peripheral margin, neither meeting at base nor extending to aperture, clearly visible from either face, separated by broad hyaline central portion of face that narrows toward base. Aperture a terminal ovate slit, with short, straight entosolenian tube.

Remarks: The present specimen differs from the typical in that there are no narrow hyaline marginal bands within the opaque areas. This species differs from Lagena Jasolini Buchner, which has a more quadrate outline and 4 very narrow, long arcuate opaque bands, well separated on the periphery. It is possible that all three forms, including the present one, are part of a single plexus.

Fissurina quadricarinata (Sidebottom)

Lagena staphyllearia (Schwager) var. quadricarinata SIDEBOTTOM, 1912, p. 404, pl. 21, fig. 16.

Fissurina staphyllearia quadricarinata (Sidebottom). BOLTOVSKOY AND de KAHN, 1982, p. 431, pl. 7, fig. 15.

Test nearly circular in outline, very gently compressed, periphery with very narrow keel in its upper third that is no more than a fine imperforate margin, thereafter becoming very thin, flaring, and exceptionally ragged to irregularly spinose at the base; lower 1/3 to 1/4 of chamber with very fine keel transverse to periphery, becoming higher toward base, the quadrants of the chamber created thereby often with a few very fine spines on lowermost surface. Aperture terminal, within very slightly produced imperforate collar, with long entosolenian tube attached to one face of test, reaching base.

Remarks: The combination of test shape and ornament is diagnostic.

Fissurina quadriculcata McCulloch

Fissurina (?) quadriculcata McCULLOCH, 1977, p. 125, pl. 56, fig. 24.

Test pyriform in outline, compressed, base rounded and periphery slightly truncate. Both faces with 2 marginal features that superficially resemble carinae, but are in fact slight grooves or depressions running parallel to periphery, from very near apertural lips almost to base, where they are distinctly separate; the grooves are bordered by narrow raised rims which are thicker and higher on the peripheral as compared to the inner edge, the peripheral ridge projects beyond the chamber in outline. Aperture terminal, in slit between high, broad convex lips, entosolenian tube presumed.

Remarks: Oolina fasciata Egger has a distinct neck with slightly flared upper edge, and has 4 ridges, parallel to but well inboard of the periphery in outline.

Fissurina simplex (Buchner)

Lagena simplex BUCHNER, 1940, p. 465, pl. 11, figs. 193, 194.

Fissurina simplex (Buchner). BOLTOVSKOY AND de KAHN, 1982, p. 431, pl. 7, fig.

4.

Test ovate, appreciably but not much longer than broad, compressed, periphery rounded and emarginate, base often with weakly developed caudal structure. Surface smooth. Aperture terminal, nearly round, with slight imperforate inner collar, and straight entosolenian tube of about 1/3 test length.

Remarks: The ovate emarginate test is distinctive. Lagena (Entosolenia) marginata (Montagu) var. ventricosa Wiesner has the correct shape, but is not clearly emarginate. His first figure would seem to indicate a well developed margin, as would the specific assignment, while his second figure shows no trace of this. Because the type description is in German, the present form is assigned for the moment to Buchner's later species.

Fissurina stewartii (Wright)

Lagena stewartii WRIGHT, 1911, p. 12, pl. 2, fig. 8.

Fissurina lamellata ?McCULLOCH, 1977, p. 112, pl. 66, figs. 5,7.

Fissurina stewartii (Wright). BOLTOVSKOY AND de KAHN, 1982, p. 431, pl. 7, fig. 16.

Test circular in outline, compressed, periphery rounded, may be imperforate but is non-carinate, base may have caudal protrusion or bump. Aperture essentially flush to barely produced, an oval slit with entosolenian tube.

Remarks: McCulloch's species is explicitly emarginate, and so the two may not be synonymous. Lagena immodesta Buchner has a long slit-like aperture that is clearly apparent even in side view.

Fissurina subcarinata (Cushman)

Lagena auriculata Brady var. subcarinata CUSHMAN, 1913a, p. 32, pl. 17, fig. 4.

Test unilocular, compressed, ovate to somewhat trigonal in outline, apertural end obtuse, base subtruncate only in outline. Fairly thick crescentic apertural collar passes into narrow keels which soon flare out from chamber into wide, thin keels which embrace two fimbriate compressed loops or wings, one on each basal margin,

connected by a short ragged keel at the base.

Remarks: The present specimens differ from the typical in having a peripheral keel throughout, though this range was originally embraced in the type description of L. auriculata Brady. Lagena auriculata var. duplicata has a pair of loops on both sides of the peripheral margin, for a total of 4, of which only 2 are visible in outline or face view.

Fissurina wiesneri Barker

Lagena (Entosolenia) marginata (Montagu) var. carinata WIESNER, 1931, p. 121.

Fissurina wiesneri BARKER, 1960, p. 124, pl. 59, f. 23.

NOT Fissurina wiesneri Barker. INGLE et al, 1980, p. 136, pl. 7, fig. 3.

Test nearly circular in outline, quite strongly compressed, resembling a fried egg, with inflated subcircular chamber having slight caudal protrusion in some specimens, others with slight dimple, the whole encircled by very broad, thin keel 1/3 chamber width, slightly produced at apertural end where it embraces very slender, quite long neck, with barely perceptibly thickened lips of a crescentic or battle-axe shape. Aperture terminal, a very narrow slit, entosolenian tube not seen.

Remarks: The slightly thickened lips are considered insufficient to place this species in Palliolatella. Its circular chamber, with extremely broad thin keel, is distinctive. Lagena schwageriana Cushman has fine radiating tubules in the keel, and a true but slight palliolatelline hood. Ingle et al referred tricarinate forms with an elongate, angled, unembraced neck to this species, but their forms probably belong in Buchnerina.

Fissurina sp. A

Test elongate, nearly 3 times as long as broad, nearly parallel-sided for the most part, barely tapering to roundly truncate apertural end, and rapidly to pointed base, which has slight caudal protrusion, compressed elliptical in section, periphery rounded, emarginate. Wall hyaline, with 4 pairs of longitudinal rows, one pair on each lateral margin of each face, of very coarse perforations which follow the test

outline, within pairs the perforations of one row are offset from those of the other. Aperture a terminal ovate slit, entosolenian tube presumed but not preserved.

Remarks: This species resembles E. dilineoperforata McCulloch and related forms, but those have only single rows of perforations, and a rounded base.

Fissurina sp. B

Test elongate quadrate in outline, twice as long as broad, compressed, chamber itself is somewhat teardrop-shaped in outline and inflated, but the whole, from base to aperture, is furnished with fairly thick, wide, tubulated keel which is broader at the corners to produce a rectangular outline. Aperture a terminal, ovate slit splitting the keel, with slight lateral lips and a free straight entosolenian tube of about 1/3 chamber length.

Remarks: There are many similar forms that differ primarily in lacking a keel with these characteristics. The present species has lips at the top of the keel, rather than an elongate slender neck beyond the keel, as is found in Lagenosolenia lagenoides sanpedroensis McCulloch.

Fissurina sp. C

Test elongate, about 2 1/2 times as long as broad, very gently compressed, greatest breadth toward base, and tapering toward apertural end, which is somewhat pointed but rounded. Surface smooth but coarsely perforate, base with very weakly developed elliptical ridge, within which arises a pair of higher straight, thin, ragged ridges which are mutually perpendicular and intersect at a large caudal tube or spine, and where the peripheral ridge meets the elliptical ring, two long, hyaline spines are directed basalward and somewhat inward, continuing the inward taper of the chamber outline. Aperture terminal, broken off specimen.

Remarks: This form is unique, differing from Lagena truncata Brady which is circular in section, and whose base is truncate and spinose, rather than having the system of ridges, tubes, and spines of the present form.

Fissurina sp. D

Test essentially circular in outline, strongly compressed, wall smooth, periphery acute with very narrow carina which, on basal half, is furnished with a series of fine flat retral spines that produce a bearded appearance. Aperture terminal, oval, with slight thickened imperforate collar or lips, and with free straight entosolenian tube of about 1/3 chamber diameter.

Remarks: This species differs from E. nummiformis in having a basal fringe of spines, and from E. mennellae which has long radial spines.

Fissurina sp. E

Test somewhat pyriform in outline, compressed but very thick or inflated, periphery with fairly broad, thin keel that narrows as it passes toward heavy, clear, imperforate and convex apertural collar. Each face has a ridge well inboard of and parallel to periphery, continuous around base and fading out on lowermost part of collar, surface within these ridges with very faint to absent longitudinal striae. Aperture terminal, ovate, with short straight entosolenian tube projecting from base of collar.

Remarks: This species resembles E. marginata in its general form, but its supplementary keels and fine striae are distinctive.

Fissurina sp. F

Test nearly circular in outline, very thick, faces slightly inflated, periphery somewhat truncate. Periphery with narrow keel arising just below thickened but flush hyaline apertural area, rapidly acquiring an additional very broad, thin, ragged hyaline keel; 2 slightly heavier, narrower keels arise, one on each face, also at the base of the apertural region, inclined to plane of compression and running to base, where they are notched or "v'd" as they pass into a broad, thin transverse keel that intersects the central peripheral keel. Aperture terminal, nearly flush, barely ovate, with entosolenian tube which is free, then soon curves to meet one wall of chamber, whence it runs sigmoidally to base.

Remarks: The only similar species known to this author, so thick and round

with 3 keels and a transverse basal keel, is Pseudofissurina mccullochae R.W. Jones, but in that species the aperture is an elongate slit to one side of the peripheral keel, which is continuous across the apertural end.

Fissurina sp. G

Test broad pumpkin-seed shaped, not quite 1 1/2 times as long as broad, compressed, greatest breadth near middle, but is very broad and rounded at the base, which has slight caudal protrusion, and tapers markedly to narrow apertural end. Periphery angled but not truly acute, with imperforate carina which is clearly evident in face view, merging smoothly into imperforate internal apertural collar, but basalward this carina becomes produced as a broad thin keel that is smooth on its lateral convex contour, curving inward, but ragged to spinose on its basal edge. From the point where keel begins to broaden, a distinct area occurs on the chamber surface, bounded above by a shallow downward-pointing "V", that is creamy white and opaque rather than hyaline and perforate like the rest of the test. Aperture a terminal, slightly ovate slit, with thick, free, straight entosolenian tube of about 1/4 chamber length.

Remarks: The combination of a thin broad basal keel, with basal opaque patches of this shape, has not apparently been described before.

Genus Globofissurella Patterson, 1986

Globofissurella scotti

Globofissurella scotti PATTERSON, 1986a, p. 96, pl. 16, figs. 5-8.---PATTERSON, 1986b, p. 68, pl. 1, figs. 1-7; pl. 2, fig. 6.

Test globular, not evidently compressed, base with irregular small caudal tube, whence arise 4 thin, fairly high costae, an opposed pair of which continue almost to aperture, having become by midline of test merely a distinct but very low carina or ridge. Between the 4 principal costae are inserted 2 or 3 thin costae that do not reach caudal tube, and these, plus the pair that did not form carinae, pass up and terminate just beyond the midline; they flare slightly in breadth just below this, and

are somewhat ragged down to the base. Aperture terminal, in distinct compressed slit whose elongation is parallel to plane of carina, entosolenian tube presumed.

Remarks: This form has distinct bilateral symmetry, but is not a Fissurina. The style of the costae is distinctive.

Globofissurella sp. A

Fissurina gratio (Buchner). ?BOLTOVSKOY AND de KAHN, 1982, p. 426, pl. 4, figs. 8,9.

Test pyriform in outline, about 1 1/2 times as long as broad, slightly compressed, base and apertural end well rounded, chamber somewhat ovate, with constriction before heavy broad convex apertural neck or collar that is hyaline imperforate and almost half as large in outline dimensions as the chamber. Surface with numerous sharp costae, with one set distinctly continuous at periphery and across the base, which is slightly apiculate, a narrow carina being formed thereby. Each face with 6 to 8 costae, not all reaching as far to ward base, and none contacting the carina, becoming lower as they pass up chamber onto neck, eventually disappearing over halfway up the neck. Aperture terminal, a compressed oval slit, with entosolenian tube which appears to be attached to one side.

Remarks: This species differs from G. bulabra Patterson, in which the costae terminate at the base of the neck, and anastomose at the base, forming a zigzag keel or ridge where they meet. Lagena gratio Buchner has a longer, constricted, straight neck with a slightly flared lip, all of which is embraced by broad carinal flanges. Boltovskoy and de Kahn's form clearly does not belong in that species, but it cannot be referred confidently to the present species without a basal view.

Genus Lagenosolenia McCulloch, 1977

Lagenosolenia echinata (Seguenza)

Fissurina (Fissurine) echinata SEGUENZA, 1862b, p. 58, pl. 1, fig. 54.

Test pyriform to trigonal in outline, strongly inflated, greatest breadth near base, periphery angled but not evidently carinate. Whole of test hispid. Aperture

terminal, round, on long slender tubular neck, presumed entosolenian.

Remarks: The simple tubular neck and trigonal chamber distinguish this species from Lagena sp. C, and the hispid surface from others. It is assumed the neck has simply been broken off the type specimen.

Lagenosolenia frangens (Buchner)

Lagena frangens BUCHNER, 1940, p. 504, pl. 19, figs. 407-409.

Test pyriform in outline, chamber compressed ovate, barely broader than high, with fairly long, stout angular neck, broken but presumed lipped. Periphery with broad thin keel encircling test and embracing neck, chamber with a low ridge on each face, the edge of a band which encircles the chamber and slopes out to the peripheral keel, periphery not truncate. Aperture terminal, ovate, presumed entosolenian.

Remarks: This species differs from Buchnerina bradyi in having a longer neck, non-truncate periphery, and a more strongly compressed form, while Fissurina (Fissurina) orbignyana Seguenza has broad, low lips or collar, rather than an elongate neck.

Lagenosolenia incomposita Patterson and Pettis

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.---COLE, 1981, p. 79, pl. 19, fig. 20.---BOLTOVSKOY AND de KAHN, 1982, p. 424, pl. 2, figs. 17,18, 19,20.

Fissurina spinifera (Earland). JONES, 1984, p. 111, pl. 3, fig. 13.

Lagenosolenia incomposita PATTERSON AND PETTIS, 1986, p. 74. ---PATTERSON, 1986a, p. 110, pl. 21, figs. 4-6.

Test rather elongate pyriform in outline, well compressed, chamber circular and somewhat inflated, surrounded by keel of significant width and thickness, which becomes wider as it embraces neck, thinning again toward aperture; keel may have thinner keel as an extension of the primary one, particularly forming flanges on the neck. Base usually has caudal extension of chamber projecting into keel for

most of keel breadth, the keel then furnished with fairly stout imperforate apical spine; keel has spine regardless. Surface usually smooth, but rarely with a pair of fine costae from upper chamber surface onto base of neck. Aperture terminal, oval, on thick broad neck of about 2/3 chamber length, having clear imperforate collar at its end.

Remarks: Lagena crebra Matthes, although including Brady's (1884) pl. 59, fig. 6 in synonymy, does not match well, being a highly variable form that never has such a well-developed neck or basal spine, and usually has a lesser keel, although rarely it is broad and thin. Earland referred to the same figure in Brady, but unfortunately his name was a homonym of Lagena aspera Reuss var. spinifera Chapman, hence the new name proposed by Patterson and Pettis. The present species differs from Lagenosolenia neocincta which has a more ovate chamber, a broader and more blunt spine, and a short, broad neck. It may be that these two species are simply different ontogenetic stages of the same species.

Lagenosolenia neocincta McCulloch

Lagenosolenia neocincta McCULLOCH, 1977, p. 65, pl. 61, fig. 7.

Test ovate in outline, compressed but rather thick, chamber nearly circular in outline, with narrow thick keel, which incorporates mucronate protrusion, and passes up to a very broad, concave-sided neck or collar that is also fairly high, truncate, and toothed. Aperture terminal, a lenticular slit passing funnel-like through the collar to a straight entosolenian tube of almost half the chamber length.

Remarks: The present species has a less pronounced basal structure and a much shorter, broader neck than L. incomposita, and as well the keel is not distinct from the neck.

Lagenosolenia petila McCulloch

Lagenosolenia petila McCULLOCH, 1977, p. 68, pl. 67, fig. 25.

Test elongate pyriform, about twice as long as broad, greatest breadth below midline, compressed but not too strongly, base with gently produced caudal

structure, and rather stout but reasonably long neck that is angled and has lip. Margin carinate, of negligible breadth at midline, but becoming broad to produce thin broad neck flanges, and becoming broad at base of test as well. Aperture terminal, ovate, presumed entosolenian.

Remarks: The present specimens differ from McCulloch's type in that the keel also broadens at the base. The form of the keel, shape of the chamber, and relative length of the neck combine to distinguish this species.

Lagenosolenia pressa McCulloch

Lagenosolenia pressa McCULLOCH, 1977, p. 69, pl. 68, fig. 10.

Test ovate, well compressed, greatest breadth at midline. Periphery with fairly thick and narrow keel, drawn out to embrace caudal protrusion with spine, also embracing very short, compact neck with broad, thick lip. Aperture terminal, a large fusiform slit, with free entosolenian tube of about 1/3 chamber length.

Remarks: The ovate, carinate test with caudal structure and short broad neck are distinctive. The type lacks the caudal structure of the present species. Although the neck is very short, this species is assigned to the present genus because it lacks the multiple carinae and rounded aperture more typical of Buchnerina.

Lagenosolenia seguenziana (Fornasini)

Lagena seguenziana FORNASINI, 1886, p. 351, pl. 8, figs. 1-6, ?not 7,8.

Fissurina seguenziana (Fornasini)?, BARKER, 1960, p. 122, pl. 59, fig. 1.

Fissurina seguenziana (Fornasini). BOLTOVSKOY AND de KAHN, 1982, p. 430, pl. 6, figs. 26,27.

Test somewhat pyriform in outline, with subelliptical chamber whose greatest breadth lies just below midline, faces convex but the whole well compressed. Periphery with a raised rounded margin encircling each face, and for the most part completely flat between them; basalward periphery becomes slightly excavated, may have apical spine or pair of spines and trace of central keel. Toward apertural end ridges or keels are produced to leave face excavated at base of neck, which is

elongate, stout, strongly tapering and circular in section, distinct from truncate margin and greater in thickness at its base than is subjacent chamber. Aperture terminal, round, without lip, and with short, free, projecting entosolenian tube.

Remarks: The ovate chamber with completely truncate, bicarinate margin and heavy smooth tapering neck is distinctive. The latter pair of figures of Fornasini are questioned as having too rounded a periphery, and too short a neck.

Lagenosolenia trinitatensis (Nuttall)

Lagena orbignyana (Seguenza) var. trinitatensis NUTTALL, 1928, p. 80, pl. 3, figs. 22,23.

Test with very thick but slightly compressed circular chamber, base and periphery rounded, neck long and slightly compressed, about 2/3 length of chamber, with distinct fine lip. Periphery with, apparently, 3 fine carinae, low and rounded, all subequal and closely spaced, terminating at or near base of neck, central keel may form angle on neck. Just inboard of these, on each face, is a single concentric costa, even finer than carinae and barely discernible. Aperture terminal, slightly ovate, presumed entosolenian.

Remarks: The only difference between these and the type is that the type has 4 principal carinae that all pass up the neck to the base of the lip. The chamber shape, combined with numerous fine, low carinae and costae, and a long neck, are distinctive.

Lagenosolenia sp. A

Test with nearly circular chamber, compressed, with acute and imperforate but non-keeled margin, base rounded with slight caudal projection. Wall finely perforate, smooth. Aperture terminal, somewhat ovate, on long, straight, fairly compressed neck which is broken on specimen, entosolenian tube presumed.

Remarks: The simple chamber and very long neck are distinctive in combination.

Lagenosolenia sp. B

Test with rather strongly inflated but distinctly compressed ovate chamber, with rounded base and perforate periphery. Base with small caudal ring, whence arise two faint peripheral carinae, quite widely spaced, which eventually meet near the top to provide thin small flanges for apertural neck, which is fairly long but not particularly slender. Aperture terminal, nearly round, presumed entosolenian.

Remarks: This species is distinguished by its rounded, perforate periphery with barely perceptible carinae.

Lagenosolenia sp. C

Test with ovate chamber, compressed, base usually rounded, often apiculate, periphery acute, likely carinate, but obscured somewhat by fine hispid ornament covering entire chamber. Aperture terminal, ovate, presumed entosolenian, ideally on fairly long, stout neck with lip frequently developed, the neck with narrow to broad flange as extension of carina.

Remarks: The hispid test with neck distinguishes this species from most, while the chamber shape and carinate neck distinguish it from L. echinata.

Genus **Palliolatella** Patterson and Richardson, 1987

Palliolatella palliolata (Earland)

Lagena palliolata EARLAND, 1934, p. 158, pl. 7, figs. 5,6.

Lagenosolenia palliata McCULLOCH, 1977, p. 67, pl. 61, fig. 21.

Fissurina palliolata (Earland). BOLTOVSKOY AND de KAHN, 1982, p. 429, pl. 5, figs. 24-26.

Palliolatella palliolata (Earland). PATTERSON, 1986a, p. 119, pl. 23, figs. 8-10.

Test pyriform in outline, distinctly compressed, chamber nearly circular in outline with slender neck of about 1/2 chamber length. Whole of test encircled by broad thin keel whose greatest extent is at base and adjacent to neck, where it forms flange with extremely fine arcuate radial opaque inclusions; upper surface of flange and neck is thickened or expanded, beginning where keel is narrowest about 1/3 down chamber, with its maximum expansion forming a convex apertural hood.

Lower half of chamber on each face variably ornamented, with at least one but frequently 2 ridges concentric to chamber outline, usually produced as basally directed, broad, thin secondary keels; frequently number of these ridges differs from one face to the other on the same specimen. Aperture terminal, oval, with entosolenian tube projecting into chamber.

Remarks: The style of ornament, with basal ridges and keels on the chamber, is distinctive, and variable enough that it embraces both the type, with but a single ridge on each face, and McCulloch's form, with 2 ridges or keels per face. The hood in the present material is never so greatly expanded as it is in any of the references included in synonymy.

Palliolatella variabilis (Wright)

Lagena orbignyana (Seguenza) var. variabilis WRIGHT, 1891, p. 482, pl. 20, fig. 9.

Fissurina alveolata semisculpta Parr. BOLTOVSKOY AND de KAHN, 1982, p. 421 (pars), pl. 1, figs. 9,10 only.

Lagenosolenia variabilis (Wright). JONES, 1984, p. 118, pl. 4, fig. 13.

Test somewhat trigonal in outline, with rounded base, having circular and inflated but compressed chamber, and a fairly long, slightly tapering neck about 2/3 chamber length. Principal ornament consists of a broad thin keel which more or less follows chamber outline, but may be ragged basally; above midline keel forms broad triangular flanges on the entire length of neck, with arcuate radial opaque inclusions. End of neck thickened, as is upper half of carinal flange, to produce apertural hood, within which is terminal oval aperture, furnished with short straight entosolenian tube projecting into chamber. In addition to the peripheral carina, each face has a thicker and narrower ridge encircling the chamber, possibly interrupted at the base, and either fading out near the neck, or running into 2 fairly strong costae which, when developed, run from upper 1/4 of chamber well onto neck. Surface of chamber with numerous low, fine, rounded longitudinal costae, usually discontinuous, particularly weak to absent on central part of chamber.

Remarks: The palliolatelline hood in particular, and the lack of basal alveolar or auricular loops distinguish this from most other similar genera and species, while the longitudinal costae separate it from other species of the genus. The problems with Boltovskoy and de Kahn's assignment have already been noted under Lagena semisculpta.

Palliolatella sp. A

Fissurina alato-marginata (Jones). BOLTOVSKOY AND de KAHN, 1982, p. 421, pl. 1, figs. 1,2.

Test elongate teardrop to subfusiform in outline, about 2 1/2 times as long as broad, distinctly compressed but chamber faces gently convex, greatest breadth below midline, base apiculate, neck of considerable length, about 1/4 that of chamber. Periphery ornamented by 3 keels, of which usually the central one is predominant on the upper part and the outer pair on the lower part of test. Central keel embraces neck in a rather narrow flange, with the upper surface and lip expanded to form an acutely angled hood; usually this keel becomes narrow while remaining thin, and often disappears by midline of chamber, but may persist with appreciable breadth to base of test. Each face encircled by a rather thicker and rounded ridge, which is interrupted at the base to produce a spine or flange by fusion with the other, then narrowing as they pass up to base of neck. Lower face of chamber rarely with a few fine costae. Aperture terminal, oval, with free straight entosolenian tube of comparable length to neck.

Remarks: The teardrop outline, with 3 closely spaced keels of inversely related breadth, is distinctive. Lagena vulgaris Williamson var. alato-marginata F.W. Jones has no palliolatelline hood, and has but a single marginal keel, which has broader extensions near the apertural end. It thereby simulates the present species in outline, but the specimens of Boltovskoy and de Kahn agree well with this form in being tricarinate.

Palliolatella sp. B

Test pyriform in outline, not very much longer than broad, much compressed, chamber more or less circular in outline, with slender tubular neck about 1/2 length of chamber. Neck embraced by carina, which is very broad, thin, and convex in outline, with faintest radial opaque lines, the keel narrowing as it passes toward base, where it runs into a pair of basal auricular loops separated by a large caudal tube or open box of comparable dimensions to the loops. There are no evident supplementary keels or costae of any kind. Aperture terminal, compressed oval, in thickened crescentic hood formed by lips, which continue as a thickened rim well down the carina; entosolenian tube long, straight in face view, attached to one chamber wall and running to base.

Remarks: There is nothing like it, with auricular loops, caudal tube, and lack of ornament apart from the primary peripheral keel. Lagena orbignyana (Seguenza) var. coronata Sidebottom is tricarinate at the base, but otherwise similar as to shape.

Palliolatella sp. C

Test elongate trigonal in outline with rounded base, chamber circular in outline and very strongly inflated, neck long and slender, 2/3 or more of chamber length. Periphery with thin, fairly broad keel adhering quite closely to chamber, then producing triangular flanges to neck, with radiating opaque lines. Aperture terminal, ovate, in very slightly expanded hood at end of neck and upper carinal flange, entosolenian tube free and short, projecting into chamber.

Remarks: This species is distinguished by the test outline, absence of surface sculpture, and presence of only a single simple keel.

Genus Pseudoolina R.W. Jones, 1984

Pseudoolina becella Patterson

Pseudoolina becella PATTERSON, 1986a, p. 132, pl. 27, figs. 1-5.

Test with globular chamber, very slightly compressed, base may have rounded caudal projection, apertural end produced with very high and broad apertural lips, half as high again as chamber, with well rounded if somewhat quadrate outline.

Aperture a small round opening into very narrow fissure which occupies full extent of lips, with entosolenian tube unknown but presumed.

Remarks: Pseudoolina fissurinea differs in having much shorter and narrower apertural lips, and in being uncompressed. The present species is not yet validated by publication.

Pseudoolina bisymmetrica (McCulloch)

Lagena bisymmetrica McCULLOCH, 1977, p. 28, pl. 55, fig. 20.

Test globular with produced convex apertural lips, base rounded, surface with some 5 or so irregularly disposed low costae which run from base up onto apertural lips. Aperture terminal, ovate, within lips, presumed entosolenian.

Remarks: It is assumed that the present material corresponds to McCulloch's, and that she too was unable to observe an entosolenian tube. This species differs from Lagena acuticosta Reuss var. paucicostata Cushman which has a round aperture and 3 costae at 120° to each other.

Pseudoolina fissurinea R.W. Jones

Pseudoolina fissurinea JONES, 1984, p. 119, pl. 4, figs. 19,20.---PATTERSON, 1986a, p. 133, pl. 26, figs. 10-12

Test globular, unornamented, perforate, with distinct produced and compressed imperforate lips or collar, about 1/3 as broad as test. Aperture a fairly broad fissurine slit, presumed entosolenian, symmetrical with respect to the lips.

Remarks: This species is distinguished from Oolina globosa by its fissurine aperture, from P. beccella by its much smaller lips, and from Parafissurina by its symmetrically disposed aperture.

Genus Tortaguttus Barrick, Beveridge, Patterson, and Schubert, 1989

Tortaguttus sp. A

Test ovate in outline, greatest breadth about 1/3 from base, chamber inflated while whole of test distinctly compressed. Chamber surrounded by very broad, thin keel which almost doubles test width, keel sigmoid and strongly offset at base, the

two sides not overlapping, but joining through oblique keel passing through caudal structure, keel hyaline and thin for the most part, with short radiating tubuli from the chamber which stop short of the thickened margin of the keel that has its own separate set of tubuli. Short tubular neck passes through keel to thin, broad crescentic hood or lips; aperture fine and obscure in this specimen, with entosolenian tube attached to one wall, skewed rather than straight.

Remarks: The form of the keel, with a broad, thin, partially tubulated inner portion, and the apertural hood or lips, distinguish this from other species of the genus.

Subfamily PARAFISSURININAE R.W. Jones, 1984

Genus Parafissurina Parr, 1947

Parafissurina abnormis Parr

Parafissurina abnormis PARR, 1950, p. 314, pl. 9, fig. 11.

Test circular in outline, barely compressed, periphery very broadly rounded and non-marginate, base rounded, may have apical spine. Aboral side with very broad, fairly high apertural hood, with imperforate rim, oral side with a low perforate flap; entosolenian tube irregularly curved, attached to aboral side most frequently.

Remarks: The present specimens differ from the type, in which the entosolenian tube was attached to the oral side. Nevertheless, it was also irregular, and combined with the distinctive apertural hood, and non-marginate thick circular test, seems to be the same species.

Parafissurina alata (Buchner)

Lagena lateralis Cushman forma alata BUCHNER, 1940, p. 521, pl. 23, figs. 501-503

Parafissurina impariiformis McCULLOCH, 1977, p. 148, pl. 71, fig. 23.

Parafissurina lateralis alata (Buchner). BOLTOVSKOY AND de KAHN, 1982, p. 445, pl. 14, figs. 4,5.

Test pyriform in outline, compressed but strongly inflated, periphery with

thin imperforate keel, of almost no breadth on upper chamber surfaces, but from midline down, and around the base, very broad and thin, with radial striae or crenulations, and occasionally a central cleft or indentation. Aperture with fairly well produced curved hood, and slight central oral cleft, entosolenian tube presumed.

Remarks: The keel, with its greater breadth toward the base, is distinctive. Whether the apertural cleft noted by McCulloch is of significance is unknown, as all six of Buchner's illustrations were from the aboral side of the test.

Parafissurina arctica Green

Parafissurina arctica GREEN, 1960, p. 70, pl. 1, fig. 2.---LAGOE, 1977, p. 122, pl. 3, fig. 15.

Parafissurina aff. P. arctica Green. LAGOE, 1977, p. 122, t.f. 7, pl. 3, figs. 8,10.

Fissurina kerguelenensis Parr. HERMELIN AND SCOTT, 1985, p. 208, pl. 2, fig. 12.

Test unilocular, barely compressed, essentially circular in outline. Periphery with very narrow keel, and 4 spines projecting from basal 1/4 to 1/3 of test. Aperture slitlike but asymmetric relative to peripheral plane, therefore hooded by keel, and furnished with entosolenian tube.

Remarks: Lagoe's "aff." forms are merely smaller and with shorter entosolenian tubes than Green's type, and are not distinguished in this study. The reassignment of Hermelin and Scott's forms has already been discussed under that species.

Parafissurina boonei McCulloch

Parafissurina boonei McCULLOCH, 1977, p. 140, pl. 69, figs. 20,21.

Test circular to pyriform in outline, chamber compressed but inflated, circular in outline, surrounded by fairly broad and reasonably thick keel, which is pinched in near the aperture, then produced as a hood which is convex in outline, but strongly concave on its oral face; keel and hood traversed by a few tubuli of no apparent pattern, and not thicker than keel. Aperture hooded, and partially bordered in front by slightly convex extension or flap of chamber face, entosolenian

tube attached to aboral wall, straight, about 3/4 test length.

Remarks: This species represents an extreme of the variable development of the markings of the keel in P. lata, in which they may be absent to striate to tubulated. This may not be a distinct species. Its thick circular chamber with broad keel and strongly convex produced apertural hood distinguishes it from most species.

Parafissurina clavigera (Buchner)

Lagena clavigera BUCHNER, 1940, p. 529, pl. 26, figs. 544,545.

Parafissurina clavigera (Buchner). BOLTOV, 1977, p. 13, figs. 15,16. AND de KAHN, 1982, p. 444, pl. 13, figs. 15,16.

Test elongate teardrop-shaped in outline, greatest breadth about 1/3 from base, tapering to fairly narrowly rounded apertural end, compressed fairly strongly, without imperforate margin, section elliptical, base broadly rounded, may have anything from small opaque dot to slight caudal spine. Aperture hooded, hood a smooth continuation of test outline, about as high as broad, with long entosolenian tube, straight in face view, attached to aboral wall, flared slightly at base.

Remarks: The gentle teardrop shape, compression, and lack of imperforate margin are distinctive. Lagena lateralis Cushman has a distinctly imperforate margin, while P. viduosa is much broader at the base and tapers much more strongly.

Parafissurina curta Parr

Parafissurina curta PARR, 1950, p. 318, pl. 10, figs. 6,7.

Parafissurina limpidiformis McCULLOCH, 1977, p. 150, pl. 71, fig. 8.

NOT Parafissurina curta Parr. PATTERSON, 1986a, p. 122, pl. 24, figs. 5,6.

Test broadly pyriform in outline, compressed, base with very slight point if any, apertural hood fairly narrow and high, periphery angled and imperforate, but without distinct keel. Aperture at junction of oral face and margin, a fairly deep equant opening cut well into oral face, clearly showing hood folded inward and converging to produce entosolenian tube, which soon attaches to aboral wall and is

Remarks: The chambers are much less strongly embracing than in Globulotuba sp. A, and the nature of the entosolenian tube is also completely different. In addition, the base is somewhat rounded, rather than acute projecting.

Genus Globulotuboides McCulloch, 1977

Globulotuboides sp. A

Pyrulina cylindroides (Roemer). BARKER, 1960, p. 150, pl. 72, figs. 5,6.

Test elongate, fusiform, very slightly compressed, base apiculate. Chambers initially obscurely quinqueloculine, rapidly becoming biserial, uninflated, occupying about half of test length, embraced chamber surfaces resorbed. Sutures distinct, oblique, flush, very gently curved. Aperture terminal, radiate, with entosolenian tube.

Remarks: Polymorphina cylindroides Roemer has a rounded base, no entosolenian tube, and tapers from near the apertural end, and so Barker's reference is transferred herein. This form is distinguished from Pyrulina not only by the entosolenian tube, but also by the resorption of embraced material.

Genus Laryngosigma Loeblich and Tappan, 1953

Laryngosigma invecta McCulloch

Polymorphina angusta Egger. CUSHMAN, 1913a, p. 86, pl. 39, fig. 6.

Pyrulina angusta (Egger). BARKER, 1960, p. 150, pl. 72, figs. 1-3.

Laryngosigma (?) invecta McCULLOCH, 1977, p. 193, pl. 87, fig. 10.

Test elongate, subfusiform, very slightly compressed, test broadest near base, which is rounded. Chambers very elongate, reaching almost to base and increasing test length by 20 to 25% as added, uninflated, all embraced chamber surfaces resorbed. Sutures distinct, very slightly depressed, strongly oblique and gently curved or sigmoid. Aperture terminal, radiate, with entosolenian tube.

Remarks: The presence of an entosolenian tube, and the resorption of embraced material, prevent assignment of this form both to Polymorphina angusta in particular, and Pyrulina in general.

3

Microl

semicircular in section, flaring slightly at base, which is 3/4 or more of way toward base.

Remarks: The pyriform outline, distinct carinate imperforate periphery, and rather narrow high hood are distinctive. McCulloch distinguished her form as being less strongly inflated, more angular in outline due to a more strongly produced hood, and having a shorter tube. These differences do not appear to be significant. It should be noted that the depiction of the aperture in Parr's figures looks to be at odds with the description and the current material, and although McCulloch's oral face view (8a) is a good match, the apertural (8b) and edge (8c) views show the aperture within the carinate margin. There would appear to be problems with this species, and it may be that if the two forms prove not to be synonymous, McCulloch's would be a better match for the present material. The specimen illustrated by Patterson (1986a) seems too globose and uncompressed, with a long apical spine, no suggestion of an imperforate margin, and a hood too broad with respect to the test breadth.

Parafissurina felsinea (Fornasini)

Lagena felsinea FORNASINI, 1894, p. [1], 2 t.f.

Lagena emaciata Reuss var. felsinea Fornasini. FORNASINI, 1901, p. 47, t.f. 1.

NOT Lagena felsinea Fornasini. CUSHMAN, 1913a, p. 10, pl. 4, fig. 1.

Lagena felsina (Fornasini). BUCHNER, 1940, p. 528. pl. 26, figs. 546, 547.

NOT Oolina felsinea (Fornasini). BARKER, 1960, p. 114, pl. 56, fig. 4.---
BOLTOVSKOY AND de KAHN, 1982, p. 442, pl. 12, figs. 10, 11.

Parafissurina felsinea (Fornasini). PATTERSON, 1986a, p. 122, pl. 24, fig. 7.

Parafissurina fusuliformis Loeblich and Tappan. ?WARD AND WEBB, 1986, p. 187, pl. 3, fig. 15.

Test elongate, slender, almost sausage-shaped, circular in section, usually gently arcuate, base broadly rounded, apertural end narrowly rounded in face view, acute and asymmetrical in side view, the aboral side being curved, the oral face being flat and a continuation of the straight to concave contour of the oral side of

the test. Aperture subcircular, with straight base, directed completely to one side, with entosolenian tube, tube soon attached to convex side and runs at least 1/2 test length, occasionally more.

Remarks: The usually curved test that is nearly parallel-sided in both views is distinct from other elongate parafissurine forms that have apical spines, are much broader, or have their greatest breadth near the base and taper distinctly to the apertural end. Cushman (1913a) and Barker (1960) referred thicker, more strongly tapering forms, with a terminal round aperture produced slightly to one side, to this species. Fornasini (1894), contrary to Barker's claim, did not place Brady's (1884) figure in synonymy, but excluded it at least on the basis of the apical structure of Brady's specimen. Consequently the former two references as well as that of Boltovskoy and de Kahn have been transferred to Oolina exilis. Patterson's identification is accepted, although the absence of a side view prevents full assesment of the shape. Ward and Webb's specimen is arcuate, non-fusiform, and parallel-sided, and although represented only by a side view, appears to belong here rather than in P. fusuliformis.

Parafissurina fusuliformis Loeblich and Tappan

Parafissurina fusuliformis LOEBLICH AND TAPPAN, 1953, p. 79, pl. 14, figs. 18,19.---LAGOE, 1977, p. 122, pl. 3, fig. 7.---COLE, 1981, p. 85, pl. 19, fig. 35.---BOLTOVSKOY AND de KAHN, 1982, p. 444, pl. 13, figs. 22,23.

Parafissurina cf. fusuliformis Loeblich and Tappan. McCULLOCH, 1977, p. 147, pl. 71, fig. 6.

Parafissurina apertum Matthes. BOLTOVSKOY AND de KAHN, 1982, p. 443, pl. 13, figs. 9,10.

NOT? Parafissurina fusuliformis Loeblich and Tappan. WARD AND WEBB, 1986, p. 187, pl. 3, fig. 15.

Test elongate, somewhat fusiform in both views, greatest breadth generally toward but not near base, oral side nearly straight, aboral side more strongly convex, base rounded, may be faintly apiculate, apertural end rounded in oral view, acute in edge view. Aperture small, completely hooded, nearly circular, with

entosolenian tube eventually attached to aboral side, and generally less than 1/2 test length.

Remarks: As already noted, Ward and Webb's forms are not fusiform, but instead seem referable to P. felsinea. Lagena aperta Matthes is illustrated by two very different specimens, one of which is a strongly skewed cucumber-shaped form in edge view, the other being the oral face view of a symmetrically fusiform type with a long basal point. Neither of these matches the specimens of Boltovskoy and de Kahn. Lagena fornasinii Buchner has a fine entosolenian tube and rounded apertural end in both views, while P. tectulostoma Loeblich and Tappan is thicker, and more strongly apiculate and basally produced. P. kladerorhektis Patterson, which is not yet validated by publication, is almost equally convex on both oral and aboral faces, and the entosolenian tube runs almost to the base.

Parafissurina hamigera (Buchner)

Lagena hamigera BUCHNER, 1940, p. 530, pl. 26, figs. 550,551.

Test quadrate in outline, compressed, anywhere from slightly longer than broad to twice as long as broad, ends rounded to slightly angled on the corners, margins imperforate and evidently so even in face view, but without distinct keel. Aperture low and broad, hooded, with long entosolenian tube of about 2/3 test length, attached to aboral side.

Remarks: The present specimens lack the hooked basal extremity to the tube which brings it around to the oral side on the types. Most quadrate species lack an imperforate margin, while P. erecta McCulloch has a distinct keel, and P. erectiformis McCulloch has a perforate chamber extension piercing the imperforate basal margin, and a produced high apertural hood.

Parafissurina lata (Wiesner)

Ellipsolagena lata WIESNER, 1931, p. 126, pl. 24, stereo-pair figs. k,l.

Parafissurina lata (Wiesner). PATTERSON, 1986a, p. 124, pl. 24, figs. 11,12.

Test nearly circular in outline, with produced rounded apertural end,

compressed but thick and inflated, surrounded in its entirety by a broad, not particularly thin keel, which may be traversed by opaque striations, faint tubulations, or not at all, outline indented at either side of apertural hood. Surface of chamber may have increased concentrations of perforations in center, or else in 2 semicircular marginal bands on each face. Aperture a crescentic slit, bordered behind by concave extension of keel that is convex in outline, and in front by inflated convex extension of chamber that parallels aboral hood; entosolenian tube attached to aboral surface, reaching almost to base.

Remarks: There are several similar species which need to be distinguished. Parafissurina boonei appears to represent extreme development of tubuli, but is otherwise identical, while P. marginoradiata has an entire outline, and the oral apertural border is produced from the keel, not the chamber surface. Lagena pseudomarginata forma typica Buchner embraces far too much variation to be useful, while Fissurina wiesneri Barker has different apertural characteristics. Parafissurina seorsa McCulloch may be synonymous, but has an imperforate central chamber surface and coarsely perforate lateral surfaces. P. admiralis McCulloch agrees very well with respect to the aperture, but has a thick blunt keel and 4 coarsely perforate crescentic patches.

Parafissurina marginata (Wiesner)

Ellipsolagena marginata WIESNER, 1931, p. 126, pl. 20, fig. 245.

Parafissurina hongkongensis McCULLOCH, 1977, p. 147, pl. 68, fig. 24.

Test circular in outline, strongly compressed, with imperforate margin and distinct thin keel of appreciable breadth in most instances. Aperture a low broad slit to one side of non-produced encircling keel, with slightly curved entosolenian tube, attached to the aboral side, nearly reaching base, which is rarely slightly indented.

Remarks: McCulloch's form is believed to be synonymous, there being no appreciable distinction, although Wiesner did not provide an edge view, and the type description is in German. P. subcircularis Parr is clearly more strongly inflated,

and the aperture is barely but distinctly hooded.

Parafissurina marginoradiata McCulloch

Parafissurina marginoradiata McCULLOCH, 1977, p. 150, pl. 69, fig. 16.

Test and chamber circular in outline, quite strongly compressed, surrounded by an entire, very broad thin keel that may in the extreme be everted or turned over to one face on alternate sides, traversed by numerous, closely spaced, fine radial semi-opaque lines which are neither tubuli nor striae. Aperture a narrow crescentic slit in keel, about halfway between chamber and periphery, one side of keel forming the hood, and a frontal bordering lip or flap formed by outfolding of keel; entosolenian tube straight, in many cases reaching almost to base.

Remarks: The aperture is barely sunken into the hood, and this species may be referable to Pseudofissurina R.W. Jones. The entire outline, without indentations on either side of the aperture, and the aperture which is bordered on both faces by the keel, and not in front by an extension of the oral chamber surface, distinguish this species from P. lata, as does the extreme radial keel ornament.

Parafissurina neocircularis McCulloch

**Parafissurina neocircularis McCULLOCH, 1977, p. 151, pl. 71, fig. 11.---
BOLTOVSKOY AND de KAHN, 1982, p. 445, pl. 14, figs. 15,16.**

Test essentially circular in outline, gently compressed, periphery rounded and imperforate, base normally rounded but occasionally with small apical spine. Aperture barely above outline of test, in low convex hood, with long entosolenian tube attached to aboral wall, may run across base to oral side.

Remarks: The lack of an imperforate keel or margin distinguishes this from most circular species, and the low unobtrusive hood from P. abnormis.

Parafissurina ovata (Wiesner)

Ellipsolagena ovata WIESNER, 1931, p. 126, pl. 20, fig. 244.

Test ovate in outline, well compressed, surrounded by a narrow sharp keel. Aperture not produced, bordered behind by keel, consisting of an opening in the

upper oral surface, with straight entosolenian tube attached to aboral side, running to base.

Remarks: The test shape and presence of a keel distinguishes this from most species, while the aperture is not produced to disrupt the outline as it is in P. curta.

Parafissurina semicarinata (Buchner)

Lagena lateralis Cushman forma semicarinata BUCHNER, 1940, p. 520, pl. 23, figs. 493, 494.

Parafissurina semicarinata (Buchner). PATTERSON, 1986a, p. 126, pl. 25, figs. 4, 5.

Test teardrop-shaped in outline, base rounded, apertural end produced and narrowly rounded, well compressed, with imperforate margin that becomes distinct thin narrow keel for basal 1/3 or so of test, less so for more elongate specimens. Aperture well hooded by thickened aboral extension, rather small and equant, with entosolenian tube attached to aboral wall, may cross base and extend up oral face to a significant extent.

Remarks: The teardrop outline, compressed test, and well developed if narrow and thin basal keel form a distinctive combination. P. acuta McCulloch is similar, but has a very elongate, acutely pointed imperforate hood.

Parafissurina vidriosa Boltovskoy and de Kahn

Parafissurina vidriosa BOLTOVSKOY AND de KAHN, 1982, p. 447, pl. 15, figs. 15-18.

Test teardrop-shaped in outline, well compressed, base broadly rounded, with slight caudal projection, apertural end tapered but narrowly rounded, periphery without evident keel or margin. Aperture rather narrow, a short semicircle or arch, bordered by narrow, high, thick hood, entosolenian tube running down aboral wall halfway to base.

Remarks: The true teardrop shape distinguishes this species from otherwise similar forms of McCulloch. Lagena curvans Buchner has a broad thick hood which is crescentiform and imperforate, as well as a lip in front of the aperture.

Parafissurina bandita Boltovskoy and de Kahn has a distinct, densely perforate

peripheral band, a broader, more crescentiform aperture, and is more rounded than teardrop-shaped in outline. The present species is shorter and broader than P. clavigera.

Parafissurina wiesneri Parr

Parafissurina wiesneri PARR, 1950, p. 326, pl. 10, figs. 19,20.---BOLTOVSKOY AND de KAHN, 1982, p. 447, pl. 15, figs. 19,20.

Test broadly pyriform in outline, rather thick and inflated, surrounded by a fairly sharp keel of appreciable but not great breadth, narrowing at upper shoulders near apertural hood; in extreme cases may be of minimal breadth, basally apiculate. Aperture bordered behind by fairly large semicircular hood as extension of keel, and in front by somewhat straight flap from chamber face, with inverted opaque or thickened low triangular patch; entosolenian tube rather obscure, appears to be attached to aboral wall, more or less straight, nearing base.

Remarks: This species differs from P. lata not only in the lesser extent of its keel, but in the shape of the aperture, which is more broad semicircular than crescentic in face view. It may be an end member of a variable plexus with that species at the other. In many ways it looks like a parafissurine version of Fissurina marginata. Parafissurina subcarinata Parr differs in having a narrow, thick keel, and a much broader aperture, but again, may represent an extreme in a large plexus.

Parafissurina sp. A

Test elongate to almost globose teardrop-shaped, circular in section, base well rounded and rarely with caudal structure, tapering thence to very narrow apertural end, which is acute in lateral view. Aperture small, round, completely eccentric and hooded, with entosolenian tube of about half test length attached to aboral wall.

Remarks: Although apparently related to P. felsinea and P. fusuliformis, this species has its greatest breadth right at the basal diameter, tapers steadily from there, and has a pointed apertural end.

Subfamily SIPHOLAGENINAE Patterson and Richardson, 1987

Genus Bifarilaminella Patterson and Richardson, 1987

Bifarilaminella advena (Cushman)

Lagena striata (d'Orbigny) var. haidingeri (Czjzek). CUSHMAN, 1913a, p. 19, pl. 7, fig. 6.

Lagena advena CUSHMAN, 1923, p. 6, pl. 1, fig. 4.---BARKER, 1960, p. 118, pl. 57, figs. 30, 29.---BOLTOVSKOY AND de KAHN, 1982, p. 433, pl. 8, figs. 17-19.

Bifarilaminella advena (Cushman). PATTERSON, 1986a, p. 144, pl. 30, figs. 3-6.

Test rather elongate pyriform, circular in section, chamber clearly longer than broad, greatest breadth near rounded base, tapering toward apertural end. Wall bilamellar, lamellae very closely spaced, outer layer with extremely numerous, fine longitudinal costae, many of which anastomose, also furnished with a caudal spine or tube and as many as 5 or more tubular basal projections disposed in a ring around the base. Aperture terminal, on long slender neck with slight lip, and buttressed with 4 broad thin convex flanges arising about 1/4 of way down chamber, running right up to lip, entosolenian tube presumed.

Remarks: The close-set bilamellar walls, anastomosing costate surface, chamber shape and 4 broad neck flanges make a distinctive combination, as do the basal tubes. The specimen in pl. 57, fig. 29 of Barker is more elongate than the norm, but apparently within the range indicated by the present specimens, whose chambers are not particularly spherical. Oolina haidingeri Czjzek has a neck devoid of plate-like costae, and the base lacks spines. The lateral view shows an apparent basal ring at which the costae meet.

Genus Sipholagena Moncharmont Zei and Sgarrella, 1980

Sipholagena paradoxa (Sidebottom)

Lagena foveolata Reuss (?) var. paradoxa SIDEBOTTOM, 1912, p. 395, pl. 16, figs. 22, 23.

Lagena foveolata Reuss var. paradoxa Sidebottom. CUSHMAN, 1913a, p. 18, pl. 15, fig. 3.

Lagena paradoxa Sidebottom. CUSHMAN, 1933d, p. 29, pl. 7, figs. 9, 10.

NOT Lagena paradoxa Sidebottom. McCULLOCH, 1977, p. 41, pl. 50, fig. 34.

Sipholagena paradoxa (Sidebottom). BOLTOVSKOY AND de KAHN, 1982, p. 447, pl. 15, figs. 23-26.---PATTERSON, 1986a, p. 145, pl. 62, figs. 1-3.

Lagena (?) paradoxa Sidebottom. JONES, 1984, p. 132, pl. 7, figs. 7-9.

Test elongate teardrop-shaped, circular in section, over twice as long as broad exclusive of neck, greatest breadth toward base, which is rounded to rounded with produced caudal structure, and tapers uniformly to slender apertural end. Wall bilamellar, inner layer smooth, separated from outer layer by fine struts or pillars, outer layer with prominent fine, closely spaced longitudinal costae, connected by numerous closely spaced, transverse bars or ridges of lesser height; perforations lie within resultant reticulations. Aperture terminal, round, at end of long slender neck, with slight thickening or lip, and passing through neck to inner chamber, with entosolenian tube.

Remarks: The bilamellar structure distinguishes this species from most, and the chamber shape and ornament from Bifarilaminella advena. Sipholagena structiloides is essentially smooth, with prominent pinpoints, which are either perforations or the terminations of pillars, in longitudinal rows, and as well the surface has faint longitudinal furrows. McCulloch's specimen should be referred to that species. Lagena hertwigiana Brady var. undulata Sidebottom lacks the cross-bars, but may simply be a development where they are too faint. The implication of its specific assignment is that the layers are separated by raised walls or ridges, not struts or pillars, producing interlamellar cells. That this is the case is not at all clear from the type figure and description.

Sipholagena structiloides Patterson and Richardson

Lagena paradoxa Sidebottom. McCULLOCH, 1977, p. 41, pl. 50, fig. 34.

Sipholagena structiloides PATTERSON AND RICHARDSON, 1988, p. 257, t.f. 40,41,51.---PATTERSON, 1986a, p. 146, pl. 30, figs. 9,10.

Test elongate teardrop-shaped, circular in section, over twice as long as broad, greatest breadth toward base, which is rounded but may have caudal structure, tapering to slender apertural end. Wall bilamellar, layers separated by rows of fine

pillars, outer layer smooth, usually with distinct fine longitudinal furrows, intersection of pillars with wall produces bright spots as apparent perforations; development of true perforations variable. Aperture terminal, round, on long slender neck, with lip, passing to inner chamber via neck and entosolenian tube.

Remarks: The bilamellar teardrop-shaped test with smooth, furrowed perforate wall is distinctive.

Family GLANDULINIDAE Reuss, 1860

Subfamily GLANDULININAE Reuss, 1860

Genus Globulotuba Collins, 1958

Globulotuba sp. A

Test elongate, subfusiform, circular in section, base asymmetrical, rounded with respect to test axis, but has acute asymmetrical apex. Chambers very strongly embracing, nearly entire length of test and 3/4 of circumference where preceeding chambers visible, which is lower 2/3 of test; added in planes 120° apart, triserial, all previously embraced chamber surfaces resorbed. Sutures distinct, few, and nearly flush. Wall hyaline, smooth. Aperture terminal, eccentric, compressed radiate with straight, oblique entosolenian tube, flaring at end within chamber.

Remarks: The subfusiform test with very little visible except the final chamber, and the form of the aperture and entosolenian tube are distinctive. The chambers added at 120° to each other distinguish this genus from Globulotuboides.

Globulotuba sp. B

Test elongate, fusiform, rounded in section, base pointed but blunt to narrowly rounded. Chambers strongly embracing, final one occupies 2/3 to 3/4 of test length, slightly inflated, added in planes 120° apart in triserial fashion, at least 2 complete stacked whorls seen in some specimens, embraced chamber surfaces resorbed. Sutures distinct, depressed, oblique. Aperture terminal, radiate, with long curved entosolenian tube which attaches to wall and may subsequently run for much of final chamber length.

Remarks: The chambers are much less strongly embracing than in Globulotuba sp. A, and the nature of the entosolenian tube is also completely different. In addition, the base is somewhat rounded, rather than acute projecting.

Genus Globulotuboides McCulloch, 1977

Globulotuboides sp. A

Pyrulina cylindroides (Roemer). BARKER, 1960, p. 150, pl. 72, figs. 5,6.

Test elongate, fusiform, very slightly compressed, base apiculate. Chambers initially obscurely quinqueloculine, rapidly becoming biserial, uninflated, occupying about half of test length, embraced chamber surfaces resorbed. Sutures distinct, oblique, flush, very gently curved. Aperture terminal, radiate, with entosolenian tube.

Remarks: Polymorphina cylindroides Roemer has a rounded base, no entosolenian tube, and tapers from near the apertural end, and so Barker's reference is transferred herein. This form is distinguished from Pyrulina not only by the entosolenian tube, but also by the resorption of embraced material.

Genus Laryngosigma Loeblich and Tappan, 1953

Laryngosigma invecta McCulloch

Polymorphina angusta Egger. CUSHMAN, 1913a, p. 86, pl. 39, fig. 6.

Pyrulina angusta (Egger). BARKER, 1960, p. 150, pl. 72, figs. 1-3.

Laryngosigma (?) invecta McCULLOCH, 1977, p. 193, pl. 87, fig. 10.

Test elongate, subfusiform, very slightly compressed, test broadest near base, which is rounded. Chambers very elongate, reaching almost to base and increasing test length by 20 to 25% as added, uninflated, all embraced chamber surfaces resorbed. Sutures distinct, very slightly depressed, strongly oblique and gently curved or sigmoid. Aperture terminal, radiate, with entosolenian tube.

Remarks: The presence of an entosolenian tube, and the resorption of embraced material, prevent assignment of this form both to Polymorphina angusta in particular, and Pyrulina in general.

Genus **Phlegeria** Loeblich and Tappan, 1963

Phlegeria hyalina Loeblich and Tappan

Phlegeria hyalina? LOEBLICH AND TAPPAN, 1963, p. 213, t.f. 1.

Test elongate, uniserial, arcuate to asymmetrically fusiform, rounded in section, base acute to narrowly rounded, apiculate. Chambers increasing rapidly in height and breadth as added, with greatest test breadth about 2/3 from base, rapidly tapering to both ends, not appreciably inflated, very strongly embracing such that final chamber occupies 1/3 to 1/2 of test length, chambers below this appear broader than high, all embraced chamber surfaces resorbed. Sutures distinct, essentially flush and oblique, when viewed from concave margin of test are strongly arched up toward aperture. Aperture terminal, radiate, often produced and compressed in plane of symmetry, with short entosolenian tube.

Remarks: The Dentalina-like chamber arrangement and shape, along with the entosolenian tube and resorbed chambers, are distinctive. Externally this species bears a strong resemblance to forms assigned to Dentalina by Barker (1960) and Boltovskoy (1978), referred to Nodosaria intorta Dervieux. It is not possible to assess the presence or absence of an entosolenian tube in those references, however.

Subfamily ENTOLINGULININAE Saidova, 1981

Genus **Entomorphinoides** McCulloch, 1977

Entomorphinoides intricata McCulloch

Entomorphinoides intricata McCULLOCH, 1977, p. 211, pl. 92, figs. 9,12,13?.

Test elongate, over 3 times as long as broad, strongly flattened, subpalmate to almost parallel-sided, converging slightly toward apertural end and rapidly tapering toward base, periphery rounded, basal chambers projecting but rounded. Chambers much longer than broad, not inflated appreciably, in sigmoid biserial series, strongly overlapping anteriorly, embracing laterally, but removed from base to produce rounded stepwise basal outline, all embraced chamber surfaces resorbed. Sutures distinct, essentially flush, strongly oblique to subvertical, curving across top of

preceeding chamber. Aperture broken in present specimen, presumably a compressed slit with entosolenian tube.

Remarks: This species is much more quadrate in outline than E. varigata, which is almost rhomboid, with oblique sutures, and chambers which are neither as strongly overlapping nor produced at the base. Entomorphinoides opposita McCulloch has a rounded base, oblique upper margins, and fewer chambers.

Entomorphinoides varigata McCulloch

Sigmomorphina semitecta (Reuss) var. terquemiana (Fornasini). CUSHMAN, 1933d, p. 40, pl. 9, figs. 6-9.

Entomorphinoides varigata McCULLOCH, 1977, p. 214, pl. 86, figs. 19,20.

Test elongate, compressed, over 2 1/2 times as long as broad, base oblique but rounded, test parallel-sided, with final chamber margin straight for almost entire length of test, other side straight only to midline, thereafter oblique and running to narrowly rounded apertural end, periphery rounded. Chambers elongate, uninflated, increasingly removed from base as added in biserial fashion, laterally embracing but only overlapping 2/3 of test width at apertural end, all embraced chamber surfaces resorbed. Sutures distinct, flush, curved to sigmoid and oblique, not vertical. Aperture terminal, a projecting compressed slit with short entosolenian tube.

Remarks: Polymorphina amygdaloides Reuss var. terquemiana Fornasini is proportionately much broader, being only 1 1/2 times as high as broad, and has no entosolenian tube. The species E. opposita is quite similar, but is quadrate in outline, the base is broadly rounded, and the sutures curve sharply across the top, being almost vertical otherwise. The nearly rhomboid outline and oblique sutures of the present species are distinctive.

Subfamily SEABROOKIINAE Cushman, 1927

Genus Seabrookia Brady, 1890

Seabrookia pellucida Brady

Seabrookia pellucida BRADY, 1890, p. 568, t.f. 60.---LOEBLICH AND TAPPAN,

1987, p. 437, pl. 470, figs. 28-30.

Test pyriform in outline, compressed, with one side strongly convex, other flattened to gently curved, periphery acute, carinate, with thin keel that is very finely spinose or fringed at the base. Chambers enrolled, initially 3 per whorl, but soon 2 per whorl, completely embracing with previous chambers attached to one wall. Aperture terminal, at slightly truncate end of test, a slit bordered by lip with thick entosolenian tube, successive apertures at opposite ends of test.

Remarks: This species is distinguished from others of the genus in being somewhat planoconvex, with inner whorls not eccentric in face view, and in having a basal carinal fringe and no neck.

Suborder ROBERTININA Loeblich and Tappan, 1984

Superfamily CERATOBULIMINACEA Cushman, 1927

Family CERATOBULIMINIDAE Cushman, 1927

Subfamily CERATOBULIMININAE Cushman, 1927

Genus Ceratobulimina Toula, 1915

Ceratobulimina arctica Green

Ceratobulimina arctica GREEN, 1960, p. 71, pl. 1, fig. 1.---LAGOE, 1977, p. 128, pl. 5, figs. 4,5.

Test elongate, over twice as long as broad, low trochospiral, distinctly flattened with convex dorsal and excavated ventral side, outer margin well rounded, nearly entire. Chambers 4 plus large globular proloculus, increasing fairly rapidly in size as added, higher than broad ventrally, but broader than high and a bit wedge-shaped on dorsal side, and barely inflated if at all. Sutures distinct, very finely limbate, on dorsal side very slightly depressed, oblique and nearly straight, reaching back to proloculus, on ventral side nearly radial and straight, virtually flush. Aperture somewhat obscure due to broken specimen, with an umbilical component opening into a produced flap from the dorsal side which wraps across periphery, leaving very slight indentation in outline, and an elongate apertural opening

parallel to long axis of test.

Remarks: This species is distinguished by its shape, the oblique dorsal sutures, strong compression, and the vestibule into which the aperture opens.

Ceratobulimina contraria (Reuss)

Rotalina contraria REUSS, 1851a, p. 76, pl. 5, fig. 37.

Buliminella contraria (Reuss). CUSHMAN, 1911, p. 89, fig. 143.---CUSHMAN, 1921, p. 167, pl. 31, fig. 9.

Ceratobulimina pacifica Cushman and Harris. BARKER, 1960, p. 112, pl. 54, fig. 18.---TODD, 1965, p. 57, pl. 23, fig. 1.

Ceratobulimina contraria (Reuss). LOEBLICH AND TAPPAN, 1964, p. 766, fig. 630:1.

Test ovate, slightly compressed, periphery broadly rounded. Chambers 6 to 7 in final whorl, increasing rapidly in size as added. Sutures limbate, only slightly depressed, all but outer whorl covered by clear boss or plug on spiral side. Aperture a fairly large slit parallel to periphery in ventral view, curving along inflated ventral face into umbilicus. On spiral side, extension of apertural folds seen on chamber surface, rising from lower suture and eventually hooking back down as it progresses toward previous whorl.

Remarks: Ceratobulimina pacifica Cushman and Harris differs in being virtually as broad as high, and in having the aperture strike straight toward the umbilicus, with accompanying narrowing halfway there.

Ceratobulimina sp. A

Test low trochospiral, auriculate in outline, dorsal side evolute but with protruding inner whorl or proloculus, ventral side involute, with deep umbilicus, whorls translated ventralward as added, periphery broadly rounded and mildly lobulate. Chambers 7 in outer whorl, inflated gently on both sides, produced strongly ventralward, increasing quite rapidly in size as added. Sutures distinct, limbate, slightly curved and nearly radial, depressed, on dorsal side with very short inner partitions discernible on anterior side of sutures, near inner end. Aperture

somewhat obscure, an elongate narrow slit parallel to periphery up inflated apertural face, and maintaining that orientation while opening into umbilicus.

Remarks: This species is much more elongate than C. contraria, has a less well-developed aperture, and the whorls are strongly translated. Its sutures are more nearly radial, and its apertural style is distinct from that of C. arctica.

Family EPISTOMINIDAE Wedekind, 1937

Subfamily EPISTOMININAE Wedekind, 1937

Genus Hoe glundina Brotzen, 1948

Hoe glundina elegans (d'Orbigny)
(Plate 5, Figures 6-8)

Rotalia (Turbinulina) elegans d'ORBIGNY, 1826, p. 276.

Pulvinulina elegans (d'Orbigny). CUSHMAN, 1915, p. 63, pl. 26, fig. 3.

Hoe glundina elegans (d'Orbigny). BARKER, 1960, p. 216, pl. 105, figs. 3-6.

Hoe glundina elegans (d'Orbigny). LOEBLICH AND TAPPAN, 1964, p. 775, fig. 636:3-5.---TODD, 1965, p. 56, pl. 23, fig. 2.---CORLISS, 1979, p. 12, pl. 5, figs. 11-13.---INGLE et al., 1980, p. 138, pl. 2, fig. 11.---BURKE, 1981, pl. 3, figs. 12,13.---POAG, 1981, p. 69, pl. 19, fig. 3; pl. 20, fig. 3.---HERMELIN AND SCOTT, 1985, p. 210, pl. 6, figs. 6,7.---MEAD, 1985, p. 244, pl. 7, figs. 6,7.

Test low trochospiral, lenticular, inequally biconvex, ventral side more strongly so, biumbonate. Chambers on dorsal side curved quadrangular, on ventral side triangular. Sutures distinct, strongly limbate, flush to only slightly depressed, the latter on ventral side only; on dorsal side curved, on ventral side nearly radial. Wall aragonitic and distinctly mottled. Aperture lateromarginal, almost peripheral, a slit running full peripheral extent of chamber on ventral side, preceeding apertures may remain visible as whitish trace.

Remarks: Cushman (1915) mentioned an interiomarginal umbilical aperture, not seen in the present study, as well as a lesser peripheral one. Hermelin and Scott referred to a narrow ventral aperture at the base of the last-formed chamber, and their axial view shows no hint of the typical aperture of this species. There is no apparent explanation for either of these.

Superfamily ROBERTINACEA Reuss, 1850
 Family ROBERTINIDAE Reuss, 1850
 Subfamily ALLIATININAE McGowran, 1966
 Genus Cerobertina Finlay, 1939

Cerobertina sp. A

Test ovate to auriculate in outline, biconvex with excavated ventral umbilical region, trochospiral, periphery very gently lobulate and well rounded. Chambers 8 in outer whorl, gently inflated, increasing fairly rapidly but not so much in breadth as added, with internal partition producing subglobular chamberlets rimming the umbilicus only, none on dorsal side. Sutures distinct, gently depressed, slightly curved and nearly radial. Aperture a large irregular umbilical opening, almost transverse to test axis, with supplementary gentle fold running up apertural face.

Remarks: This species is distinguished from most related forms by the presence of chamberlets on the ventral side alone, rather than on both sides. Cerobertina bartrumi Finlay is more elongate, and the aperture is elongate in the same direction as the test axis.

Subfamily ROBERTININAE Reuss, 1850
 Genus Robertinoides Höglund, 1947

Robertinoides bradyi (Cushman and Parker)

Robertina bradyi CUSHMAN AND PARKER, 1936, p. 99, pl. 16, fig. 9.

Robertinoides charlottensis (Cushman). HERMELIN AND SCOTT, 1985, p. 216, pl. 6, figs. 11,12.

Test elongate, twice as long as broad, base bluntly pointed, apertural end broadly rounded. Chambers added in pairs, oblique to test axis, 4 in final whorl, slightly inflated. Sutures distinct, slightly depressed, limbate. Aperture an elongate, straight to slightly curved slit across middle of apertural face, parallel or at slight angle to axis of test. Supplementary aperture along basal suture of final chamber, bordered by variably placed flap with or without extensions of corners to connect

with previous whorls. Small triangular supplementary aperture also exists on opposite side of test between final and preceeding pairs of chambers.

Remarks: Only three pairs of chambers are seen in apertural or ventral view in contact with the final pair of chambers, and the chambers in dorsal view are as broad as high. Both of these characteristics serve to distinguish this species from Robertina tasmanica Parr and R. weisneri Parr. The chambers in R. translucens Cushman and Parker are much too strongly embracing, and Cassidulina charlottensis Cushman has a strongly indented outline, which is not seen in the illustrated specimen of Hermelin and Scott.

Suborder ROTALIINA Delage and Hérouard, 1896

Superfamily BOLIVINACEA Glaessner, 1937

Family BOLIVINIDAE Glaessner, 1937

Genus Bolivina d'Orbigny, 1839

Bolivina compacta Sidebottom
(Plate 3, Figures 11,12)

Bolivina robusta Brady var. compacta SIDEBOTTOM, 1905, p. 15, pl. 3, fig. 7.

Bolivina compacta Sidebottom. CUSHMAN, 1921, p. 137, pl. 26, fig. 7.---CUSHMAN, 1942, p. 20, pl. 7, figs. 2,3.

Test elongate, biserial, compressed, periphery rounded, base bluntly rounded to subacute. Chambers in 6 or more pairs, only slightly inflated, with overhanging retral lobes, slightly broader than high throughout. Sutures very gently depressed, essentially straight. Surface rough, with large pores sunk into pits. Aperture a narrow interiomarginal arch or slit, with tooth.

Remarks: The closely similar Textularia variabilis Williamson is more elongate, with more strongly inflated chambers and a distinctly lobulate periphery throughout, and the chambers are as high as broad for several pairs.

Bolivina dilatata Reuss
(Plate 1, Figures 1,2)

Bolivina dilatata REUSS, 1850, p. 381, pl. 48, fig. 15.---CUSHMAN, 1911, p. 33, fig. 54.---CUSHMAN, 1921, p. 128, pl. 26, fig. 6.

Brizalina spathulata (Williamson). ?WESTON, 1985, pl. 1, fig. 2.

Test elongate, biserial, tapering, periphery entire, acute, base rounded. Chambers numerous, low and broad, curved. Sutures initially limbate, later gently depressed and non-limbate. Basal margins of chambers with reentrants and retral lobes, particularly near median line of test. Surface smooth. Aperture a high interiomarginal slit, with tooth.

Remarks: Textularia variabilis Williamson var. spathulata Williamson is much more strongly compressed and broad, with very broad, more strongly curved chambers which are only slightly inflated, if at all. The assignment of Weston's figured specimen to the present species is tentative, due to the absence of any description or apertural view to assess the degree of test compression.

Bolivina pseudoplicata Heron-Allen and Earland

Bolivina pseudo-plicata HERON-ALLEN AND EARLAND, 1930, p. 81, pl. 3, figs. 36-40.

NOT Bolivina pseudoplicata (Heron-Allen and Earland). COLE, 1981, p. 87, pl. 10, fig. 3.---HERMELIN AND SCOTT, 1985, p. 203, pl. 2, fig. 16.

Test elongate, biserial, tapering rather gradually, periphery very slightly lobulate, often somewhat acute. Chambers broader than high. Test coarsely punctate, roughly finished, with raised irregular ridges running down length of test, one on each series of chambers, and bases of chambers gently excavated. Resultant cross section is distinctive, a compressed hexagon with concave faces. Aperture an interiomarginal arch, with tooth.

Remarks: The form referred to this species by Cole, and by Hermelin and Scott, is actually Abditodentrix pseudothalmanni. A more complete discussion is given in the remarks section for that species.

Bolivina robusta Brady

Bolivina robusta BRADY, 1881, p. 57.---BRADY, 1884, pl. 53, figs. 7-9.---CUSHMAN, 1911, p. 36, figs. 59,60.---CUSHMAN, 1942, p. 17, pl. 6, fig. 2.---BARKER, 1960, p. 108, pl. 53, figs. 7-9.

Test elongate, biserial, narrowly to broadly ovate or rhomboid in outline,

greatest breadth $\frac{2}{3}$ of way from base, which is rounded and may have single long, stout spine. Strongly compressed, periphery acute, almost entire. Chambers low, broad, strongly curved and overhanging on periphery, basal margins with lobes and reentrants. Sutures gently depressed. Aperture a high, narrow interiomarginal arch, with tooth.

Remarks: Bolivina goesii Cushman is also rhomboid with arched chambers, but the base is acute, and the chambers have a single large retral projection near the test axis.

Bolivina semilineata (Belford)

Brizalina semilineata BELFORD, 1966, p. 35, pl. 2, figs. 13-16.

Test elongate, biserial, about 3 times as long as broad, tapering very little especially in later stages, base rounded, periphery initially acute and very finely carinate, later gently angled to rounded, without keel. Chambers initially broader than high, later of comparable height, increasingly but never strongly inflated as added, with single prominent acute retral lobe at base of each chamber where it meets suture between 2 previous chambers. Sutures oblique, initially limbate and essentially flush, later finely limbate and gently depressed. Wall with over 12 fine longitudinal costae evenly distributed and continuous across all but final pair of chambers and upper part of penultimate pair. Aperture a long narrow interiomarginal slit or arch, with very slight lip and well developed toothplate.

Remarks: The type description specifies 4 to 8 costae, while one of the type figures shows at least 11. This species is distinguished by the change from carinate to rounded periphery, and the fine numerous costae which do not run the length of the test. Bolivina striatula Cushman is initially rounded and later angled at the margins, and the chambers are more quadrate in outline. Brizalina semicarinata Belford has a wider keel that is restricted to the lower half of the test, but is otherwise very similar.

Bolivina tuberosa (Belford)

Brizalina tuberosa RELFORD, 1966, p. 41, pl. 3, figs. 5-7.

Test elongate, biserial, $1\frac{1}{2}$ to $1\frac{3}{4}$ times as long as broad, tapering fairly rapidly from narrowly rounded base, periphery highly irregular. Chambers low and broad, inflated, with distinct retral lobes in less heavily ornamented specimens, increasing fairly rapidly in size as added. Sutures distinct, especially in later stages, depressed and oblique. Wall very rugose, with raised tubules surrounding pores, often with lateral margins of chambers as strongly produced tubules. Aperture interiomarginal, a small arch with tooth.

Remarks: The very rough surface, oblique inflated chambers, and the tubules produced particularly at the margins are distinctive.

Bolivina sp. A

Test elongate, biserial, somewhat kite-shaped, greatest breadth near top, $2\frac{1}{2}$ times as long as broad, base narrowly rounded, periphery acute and carinate to costate at base. Chambers 7 pairs or more, low, broad, slightly inflated, increasingly oblique as added, marginal angles increasingly curved basalward. Sutures distinct, limbate, depressed or slightly excavated at lower margin of succeeding chambers. Wall with numerous fine longitudinal costae, most noticeable near periphery. Aperture interiomarginal, a narrow arch with tooth.

Remarks: This species looks somewhat like a costate version of B. robusta, although it is more kite-shaped than ovate.

Bolivina sp. B

Test elongate, biserial, about twice as long as broad, tapering quite rapidly and increasing quite rapidly in thickness from rounded base, periphery lobulate and rounded. Chambers inflated, at least $1\frac{1}{2}$ times as broad as high, oblique, with several strong retral lobes and corresponding reentrants. Sutures distinct, depressed, oblique and interrupted by retral lobes. Wall coarsely perforate or pitted. Aperture a large interiomarginal arch, tooth missing from specimen.

Remarks: The rapid increase in test thickness as well as width, and the heavy

retral lobes on strongly inflated chambers, are diagnostic.

Bolivina sp. C

Test elongate, biserial, compressed, over 3 times as long as broad and parallel-sided after initial rapid taper, base rounded, periphery angled but narrowly rounded, very slightly undulose rather than lobulate. Chambers almost twice as broad as high, slightly curved and oblique, upper surfaces convex, with distinct angle near base, below which surface is excavated, and with few mild retral lobes. Sutures distinct, depressed, curved and oblique. Upper chamber surfaces imperforate, lower surfaces and angles perforate. Aperture an interiomarginal arch with toothplate and lip.

Remarks: Bolivina ordinaria Phleger and Parker tapers much more strongly, and the sutures are not apparently depressed, nor is there an uneven pore distribution. Textularia variabilis Williamson var. spathulata Williamson tapers markedly, and is very strongly compressed with acute margins.

Genus **Brizalina** O.G. Costa, 1856

Brizalina abbreviata (Heron-Allen and Earland)
(Plate 2, Figures 4,5)

Bolivina limbata Brady var. abbreviata HERON-ALLEN AND EARLAND, 1924, p. 622, pl. 36, figs. 25-27.

Bolivina abbreviata Heron-Allen and Earland. CUSHMAN, 1942, p. 33, pl. 9, fig. 5.

Brizalina lowmani (Phleger and Parker). POAG, 1981, p. 46, pl. 25, fig. 3; pl. 26, fig. 3.

Test elongate, biserial, early portion increasing rapidly in width, thereafter nearly parallel-sided, base rounded, periphery rounded, not in the least acute. In adult 8 or more pairs of chambers; in initial stages chambers broader than high, later almost as high as broad and alternating in inflated adult stage. Sutures heavily limbate, flush and gently curved to straight in juvenile portion, later straight and depressed. Early portion heavily calcified and perforations reduced, all resulting in marked changes in appearance, thickness, and breadth of test, as well as a change

from entire to lobulate periphery. Aperture a fairly large interiomarginal arch, with tooth.

Remarks: Poag referred this form to Bolivina lowmani Phleger and Parker, which has a subacute to subrounded base, and non-limbate sutures which are explicitly depressed, never flush. The change in appearance of the test along its length is very distinctive.

Brizalina bevrichi (Reuss)
(Plate 4, Figures 1,2)

Bolivina bevrichi REUSS, 1851a, p. 83, pl. 6, fig. 51.

NOT Bolivina bevrichi Reuss. CUSHMAN, 1911, p. 34, fig. 56.

Bolivina pygmaea Brady. HERMELIN AND SCOTT, 1985, p. 204, pl. 2, fig. 15.---
WARD AND WEBB, 1986, p. 190, pl. 4, figs. 6,7.

Test elongate, biserial, tapering, base narrowly to broadly rounded. Chambers numerous, strongly inflated, broader than high where overlapped, though final chambers occasionally of comparable height and breadth. Periphery rounded except for chamber margins which are acute, produced as retrally directed spines. Aperture a narrow interiomarginal arch, with tooth.

Remarks: Bolivina bradyi Asano is parallel-sided in the adult, with chambers much higher than broad, the last 2 pairs occupying at least 1/2 the test length. Thus Barker's assignment of Brady (1884), pl. 53, fig. 1 to that species was correct, while Cushman (1911) had assigned them to the present species. Bolivina pygmaea Brady is much more strongly compressed, and the margins are directed at an angle subparallel to the sutures, with a more strongly serrate outline as a result.

Brizalina ligularia (Schwager)

Bolivina ligularia SCHWAGER, 1866, p. 255, pl. 7, fig. 102.---CUSHMAN, 1942, p.34, pl. 9, figs. 6,7.

Test elongate, biserial, initially increasing rapidly in width, thereafter essentially parallel-sided, base narrowly rounded to subacute, periphery rounded and gently lobulate throughout. Chambers slightly inflated, broader than high but

becoming fairly well arched and overlapping. Sutures depressed, not limbate. Aperture an interiomarginal arch, with tooth.

Remarks: Brizalina abbreviata has strongly limbate early sutures, and Bolivina silvestrina Cushman is much more elongate and slender than the present species.

Brizalina nitida (Brady)

Bolivina laevigata (non Karrer). BRADY, 1881, p. 57.

Bolivina nitida BRADY, 1884, p. 420, pl. 52, fig. 30.---BARKER, 1960, p. 108, pl. 52, fig. 30.

Test elongate biserial, subpalmate in outline, strongly compressed, about twice as long as broad, greatest breadth on oblique line running from midpoint of side with penultimate chamber up to 1/4 distance from top on final chamber; periphery rather irregular in outline, well rounded, consisting of very thick deposits beyond chamber proper, base rounded. Chambers completely uninflated, low, twice as broad as high and very strongly oblique (over 45° to test axis) and overlapping, increasing quite rapidly in size as added. Sutures distinct, flush, heavily limbate. Aperture a very large, high and fairly broad arch, distinctly oblique to plane of biseriality.

Remarks: The heavy calcification of the periphery and sutures, low broad oblique chambers, and large oblique aperture are distinctive. The aperture seems to suggest something other than Brizalina, but the single specimen has at least the top two chambers broken away, so the aperture is incompletely known.

Brizalina oceanica (Cushman)

Bolivina oceanica CUSHMAN, 1933a, p. 81, pl. 8, fig. 10.---CUSHMAN, 1942, p. 24, pl. 7, fig. 4.

Test small, elongate, increasing rapidly in width for first four or so pairs of chambers, thereafter nearly parallel-sided, base nearly acute. Chambers almost twice as broad as high, very uniform, not arched, increasing slowly in size as added. Periphery narrowly rounded and barely lobulate, sutures only slightly depressed. Surface smooth. Aperture interiomarginal, centered, a small arch.

Remarks: The simplicity of this species is distinctive.

Brizalina pseudopunctata (Höglund)

Bolivina pseudopunctata HÖGLUND, 1947, p. 273; p. 268, t.f. 280,281; p. 269, t.f. 287, pl. 24, fig. 5; pl. 32, figs. 23,24.---HERMELIN AND SCOTT, 1985, p. 203, pl. 2, fig. 18.---WARD AND WEBB, 1986, p. 190, pl. 4, fig. 5; pl. 9, fig. 6.

Brizalina cf. **B. pseudopunctata** (Höglund). ?MURRAY, 1971, p. 109, pl. 44, figs. 1-6.

Bolivina cf. **B. pseudopunctata** Höglund. LAGOE, 1977, p. 126, pl. 3, figs. 25,26.

Test elongate, biserial, gradually tapering, slightly compressed, ovate in section, periphery rounded, base rounded in megalospheric form. Chambers slightly inflated, initially broader than high, later higher than broad. Sutures gently depressed, outline slightly lobulate. Wall finely perforate on lower 1/2 to 2/3 of chamber, upper chamber surface more finely perforate or imperforate. Aperture an interiomarginal arch, with tooth.

Remarks: There are many similar species that need to be distinguished from the present one. **Bolivina seminuda** Cushman is finely perforate on the upper chamber surfaces and coarsely perforate on the lower surfaces, and **B. silvestrina** Cushman is coarsely perforate throughout, and the chamber form does not change through the ontogeny. **Bolivina punctata** d'Orbigny is slightly carinate or acute, especially in the early stages, and **B. carlandi** Parr has too few chambers that are also relatively too high. Murray's specimens differed from the typical in being finely striate or costate on the lower portion of the test.

Brizalina pusilla (Schwager)
(Plate 6, Figures 9,10)

Bolivina pusilla SCHWAGER, 1866, p. 254, pl. 7, fig. 101.---CUSHMAN, 1911, p. 41, fig. 67.---PFLUM AND FRERICHs, 1976, pl. 1, fig. 7.---BOLTOVSKOY, 1978, p. 152, pl. 1, figs. 16-18.

Loxostoma karrerianum (H. B. Brady) var. **carinatum** (Millett). CUSHMAN, 1942, p. 38, pl. 10, fig. 7.

Test elongate, biserial, slender and gradually tapering, upper margin obtusely angled, base rounded and furnished with apical spine, margins carinate becoming costate, or in some cases becoming smooth, rounded, especially in fully adult stage. Chambers in 8 or more pairs, low and broad, slightly arcuate and tapering to

margins, very slightly inflated and overlapping. Sutures distinct, limbate, essentially straight, gently depressed. All but final pair or final pair plus upper 1/2 to 2/3 of penultimate pair of chambers covered in fine, low costae that fuse at base to encircle proloculus, may also have peripheral costae that run into marginal carinae. Aperture a high interiomarginal arch, with tooth.

Remarks: Brizalina aenariensis Costa and Brizalina subaenariensis are distinguished by having a median pair of full longitudinal costae, the latter species also having a few, short supplementary ones. Bolivina striatula Cushman and related subspecies are initially rounded, and later acute at the periphery. Bolivina karreriana var. carinata Millett has a peripheral margin that is acute or carinate even across the top of the test, is costate for the entire length of the test, and lacks a basal spine. It should be noted that the type figure for the present species shows no spine.

Brizalina subaenariensis (Cushman)

Bolivina aenariensis (Costa). CUSHMAN, 1911, p. 44, fig. 71.

Bolivina subaenariensis CUSHMAN, 1922a, p. 46, pl. 7, fig. 6.

Bolivina subaenariensis Cushman var. BARKER, 1960, p. 110, pl. 53, figs. 10, 11.

Brizalina subaenariensis (Cushman). MURRAY, 1971, p. 111, pl. 45, figs. 1-7.---
WESTON, 1985, pl. 1, fig. 3.

Test elongate, biserial, tapering gradually, base rounded and without spine, apertural end broadly rounded. Periphery entire, bluntly carinate, although the chambers themselves are somewhat inflated and periphery would be lobulate without carina. Chambers initially broader than high, later about as high as broad. Surface with 2 long, low costae that run much of test length in median area, with numerous supplementary costae of much lesser length and prominence. Aperture an interiomarginal arch, with tooth.

Remarks: Brizalina aenariensis Costa has but two median longitudinal costae, and Bolivina striatula Cushman has a rounded to angled, but not carinate,

periphery. In addition this latter species has an intermediate stage that is reticulate rather than costate. The pattern of costae, chamber shape, and periphery distinguish the present species from Brizalina pusilla.

Brizalina subspinescens (Cushman)

Bolivina subspinescens CUSHMAN, 1922a, p. 48, pl. 7, fig. 5.---BARKER, 1960, p. 108, pl. 52, figs. 24,25.---BOLTOVSKOY, 1978, p. 154, pl. 1, fig. 29.---HERMELIN AND SCOTT, 1985, p. 204, pl. 3, fig. 2.

Test elongate, biserial, may be twisted on axis, base rounded and with apical spine, apertural end somewhat angular. Periphery lobulate rounded. Chambers almost as high as broad, strongly inflated, slightly angled near lower margin, surface below angle covered in short fine spines or test surface granular. Sutures depressed, straight and oblique. Aperture a fairly large interiomarginal arch, with tooth.

Remarks: Hermelin and Scott also recorded the twisted nature of the test and the presence of an apical spine. Bolivina spinescens Cushman has a less strongly tapering, almost parallel-sided test, and the chambers are not as strongly angled.

Brizalina sp. A

Test very elongate, biserial, about 4 times as long as broad and barely tapering, base rounded, periphery narrowly rounded and completely non-lobulate, with distinct imperforate carina. Chambers uninflated, oblique, slightly curved and about 1 1/2 to 2 times as broad as high. Sutures distinct, limbate, flush, oblique and strongly curved basalward at the median line. Wall smooth, polished, perforate. Aperture a narrow interiomarginal arch with toothplate.

Remarks: Bolivina vadeszens Cushman has the same peculiar downward curve to the inner end of the sutures, and much the same appearance, but is shorter and has no apparent imperforate carina. Bolivina lanceolata Parker is keeled only latterly, and has a few fine costae on the lower part of the test. Parker claimed B. punctata d'Orbigny was distinguished from her species in lacking costae, and in being keeled in the early, but not adult stage. However, the type figure of this latter

species shows it to be lobulate with depressed sutures, and completely distinct from the present one.

Brizalina sp. B

Test large, elongate, biserial, compressed, tapering very slowly, almost 4 times as long as broad, base broadly rounded, periphery lobulate and initially rounded, later angled. Chambers 8 pairs or more, inflated but very strongly appressed, producing an oblique ridge near base of chamber, below which surface is excavated. Sutures distinct, depressed, oblique. Wall coarsely pitted, ornamented by these oblique chamber ridges which fuse in the median area to produce a contiguous diamond or zig-zag pattern of raised rough ridges, confined to the median area. Aperture a compressed interiomarginal arch, with tooth.

Remarks: The chamber shape with basal ridges fusing to form a zig-zag median pattern is distinctive.

Brizalina sp. C

Test elongate, biserial, compressed and tapering, nearly twice as long as broad, base narrowly rounded, periphery barely lobulate and initially rounded, later truncate due to the presence of at least a pair of closely spaced keels, which are severely broken. Chambers inflated, subglobular, broader than high, oblique. Sutures distinct, depressed, oblique. Aperture unknown due to the broken upper surface and ragged keels.

Remarks: This species differs from Bolivina hankeniana Brady which has a single keel and often a few fine longitudinal costae.

Superfamily LOXOSTOMATACEA Loeblich and Tappan, 1962

Family BOLIVINELLIDAE Hayward, 1980

Genus Bolivinella Cushman, 1927

Bolivinella folia (Parker and Jones)

Testularia folium PARKER AND JONES, 1865, pp. 370,420, pl. 18, fig. 19.---
CUSHMAN, 1911, p. 19, figs. 31-33.

Bolivinella folia (Parker and Jones). CUSHMAN, 1942, p. 3, pl. 2, figs. 1,4,6, ?not

2,3---LOEBLICH AND TAPPAN, 1964, p. 526, fig. 411:4.

Bolivinella folium (Parker and Jones). BARKER, 1960, p. 86, pl. 42, figs. 1,2.

Test biserial, flaring to flabelliform, outline often gently convex as opposed to much more rapidly flaring, strongly compressed, base narrowly rounded. Chambers low, broad, curved to sigmoid, increasing more rapidly in breadth than height as added. Lateral margins produced as spines, and occasionally short broad spines present on sides of test as well as single stout basal spine. Sutures limbate, raised. Aperture a very fine, almost obscure, interiomarginal slit.

Remarks: This species is distinguished from the much more rapidly flaring Bolivinella elegans Parr by the present species's outline, which has essentially convex sides. Bolivinella folia var. ornata Cushman has a much more convex apertural end, purely convex as opposed to occasionally sigmoid sutures, which are also raised into fine beading, and sides that are convex and angled approximately 70° to each other.

Superfamily BOLIVINITACEA Cushman, 1927

Family BOLIVINITIDAE Cushman, 1927

Genus Abditodentrix Patterson, 1985

Abditodentrix pseudothalmanni (Boltovskoy and de Kahn)

Bolivina cf. B. thalmanni Renz. BOLTOVSKOY, 1978, p. 154, pl. 1, figs. 24-27.

Bolivina pseudoplicata Heron-Allen and Earland. COLE, 1981, p. 87, pl. 10, fig. 3---HEPMELIN AND SCOTT, 1985, p. 203, pl. 2, fig. 16.

Bolivinita pseudothalmanni BOLTOVSKOY AND de KAHN, 1981, p. 44, pl. 1, figs. 1-5.

Abditodentrix asketocomptella PATTERSON, 1985, p. 140, pl. 1, figs. 1-9.

Test elongate, biserial, base rounded, apertural end asymmetrically angled. Periphery lobulate, flattened to truncate with thin carinae, producing quadrate transverse section. Chambers twice as broad as high. Sutures angled at approximately 45° to test axis, sometimes incised, and marked by distinctive pattern of raised ornament. Upper chamber surfaces as formed are rounded to mildly

carinate, becoming increasingly carinate as subsequent chambers are added, so that penultimate chamber and test margin are distinctly truncate and carinate, more so than final chamber. The resultant raised suture at the base of the pre-penultimate chamber extends halfway across the penultimate chamber, while those of preceding chambers may completely cross the immediately succeeding chamber, producing a complex diamond-shaped pattern that is more or less clearly developed. Aperture a small interiomarginal arch, with obscure tooth.

Remarks: The incised nature of the sutures is very obscure, due mostly to the raised ornament, but is evident in Patterson's figures. The inconsistent development of the marginal carinae prevents assignment to Bolivinita. Bolivina thalmani has simply a raised zigzag suture pattern in the axial region of the test, while Bolivina pseudoplicata has a compressed hexagonal cross-section, irregular ridges running down both series of chambers, and excavated lower chamber surfaces. On the basis of these features, the specimens of Boltovskoy (1978), Cole (1981), and Hermelin and Scott (1985) have been referred to the present species.

Genus Bolivinita Cushman, 1927

Bolivinita quadrilatera (Schwager)

Textularia quadrilatera SCHWAGER, 1866, p. 253, pl. 7, fig. 103.

Textularia quadrilatera Schwager. CUSHMAN, 1911, p. 24, figs. 42-44.---CUSHMAN, 1921, p. 125, pl. 23, fig. 2.

Bolivinita quadrilatera (Schwager). CUSHMAN, 1942, p. 2, pl. 1, figs. 1-4.---BARKER, 1960, p. 86, pl. 42, figs. 8-12.

Test elongate, biserial, tapering not too rapidly, quadrate in section, angles continuously carinate and outline slightly lobulate, base somewhat rounded. Chambers nearly as high as broad, very gently inflated. Sutures limbate, raised, angled at 45° to axis of test. Aperture a large interiomarginal arch, with well developed toothplate folded downward from apex of aperture, not projecting.

Remarks: The quadrate section, continuous marginal carinae, and raised limbate sutures distinguish this species. The single specimen of the current study

lacked apical spines.

Bolivinita rhomboidalis (Millett)

Textularia rhomboidalis MILLETT, 1899, p. 559, pl. 7, fig. 4.---CUSHMAN, 1911, p. 16, fig. 25.

Bolivina rhomboidalis (Millett). CUSHMAN, 1942, p. 19, pl. 6, figs. 7,8.

Test biserial, compressed, flaring rapidly from narrowly rounded base. Cross-section quadrate but distinctly rhomboid, not rectangular, with carinate margins, nevertheless outline still lobulate. Chambers oblique, broader than high, gently inflated. Sutures excavated, quite strongly arched. Aperture obscure on account of broken specimens.

Remarks: The rhomboid section is distinctive.

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family CASSIDULINIDAE d'Orbigny, 1839

Subfamily CASSIDULININAE d'Orbigny, 1839

Genus Cassidulina d'Orbigny, 1826

Cassidulina carinata Silvestri
(Plate 4, Figures 10,11)

Cassidulina laevigata d'Orbigny var. carinata SILVESTRI, 1896, p. 104, pl. 2, fig. 10.

Cassidulina laevigata d'Orbigny. CUSHMAN, 1921, p. 171, pl. 31, fig. 7.---BELFORD, 1966, p. 138, t.f. 16:1,2, pl. 24, figs. 1-4.

NOT Cassidulina laevigata d'Orbigny var. carinata CUSHMAN, 1922a, p. 124, pl. 25, figs. 6,7.

Cassidulina carinata Silvestri. BARKER, 1960, p. 110, pl. 54, figs. 2,3.---TODD, 1965, p. 40, pl. 17, fig. 4.---MURRAY, 1971, p. 187, pl. 78, figs. 1-5.---MEAD, 1985, p. 232, pl. 3, figs. 1-3.

Cassidulina laevigata carinata Silvestri. INGLE et al, 1980, p. 131, pl. 6, figs. 5-8.

Test biserial enrolled, lenticular, periphery lobulate and carinate. Chambers 4 pairs in outer whorl, slightly curved. Sutures very gently depressed. Aperture an elongate narrow slit parallel to periphery, bordered at the base by a thin lip or flap.

Remarks: The periphery of this species is lobulate, rather than entire as in C. laevigata carinata Cushman (renamed C. neocarinata by Thalmann in a paper not

cited herein, because of the priority of Silvestri's species). The carinate periphery serves to distinguish the present species from C. laevigata, and accounts for the transfer herein of both Cushman's (1921) and Belford's specimens. Cassidulina teretis has umbonal bosses, 5 to 6 pairs of chambers in the outer whorl, and flush sutures.

Cassidulina? sp. cf. C. curvata Phleger and Parker

Cassidulina curvata PHLEGER AND PARKER, 1951, p. 26, pl. 14, fig. 5.

Islandiella curvata (Phleger and Parker). ?POAG, 1981, p. 69, pl. 17, fig. 1; pl. 18, fig. 1.

Test lenticular, biserial enrolled, periphery acute, with keel. Chambers 4 or so pairs, slightly curved especially at inner extremities. Sutures curved, limbate, flush, obscured at umbilicus by thick umbo, which hides all detail. Aperture indeterminate, appears to be elongate parallel to periphery.

Remarks: The single specimen has the chamber surfaces of the outer whorl dissolved or broken away, leaving just the isolated sutures and a few chamber fragments preserved. The periphery is definitely acute and carinate, and is likely non-lobulate, based on a reconstruction. The remnant of an aperture in the inner whorl is long and narrow, but no detail of the tooth structure is evident. The specimen described and illustrated by Poag definitely belongs in Islandiella on the basis of its aperture, but unfortunately the type description of this species is not explicit on details of the aperture, nor is anything apparent in the rather murky type figure. The generic assignment of this species is therefore uncertain. Other similar species have shorter chambers which reach across the periphery almost all the way to the opposite umbilicus, such as C. norcrossi Cushman and vars., or else have depressed sutures, particularly C. nakamurai Uchio.

Cassidulina laevigata d'Orbigny

Cassidulina laevigata d'ORBIGNY, 1826, p. 282, pl. 15, figs. 4,5.---BOLTOVSKOY, 1978, p. 155, pl. 2, fig. 27.

NOT Cassidulina laevigata d'Orbigny. CUSHMAN, 1911, p. 96, fig. 150.---

CUSHMAN, 1921, p. 171, pl. 31, fig. 7.

Test biserial enrolled, compressed, periphery acute, lobulate. Chambers 2 to 2 1/2 times as broad as high, straight to arcuate, 3 to 4 pairs in outer whorl. Sutures distinctly depressed, may be limbate. Wall coarsely perforate. Aperture a short slit subparallel to periphery.

Remarks: The absence of a peripheral keel distinguishes this species from C. carinata. The specimens of Cushman (1911, 1921) are characterized by a carinate periphery, and those of Cushman (1921) have been referred herein to this latter species. The presence of umbos and typically greater number of chambers serve to distinguish C. teretis.

Cassidulina reflexa Galloway and Wissler

Cassidulina reflexa GALLOWAY AND WISSLER, 1927, p. 80, pl. 12, fig. 13.---
PHLEGER et al., 1953, p. 45, pl. 10, figs. 6,7.

Test biserial enrolled, lenticular, periphery slightly lobulate and subacute, non-carinate. Chambers arched, narrow, bluntly hooked at inner ends, 6 pairs in outer whorl. Sutures limbate, nearly flush, test with thick umbos obscuring detail. Aperture a short slit in barely produced apertural face.

Remarks: The similar species C. limbata Cushman and Hughes has a carinate periphery and the chambers are constricted in the middle, while C. curvatura Phleger and Parker has an acute periphery with a narrow, thickened keel in the adult, and lacks umbos.

Cassidulina reniforme Nørvang

Cassidulina crassa d'Orbigny var. reniforme NØRVANG, 1945, p. 41, t.f. 6e-h.

Cassidulina reniforme Nørvang. COLE, 1981, p. 106, pl. 14, fig. 2.

Test auriculate and compressed, biserial enrolled, non-lobulate with rounded periphery. Chambers about 4 pairs in outer whorl, uninflated, increasing rapidly in size as added and extending well past preceding chamber, producing rather large apertural face. Sutures distinct, flush, nearly radial and gently curved. Aperture

large, a fairly high arch with very large projecting basal flap at posterior margin.

Remarks: The compressed test with flush sutures and large posterior apertural flap is distinctive.

Cassidulina teretis Tappan
(Plate 5, Figures 4,5)

Cassidulina teretis TAPPAN, 1951, p. 7, pl. 1, fig. 30.---BARKER, 1960, p. 110, pl. 54, fig. 1.

Test biserial enrolled, compressed, periphery only slightly lobulate, acute and imperforate, but not carinate. Chambers ovate, not curved, as many as 8 pairs in outer whorl, separated rather than simply covered in the center of test by circular umbos of clear shell material. Sutures essentially flush. Aperture a narrow, elongate basal slit.

Remarks: This species is distinguished by its ovate chambers, distinct umbos, and acute but non-carinate periphery. The specimens assigned to C. laevigata by Boltovskoy (1978) may belong to the present species, but the nature of the periphery and the presence or absence of umbos may not be determined from his SEM illustration.

Cassidulina sp. A

Test thick, lenticular, biserial enrolled, periphery entire and well rounded. Chambers very obscure, as are the sutures, probably 3 pairs per whorl, fairly broad and uninflated. Sutures nearly radial, flush. Wall rather rough looking, coarsely pitted or perforate, obscuring all detail. Aperture a very small, obscure interiomarginal arch or loop.

Remarks: The only form known to this author that is also flush and rather featureless, with a rounded rather than angular periphery, is C. setanaensis Asano and Nakamura, which has 6 pairs of chambers and an elongate slit aperture parallel to the periphery of the penultimate chamber.

Genus Cassidulinoides Cushman, 1927

Cassidulinoides bifrons Drooger

Cassidulinoides bifrons DROOGER, 1953, p. 140, pl. 24, figs. 14,15.

Cassidulinoides tenuis Phleger and Parker. TODD, 1965, p. 46, pl. 17, fig. 9.

Test ovate, biserial enrolled becoming uncoiled, gently compressed, periphery and both ends rounded. Chambers completely uninflated, much broader than high, increasing very rapidly in size as added to produce uncoiled appearance. Sutures distinct, oblique, flush. Wall smooth. Aperture an interiomarginal loop, open at the base, with an anterior lip and posterior lip and tooth.

Remarks: This species is distinguished by its ovate outline, compressed form, and flush oblique sutures. Todd's illustrated specimen, which is compressed and neither arcuate nor tapering in outline, is not referable to C. tenuis.

Cassidulinoides bradyi (Norman)

Cassidulina bradyi NORMAN, in BRADY, 1881, p. 59.---BRADY, 1884, pl. 54, figs. 6-9, not 10.---CUSHMAN, 1911, p. 99, not fig. 153.

Cassidulinoides bradyi (Norman). BARKER, 1960, p. 112, pl. 54, figs. 6-9.

NOT Cassidulinoides bradyi (Norman). MURRAY, 1971, p. 113, pl. 46, figs. 4-7.

Test elongate, compressed, periphery narrowly rounded. Chambers initially biserial enrolled, later uncoiling, this latter stage consisting of some 3 pairs of chambers, initial coil projecting well beyond uncoiled stage; chambers broader than high, very gently inflated. Sutures gently depressed, not markedly oblique to long axis of test. Aperture a loop at the inner margin of final chamber, with tooth and bordering lip.

Remarks: This species is distinguished from others of the genus by its compressed test with large projecting initial coil. Cushman (1911) illustrated a specimen which was not appreciably compressed, and its sutures were too strongly depressed. Murray's form has very strongly oblique sutures that reach back to the initial coil, and the chambers are relatively much broader than those of the present species.

Cassidulinoides parkerianus (Brady)

Cassidulina parkeriana BRADY, 1881, p. 59.---BRADY, 1884, pl. 54, figs. 11-16.---

CUSHMAN, 1911, p. 100, fig. 154.

Cassidulinoides parkerianus (Brady). BARKER, 1960, p. 112, pl. 54, figs. 11-16.---
WARD AND WEBB, 1986, p. 190, pl. 4, fig. 9; pl. 8, fig. 6.

Test elongate, not at all compressed, initially biserial enrolled, later uncoiled and essentially rectilinear, initial coil projecting slightly. Chambers strongly inflated, about as broad as high, steadily increasing in size as added to uncoiled portion. Sutures straight, depressed. Aperture at the inner margin, a fairly broad loop with tooth and bordering lip.

Remarks: This species is distinguished from most others by its inflated chambers and non-compressed test, and from Cassidulina crassa d'Orbigny var. porrecta Heron-Allen and Earland by this latter species's tendency to have produced rather than uncoiled chambers, and only slightly depressed sutures.

Cassidulinoides tenuis Phleger and Parker
(Plate 4, Figures 8,9)

Cassidulina bradyi Norman. CUSHMAN, 1911, fig. 153, not p. 99.

Cassidulinoides tenuis PHLEGER AND PARKER, 1951, p. 27, pl. 14, figs. 14-17.---
BOLTOVSKOY, 1978, p. 155, pl. 3, fig. 2.

NOT Cassidulinoides tenuis Phleger and Parker. TODD, 1965, p. 46, pl. 17, fig. 9.

Test elongate, nearly circular in section, gently arcuate and very slightly tapering, base rounded. Chambers biserial, somewhat broader than high, a bit wedge-shaped, and very gently inflated, initial coil not discernible as such. Sutures oblique, gently depressed. Aperture a compact interiomarginal loop with small tooth and bordering lip.

Remarks: The non-compressed, arcuate test without evident initial coil is distinctive. Cushman's (1911) description cannot be used for this form, although his illustrated specimen belongs in the present species. Todd's illustrated specimen has been referred herein to C. bifrons, and has already been discussed.

Cassidulinoides sp. A

Test elongate, tapering and arcuate, nearly circular in section, base narrowly

rounded. Chamber arrangement is perfect biserial, not twisted, showing slight tendency to enrollment in early stages; chambers somewhat inflated, about as broad as high, fairly strongly embracing such that final pair occupies nearly half of test length, increasing steadily but not too rapidly in size as added, so that test is not flaring. Sutures distinct but not much depressed. Aperture a small loop at the inner margin, with tooth and bordering lip.

Remarks: This form tapers much more rapidly than C. tenuis, and has a more narrowly rounded base. The only closely similar form is Virgulina cornuta Cushman, which is twisted biserial, has an extremely inflated final pair of chambers with a depressed suture at their base, and a much larger virguline aperture. The final pair of chambers occupies over half the test length in that species.

Genus Favocassidulina Loeblich and Tappan, 1957

Favocassidulina favus (Brady)

Pulvinulina favus BRADY, 1877, p. 535.---BRADY, 1884, pl. 104, figs. 12-16.

Favocassidulina favus (Brady). BARKER, 1960, p. 214, pl. 104, figs. 12-16.---
LOEBLICH AND TAPPAN, 1964, p. 738, fig. 604:3,4.---BOLTOVSKOY, 1978,
p. 160, pl. 4, fig. 20.---BURKE, 1981, pl. 3, figs. 3,4.---NOMURA, 1984, p. 93,
t.f. 1,2, pl. 1,2.

Test biserial enrolled, lenticular, periphery entire and subacute, except for margin of apertural face. Chambers numerous, much broader than high. Surface covered in coarse reticulations in an irregular honeycomb pattern, high thin partitions usually producing 5- or 6-sided spaces. Aperture an elongate slit with complex internal tooth structure, parallel to periphery.

Remarks: Nomura's study has some outstanding illustrations of the internal features of this distinctive species, particularly the tooth.

Favocassidulina nojimana (Kuwano)

Cassidulina nojimana KUWANO, 1954, p. 79, t.f. 1,2.

Test biserial enrolled, thick lenticular with subacute periphery which is essentially non-lobulate. Virtually entire surface covered with dense, raised,

irregular meandering reticular network which obscures most details. Chambers possibly 4 or more pairs in outer whorl, uninflated, exhibiting major discrepancy in size across periphery. Sutures limbate, flush, obscure. Aperture interiomarginal, parallel to periphery, evidently with lip, the whole rather obscured.

Remarks: The lenticular shape with non-acute periphery and irregular reticular mesh is distinguished from most cassiduline species, while the ornament is nothing like the rather neat polygonal type of E. favus.

Genus Globocassidulina Voloshinova, 1960

Globocassidulina decorata (Sidebottom)

Cassidulina decorata SIDEBOTTOM, 1910, p. 107, pl. 4, fig. 2.

Cassidulina subglobosa H. B. Brady var. ornata CUSHMAN, 1927a, p. 167, pl. 6, fig. 6.

Globocassidulina ornata (Cushman). BELFORD, 1966, p. 146, t.f. 16:9,10, pl. 24, figs. 19-21.

Globocassidulina decorata (Sidebottom). THOMAS, 1985, p. 676, pl. 7, fig. 5.

Test globular, biserial enrolled, few pairs of chambers per whorl, sutures limbate and essentially flush. Entire test, except for apertural face and rarely final chambers, covered in fine irregular reticulation that is typically elongate triangular rather than pentagonal or hexagonal. Aperture a short loop up apertural face, with lip on inner or anterior margin, and a thin, curved, plate-like flap on outer or posterior margin, distinctly discontinuous with basal margin and anterior lip.

Remarks: The Cushman (1927) and Belford references should likely be placed in synonymy with this species. The range of ornamentation of both species is embraced by the present forms, which look like an ornamented G. subglobosa. Cushman's species had one poor figure and no description of the tooth and lip structures. Cassidulina costatula Cushman has more chambers per whorl, a distinctly lobulate outline with depressed sutures, and a discontinuous ornament consisting of short, curved costae that do not uniformly cover the test surface.

Globocassidulina elegans (Sidebottom)

Cassidulina elegans SIDEBOTTOM, 1910, p. 106, pl. 4, fig. 1.---EARLAND, 1934, p. 137, pl. 6, figs. 15,16.

Cassidulina alternans YABE AND HANZAWA, 1925, p. 53, t.f. a,b.

NOT Cassidulina elegans Sidebottom. BOLTOVSKOY, 1978, p. 155, pl. 2, figs. 25,26.

Test biserial enrolled, subglobular, periphery broadly rounded in axial view. Chambers with anterior portion raised and somewhat angular, with distinct, depressed sutures, producing distinctive stepped or serrate outline when viewed laterally. Aperture a small, oblique curved loop, bordered by fine lips.

Remarks: The serrate outline is completely distinctive, and is lacking in Boltovskoy's specimens. The species of Yabe and Hanzawa is identical in all respects.

Globocassidulina minuta (Cushman)
(Plate 7, Figures 9,10)

Cassidulina crassa d'Orbigny. CUSHMAN, 1911, p. 97, fig. 151.---?BARKER, 1960, p. 110, pl. 54, figs. 4,5.

Cassidulina minuta CUSHMAN, 1933a, p. 92, pl. 10, fig. 3.---TODD, 1965, p. 43, pl. 17, fig. 3.---BOLTOVSKOY, 1978, p.155, pl. 2, fig. 29.

Test biserial enrolled, ovate and slightly lobulate in outline, somewhat compressed, periphery rounded at base and narrowly so at apertural end. Chambers very high, equant, few pairs in outer whorl, only slightly inflated and sutures only weakly depressed. Aperture a long, narrow interiomarginal slit, bordered above by fine lip, usually with a transverse dash or opening up the apertural face, also bordered by fine lip.

Remarks: There are many closely similar species. Cassidulina obtusa Williamson and C. crassa d'Orbigny have more strongly inflated chambers and are lobulate in outline, C. inflata LeRoy is thicker as well as broadly rounded at the apertural end, and C. delicata Cushman has a subacute periphery and entire outline, with a simple slit-like aperture lacking flaps and tooth.

Globocassidulina moluccensis (Germeraad)

Cassidulina subglobosa Brady. CUSHMAN, 1921, p. 171 (pars), pl. 32, fig. 2.

Cassidulina moluccensis GERMERAAD, 1946, p. 72, pl. 2, figs. 29-32.---TODD, 1965, p. 43, pl. 15, fig. 2.---BURKE, 1981, pl. 2, figs. 9,10.

Islandiella sp.?. TODD, 1965, p. 46, pl. 15, fig. 3.

Globocassidulina murrhyna (Schwager). BELFORD, 1966, p. 152, t.f. 17:11,12; t.f. 18:5, pl. 26, figs. 10-13.

Globocassidulina moluccensis (Germeraad). PFLUM AND FRERICHS, 1976, pl. 4, fig. 5.

Test biserial enrolled, teardrop-shaped, apertural end produced, periphery rounded. Very few chambers visible. Aperture a large teardrop or oval opening that harmonizes with direction of production of test; upper edge with margin infolded quite deeply into test, with lip, and inner or lower edge of aperture with lip or thin flap which may be quite wide.

Remarks: Globocassidulina subglobosa has more chambers in the outer whorl, and an aperture which cuts obliquely across the apertural face. In addition, its aperture is more restricted and "shallow" in appearance than that of G. moluccensis. Sphaeroidina murrhyna Schwager differs in having a comma-shaped aperture that is closed at the base, unlike Belford's specimens. The teardrop shape and large aperture are distinctive of the present species.

Globocassidulina oblonga (Reuss)

Cassidulina oblonga REUSS, 1850, p. 376, pl. 48, figs. 5,6.

Globocassidulina oblonga (Reuss). LOEBLICH AND TAPPAN, 1964, p. 738, fig. 604:7.---BELFORD, 1966, p. 150, t.f. 17:7,8, pl. 26, figs. 1-4.

Test biserial enrolled, exhibiting tendency to uncoil, compressed, almost teardrop-shaped in outline, periphery rounded. Chambers broader than high, slightly curved and only slightly inflated in final few pairs, 4 to 5 pairs in outer whorl. Chambers project across periphery as distinct small triangles. Sutures only slightly depressed in latter stages. Aperture an oblique loop with tooth plate on posterior or outer margin, at extreme angle to periphery.

Remarks: The genus Cassidulinoides uncoils to a much greater degree. The aperture in Cassidulina orientale Cushman is an elongate slit parallel to the

periphery, while the aperture of the present species has the shape and orientation of that in G. subglobosa.

Globocassidulina parva (Asano and Nakamura)

Cassidulina parva ASANO AND NAKAMURA, 1937, p. 148, pl. 13, fig. 5.

Islandiella sp. aff. I. subglobosa (Brady). POAG, 1981, p. 71, pl. 17, fig. 4; pl. 18, fig. 4.

Globocassidulina parva (Asano and Nakamura). NOMURA, 1983a, pl. 15, figs. 6-10.--
-NOMURA, 1983b, p. 41, t.f. 34,35, pl. 3, fig. 13.

Test subglobular, biserial enrolled, barely ovate in side view and very slightly compressed, periphery non-lobulate and broadly rounded. Chambers usually 3 pairs in outer whorl, rarely 4, almost as high as broad, not much inflated. Sutures distinct, radial, straight, of appreciable thickness and incised rather than depressed, as is the suture at base of apertural face. Aperture interiomarginal, tripartite, with broad vertical areal and anterior basal slits of subequal length, bordered behind and below by thin lip, and in front by triangular flap that has a rim on its posterior or vertical edge, but not on its basal one.

Remarks: The combination of tripartite aperture and incised sutures is diagnostic. Nomura (1983b) reported that the holotype was a juvenile, wherein the aperture consists solely of the vertical component, but that topotype material clearly demonstrated the acquisition of an increasingly lengthy basal component through the ontogeny. It is therefore not clear why G. subparva Nomura, in which the basal component is but 1/3 the length of the areal, is not regarded in the same manner and synonymized. Globocassidulina oriangulata Belford agrees well with respect to the aperture, but the sutures are flush rather than incised or even depressed. Asano and Nakamura regarded the difference between the present species and G. subglobosa as strictly one of sutural style, which may explain why Poag referred the present form to this latter species. It is clear, however, that both the sutures and aperture differ between these two species.

Globocassidulina sp. cf. G. pygmaea (Voloshinova)

Cassidulina pygmaea VOLOSHINOVA, 1952, p. 100, pl. 4, fig. 3.

Test subglobular, biserial enrolled, somewhat compressed, periphery gently lobulate and rounded. Chambers gently inflated, 3 pairs in outer whorl. Sutures slightly limbate, very gently depressed. Aperture an interiomarginal loop, running transverse to periphery and facing outward rather than to the inner face, with apertural face subhorizontal rather than subvertical as is more common in the genus.

Remarks: Voloshineva's form has 4 pairs of chambers, and is more strongly inflated than the current specimens. The identification is based primarily on the distinctive apertural style.

Globocassidulina rarilocula (Cushman)

(Plate 1, Figures 5,6;
Plate 2, Figures 6,7;
Plate 3, Figures 4,5)

Cassidulina rarilocula CUSHMAN, 1933a, p. 93, pl. 10, fig. 4.

Cassidulina subtumida Cushman. TODD, 1965, p. 45, pl. 16, figs. 6, ?5; not pl. 17, fig. 1.---?BOLTOVSKOY, 1978, p. 155, pl. 3, fig. 1.

Test biserial enrolled, nearly globular, very slightly compressed and periphery rounded. Chambers subglobular, inflated, in few whorls, and few chambers per whorl. Sutures straight, depressed. Aperture a subtriangular arch, aligned in direction of test length, bordered by fine lips, and with apical notch.

Remarks: Globocassidulina subglobosa is less strongly compressed, and has a narrower aperture that is strongly oblique to the test long axis. Although the aperture of G. rarilocula may, when constricted, superficially resemble that of G. minuta, the aperture of this latter species is primarily parallel to the inner margin, and the test is more strongly compressed. Cassidulina subtumida Cushman is somewhat compressed near the periphery, which is thus narrowly rounded, and has a cross-section which is not a simple oval shape. Todd placed the present species in synonymy with that one, but the present specimens do not support this. Boltovskoy did not provide an edge view, and so his illustrated specimen cannot be referred with certainty to the present species.

Globocassidulina subglobosa (Brady)
(Plate 7, Figures 1,2)

Cassidulina subglobosa BRADY, 1881, p. 60.---BRADY, 1884, pl. 54, fig. 17.---CUSHMAN, 1911, p. 98, fig. 152.---CUSHMAN, 1921, p. 171 (pars), not pl. 32, fig. 2.---BARKER, 1960, p. 112, pl. 54, fig. 17.---TODD, 1965, p. 45, pl. 16, fig. 7.---BURKE, 1981, pl. 2, fig. 11.

Globocassidulina subglobosa (Brady). BELFORD, 1966, p. 149, t.f. 17:1-6; t.f. 18:1-4, pl. 25, figs. 11-16.---CORLISS, 1979, p. 8, pl. 3, figs. 12,13.---WESTON, 1985, pl. 2, fig. 1.---MEAD, 1985, p. 232, pl. 3, fig. 8.---BELANGER AND BERGGREN, 1986, p. 340, pl. 4, fig. 6.

Globocassidulina aff. G. subglobosa (Brady). MURRAY, 1971, p. 191, pl. 80, figs. 1-4.

Cassidulina subglobosa subglobosa Brady. BOLTOVSKOY, 1978, p. 155, pl. 2, fig. 34.---INGLE et al., 1980, p. 132, pl. 1, figs. 14,15.

Cassidulina subglobosa horizontalis Cushman and Renz. BOLTOVSKOY, 1978, p. 155, pl. 2, fig. 32.

Globocassidulina cf. G. subglobosa (Brady). WARD AND WEBB, 1986, p. 198, pl. 4, fig. 10.

Test biserial enrolled, subglobular, periphery broadly rounded and slightly lobulate. Chambers inflated, few in outer whorl, sutures gently depressed. Aperture a restricted oval or loop across apertural face, nearly perpendicular to inner margin of chamber, with inner tooth structure and bordering lips.

Remarks: The specimen illustrated by Cushman (1921) belongs in G. moluccensis, as has already been noted. The subspecies noted by Boltovskoy may be recognized but are not distinguished in the present study, there being too many intermediate specimens.

Globocassidulina sp. A
(Plate 8, Figures 12-14)

Test small, biserial enrolled, gently compressed, periphery rounded. Chambers few per whorl, only slightly inflated, smooth. Sutures distinct, barely depressed in latter stages. Aperture a very narrow slit perpendicular to inner margin of chamber, and consequently at 45° to long axis of test.

Remarks: This species is distinguished from G. subglobosa by the former's gentle compression and slit-like, rather than oval or loop-shaped, aperture. It is

distinguished from G. rarilocula only by that species's subtriangular aperture, whose trend is parallel to the test long axis.

Genus Islandiella Nørvang, 1959

Islandiella norcrossi (Cushman)

Cassidulina norcrossi CUSHMAN, 1933c, p. 7, pl. 2, fig. 7.

Islandiella norcrossi (Cushman). COLE, 1981, p. 89, pl. 19, figs. 40,41.

Test biserial enrolled, lenticular, biumbonate with large convex umbos, periphery acute and lobulate, almost notched at sutures. Chambers 4 pairs in outer whorl, uninflated, reaching across periphery to umbos on both sides, such that biserial alternation is not immediately apparent. Sutures distinct, oblique, essentially flush except where periphery notched. Aperture an elongate slit, in peripheral plane, with surrounding lip that is interrupted at the middle on the posterior or inner margin of aperture, where infolded to form tooth structure.

Remarks: The acute periphery with chambers from both sides reaching each umbo is distinctive.

Subfamily EHRENBEGININAE Cushman, 1927

Genus Burscolina Seguenza, 1880

Burscolina bullaeformis Nomura

Burscolina bullaeformis NOMURA, 1983a, p. 90, pl. 2, figs. 10,11.

Test small, subglobular, biserial enrolled, uncompressed and distinctly higher than broad, periphery rounded, barely lobulate. Chambers gently inflated, few pairs per whorl, sutures gently depressed. Aperture a long curved slit originating at inner margin, running parallel to dorsal margin, with thin bordering flap in front.

Remarks: This species differs from Cassidulina marshallana Todd and C. caudriac Cushman and Stainforth, both of which have semicircular apertures that reach nearly to the inner marginal suture at the distal end as well. Both C. pacifica Cushman and B. marshallana (Todd) minima Nomura have flush sutures.

Genus Ehrenbergina Reuss, 1850

Ehrenbergina bosoensis Takayanagi

Ehrenbergina bosoensis TAKAYANAGI, 1951, p. 87, t.f. 8.

Ehrenbergina trigona Goës. BELANGER AND BERGGREN, 1986, p. 340, pl. 4, fig. 5.

Test coiled initially, later biserial and uncoiling, triangular in outline and subtriangular in section. Chambers low and broad, uninflated. Sutures on dorsal side limbate and raised into thin, slightly ragged keels, sutures on ventral side also limbate and raised, projecting as slightly downward curved, short marginal spines. Ventral side with distinct median furrow bounded by carinate/spinose margins. Aperture a curved slit arising at inner margin, parallel to dorsal surface.

Remarks: The subspecies E. bosoensis Takayanagi decorata Takayanagi has a straight dorsal line and more quadrate outline, and the sutures may be more prominent and keeled. It may be represented in the present populations, but cannot be distinguished consistently. The illustrated specimen of Belanger and Berggren has a median furrow, a feature which E. trigona lacks.

Ehrenbergina bradyi Cushman

Ehrenbergina bradyi CUSHMAN, 1922a, p. 134, pl. 26, fig. 5.

Ehrenbergina trigona Goës. PHLEGER et al, 1953, p. 46, pl. 10, figs. 12,13.---BARKER, 1960, p. 112, pl. 55, figs. 2,3,5 only.---TODD, 1965, p. 48, pl. 20, fig. 2.---CORLISS, 1979, p. 8, pl. 3, figs. 10,11.---MEAD, 1985, p. 232, pl. 3, figs. 4-7.---HERMELIN AND SCOTT, 1985, p. 206, pl. 4, figs. 15,16.

Test triangular, tetrahedral, initially coiled with small projecting coil, later biserial uncoiled. Ventral side with chambers inflated, sutures gently depressed, dorsal side with surface smooth, curved, and sutures flush. On ventral side broad median furrow developed, ventral borders of chambers with distinct carinal ridges that nearly project as spines at furrow's margin; angles of chambers at periphery extended into long rounded spines. Aperture a curved slit originating at inner margin of final chamber, running parallel to dorsal surface.

Remarks: In describing this species, Cushman placed Brady's (1884) pl. 55, figs. 2,3,5(?) in synonymy. Brady having referred these specimens as well as others to E.

serrata Reuss. Barker referred them to E. trigona Goës. In contradistinction to Phleger *et al.*, who characterized E. trigona as having a broad central furrow, with spinose margins, the type figures of that species (E. serrata Reuss var. trigona) clearly show in apertural view the lack of a furrow, while no ventral view was provided. It seems preferable to use Cushman's species E. bradyi, which accurately embraces the present forms, than to modify Goës's concept retroactively.

Ehrenbergina pacifica Cushman

Ehrenbergina pacifica CUSHMAN, 1927c, p. 5, pl. 2, fig. 2a,b, ?not c.---BARKER, 1960, p. 112, pl. 55, figs. 6,7, ?not 4.---TODD, 1965, p. 47, pl. 20, fig. 1.

Test stout triangular in outline and section, biserial and initially enrolled, later uncoiling. Chambers rather low, broad and arched, uninflated, upper margins on ventral side limbate, raised, well above excavated chamber faces, passing into long, coarse peripheral spines and also producing a well developed ventral furrow. Sutures on dorsal side limbate and raised, less strongly so in younger stages. Base of test with short sharp ragged ridges. Aperture a curved interiomarginal slit, subparallel to dorsal face.

Remarks: This species is distinguished from others with spinose margins by the lack of a peripheral keel, its excavated ventral chamber surfaces, and by its raised ventral sutures that pass into long spines. The figures of Cushman (1927c) and Barker (1960) excluded from this synonymy are likely E. trigona, which lacks an appreciable ventral furrow.

Ehrenbergina sp. cf. E. trigona Goës

Ehrenbergina serrata Reuss var. trigona GOËS, 1896, p. 49.

Ehrenbergina pacifica Cushman. BARKER, 1960, p. 112 (pars), pl. 55, fig. 4 only.

Test biserial, initially coiled and later uncoiling. Dorsal side essentially smooth, gently convex, chambers very slightly inflated, but sutures limbate and flush to very gently raised. Ventral side with chambers mildly inflated, sutures gently depressed. Sutures on ventral side run into lateral imperforate carinae that

are serrate to bluntly spinose at test margins. Median ventral edge of chambers acute to carinate, merging to form a single serrate to spinose keel with no intervening furrow. Aperture a curved slit, subparallel to dorsal face, originating at inner margin.

Remarks: The uncertainty in referring this form to Goës's species is due to the lack of a type ventral view, as well as a poor type description. He included Brady's (1884, same plate and figure numbers as for Barker, 1960) pl. 55, figs. 2-7 in synonymy. Figures 6 and 7 are E. pacifica Cushman, while figs. 2, 3 and 5 are referred in this paper to E. bradyi. Only figure 4 is nearly triangular with no median furrow, a condition occasionally found in E. pacifica. This latter species differs, however, in having raised upper chamber margins which continue as projecting lateral spines. It is noteworthy that even Barker placed a question mark on the assignment of the specimen of fig. 4 to E. pacifica. Ehrenbergina trigona is herein restricted to forms without a furrowed or truncate ventral median line.

Ehrenbergina undulata Parker

Ehrenbergina undulata PARKER, in PHLEGER et al, 1953, p. 45, pl. 10, figs. 14-16.-
--BELANGER AND BERGGREN, 1986, p. 340, pl. 4, fig. 4.

Test elongate triangular, triangular in section becoming compressed, biserial uncoiling with very small, barely produced, initial coil. Chambers low and broad, generally uninflated except for upper ventral faces, which are compressed but still rounded and inflated. Sutures on dorsal side limbate and flush, distinct as formed but subsequently obscured by secondary deposits which are rather smooth, on ventral side sutures slightly raised as sharp ridges, passing to lateral spines beyond the acute, carinate margins, producing a serrate border as well as leaving a distinct narrow ventral furrow. Aperture interiomarginal, a curved, convex-upward slit parallel to dorsal face, with thin arched flap in front, and numerous strong radiating grooves on dorsal apertural border.

Remarks: The compressed elongate form with carinate sutures, lateral spines,

and rounded upper chamber faces is distinctive.

Ehrenbergina sp. A

Test flaring rapidly, almost as broad as high, somewhat triangular in outline, biserial enrolled becoming uncoiled, base very thick in side view, tapering up to highly compressed apertural end, which is acute and thin. Chambers low and broad between sutures, but upper ventral chamber faces high and arched, last pair comprising almost half of test length in ventral view, upper margin a broad semicircle. Sutures limbate, raised, increasingly so as subsequent chambers added, and on ventral side passing into very brief lateral spines at acute carinate margins; a 1 raised sutures and margins coalescing to produce coarse raised polygonal pattern on both sides of test, particularly on lower half, with no ventral furrow. Aperture interiomarginal, a curved slit running parallel to dorsal face, with very fine bordering lip in front, and well developed radial grooves from the dorsal edge of aperture.

Remarks: There are several similar species which need to be distinguished.

Ehrenbergina cristata Cushman and Bermúdez is very thick throughout and lacks a serrate margin and tapering outline. E. cubensis Cushman and Bermúdez has depressed sutures, no spines, and the polygonal ornament consists of crenulations in the chamber faces, and E. bermudezi Palmer has a sharp but not keeled periphery, is thick, and has polygonal facets rather than raised ornament.

Genus **Reissia** Loeblich and Tappan, 1964

Reissia hystrix (Brady)

Ehrenbergina hystrix BRADY, 1881, p. 60.---BRADY, 1884, pl. 55, figs. 8-11.---
CUSHMAN, 1911, p. 102, fig. 156.---BARKER, 1960, p. 112, pl. 55, figs. 8-11.---
BOLTOVSKOY, 1978, p. 158, pl. 3, fig. 36.

Test biserial and coiled, later uncoiled. Chambers in later stages strongly inflated, dorsal surface of test well rounded. All but final pair of chambers covered with stout spines which tend to project basally, while lateral spines at the sutures project more strongly; entire test margin also fringed with lesser spines. Aperture a

curved slit, originating at inner margin of final chamber and running parallel to dorsal surface of test.

Remarks: The inflated test covered with spines is distinctive.

Superfamily TURRILINACEA Cushman, 1927

Family TURRILINIDAE Cushman, 1927

Genus Turrilina Andreae, 1884

Turrilina? sp. A

Buliminella carteri Bhatia. ?BOLTOVSKOY, 1978, p. 154, pl. 2, figs. 13,14.

Test stout, quite high trochospiral, about as broad as high, rapidly tapering from rounded base. Chambers initially 4 to 5 per whorl, latterly but 3, very strongly inflated, increasing rapidly in size as added, each whorl on distinctly different level from previous whorls. Sutures distinct, depressed, straight. Surface of test with very widely and randomly scattered fine hispid ornament. Aperture interiomarginal, oval, in recessed umbilical region, with anterior lip and very slight posterior lip infolded as tooth structure.

Remarks: This form is quite similar to T. brevispira ten Dam, but this latter species is not so rounded at the base, and more importantly, the aperture appears to be very low and rather broad, although this is not clear from the type figure, and the type description is in German. Tosaja Takayanagi has an initial triserial stage, while B. carteri has 4 chambers in the final whorl, and a very high, narrow aperture. Both this and the following species are questionably referred to the genus Turrilina, which has been reported only from the Lower Eocene to Middle Oligocene (Loeblich and Tappan, 1987). The aperture appears to differ slightly as well.

Turrilina? sp. B

Test very high trochospiral, conical, up to a maximum of about 1 1/2 times as high as broad, base bluntly pointed and rounded, profile with distinctly convex sides, non-lobulate. Chambers initially 5 or so per whorl, reduced in adult to 4 per whorl, uninflated on sides of test but inflated on flattened upper test surface, and

subglobular in apertural view, but height of whorls not as great as diameter of chambers. Sutures very obscure, flush, apparently slightly limbate and radial on dorsal side, on ventral side radial, straight, depressed. Wall smooth. Aperture interiomarginal, umbilical, a very small asymmetrical arch, skewed slightly toward the penultimate chamber, with bordering lip which is extended or expanded slightly toward the initial chamber of final whorl, rather than penultimate chamber.

Remarks: This species is distinguished, particularly from Turrilina? sp. A, by its shape and flush sutures on the dorsal or conical side, and has 4 chambers per whorl in the adult, which is atypical for the genus.

Family STAINFORTHIIDAE Reiss, 1963

Genus Hopkinsina Howe and Wallace, 1932

Hopkinsina pacifica Cushman

Hopkinsina pacifica CUSHMAN, 1933a, p. 86, pl. 8, fig. 16.---CUSHMAN, 1942, p. 51, pl. 15, fig. 1.

Test elongate, somewhat fusiform, slightly compressed, base rounded. Chambers initially triserial for at least 2 whorls, later biserial for 2 or 3 whorls and twisted about axis, inflated and slightly higher than broad, subglobular. Sutures distinct, depressed, wall smooth. Aperture terminal, round, and wide, on very short neck with lip.

Remarks: This species is distinguished from Uvigerina auferiana d'Orbigny var. glabra Millett, which is the genotype of Hopkinsinella Bermúdez and Fuenmayor, in that this latter species is biserial throughout.

Genus Stainforthia Hofker, 1956

Stainforthia complanata (Egger)

Virgulina schreibersiana Czjzek var. complanata EGGER, 1893, p. 292, pl. 8, figs. 91,92.

Cassidella pacifica Hofker?. BARKER, 1960, p. 106, pl. 52, fig. 2.

Virgulina davis Chapman and Parr. BARKER, 1960, p. 106, pl. 52, fig. 3, not fig. 1.

Virgulina complanata Egger. CUSHMAN, 1942, p. 13, pl. 4, figs. 2-4, not 5.---BOLTOVSKOY, 1978, p. 173, pl. 8, figs. 34,35.

Fursenkoina schreibersiana (Czjzek). MURRAY, 1971, p. 185, pl. 77, figs. 6-10.

Stainforthia complanata (Egger). INGLE *et al.*, 1980, p. 144, pl. 5, figs. 10,11.

Fursenkoina fusiformis (Williamson). HERMELIN AND SCOTT, 1985, p. 210, pl. 4, fig. 14.

Test elongate, biserial and twisted, tapering gently, with apical spine. Chambers inflated, higher than broad and somewhat high wedge-shaped. Sutures straight, depressed. Aperture interiomarginal, twisted to be parallel to face of test, broad at base, narrowing upward, and very large. Complicated internal structure to aperture, with large infolded faces.

Remarks: The genera Fursenkoina and Cassidella differ in having narrow or comma-shaped (i.e. basally restricted) apertures. Virgulina schreibersiana is strongly compressed but not twisted, and the chambers are much higher in proportion. Its aperture is comma-shaped, and the base lacks a spine. Virgulina davis has too few, high chambers and a restricted aperture, hence Barker's pl. 52, fig. 3 is referred herein to the present species, while fig. 1 is left in V. davis. Bulimina pupoides d'Orbigny var. fusiformis Williamson is much too broad, the greatest breadth being at the middle of the test, and in addition it lacks a basal spine and has too restricted an aperture for the present form. Thus Hermelin and Scott's specimens are transferred. Cassidella pacifica was a new name proposed by Hofker for these forms because he was dissatisfied with the type figures and description of Egger. The specimen illustrated by Cushman (1942) in pl. 4, fig. 5 is not twisted, is too flat and plaited, and has a narrow aperture, and so is not referred to the present species.

Superfamily BULIMINACEA Jones, 1875

Family SIPHOGENERINOIDIDAE Saidova, 1981

Subfamily SIPHOGENERINOIDINAE Saidova, 1981

Genus Sagrinella Saidova, 1975

Sagrinella lobata (Brady)

Bolivina lobata BRADY, 1881, p. 58.---BRADY, 1884, pl. 53, figs. 22,23.---
CUSHMAN, 1911, p. 46, figs. 74,75.

Loxostoma lobatum (Brady). CUSHMAN, 1942, p. 36, pl. 10, fig. 5.

Loxostomum lobatum (Brady). BARKER, 1960, p. 110, pl. 53, figs. 22,23.

Test elongate, biserial, uniformly tapering, periphery lobulate and rounded. Chambers nearly as high as broad, strongly inflated, covered in granulations or coarse spines, with a prominent median row of spines. Sutures straight, depressed. Aperture interiomarginal to subterminal, a large and high arch, with bordering lip.

Remarks: Bolivina spinea Cushman has a stout basal spine, and the chambers are twice as broad as high, with only the middle portion expanded into coarse spinose projections, the rest being essentially smooth.

Saginella strigosa (Brady)

Bolivina lobata Brady var. strigosa BRADY, 1884, p. 425, pl. 113, fig. 7.

Bolivina (Bifarina) strigosa (Brady). CUSHMAN, 1911, p. 49, fig. 80.

Loxostoma strigosa (Brady). BARKER, 1960, p. 232, pl. 113, fig. 7.

Test elongate, biserial, strongly flattened, tapering appreciably from narrowly rounded base, outline sawtoothed. Chambers broader than high, somewhat triangular with apex up, uninflated, lower margins produced as blunt peripheral spines. Sutures limbate, raised to flush, upper margins of chambers also raised. Aperture subterminal, a compressed wide slit with raised bordering rim.

Remarks: The serrate outline and compressed test are completely distinctive.

Unknown genus of Subfamily Siphogenerinoidinae?

Test somewhat palmate, biserial, extremely thin, about 1 3/4 to 2 times as long as broad, base rounded, periphery acute and somewhat serrate. Chambers low and broad, slightly curved, especially lateral margins which are curved basalward and project slightly as acute or spinose margins; upper chamber surfaces limbate and raised, quite thick. Sutures depressed, horizontal, becoming curved downward at margins. Aperture nearly interiomarginal, an ovate opening turned toward one face of test, surrounded by broad everted ellipsoidal lip.

Remarks: This species is represented by a single specimen, and there is no known genus to accomodate it, on account of the form of the aperture on a biserial test. The specimen is too poor to justify or enable erection of a new genus.

Subfamily TUBULOGENERININAE Saidova, 1981

Genus Sagrina d'Orbigny, 1839

Sagrina pulchella d'Orbigny

Sagrina pulchella d'ORBIGNY, 1839a, p. 150, pl. 1, figs. 23,24.---LOEBLICH AND TAPPAN, 1987, p. 519, pl. 569, figs. 17-22.

Test elongate, biserial, tapering, over twice as long as broad, base pointed, periphery rounded and serrate in outline. Chambers inflated, subglobular, slightly broader than high. Sutures distinct, depressed, horizontal. Wall with fine hispid ornament on upper surfaces of chambers, coalescing basalward into fine rough costae that project basally to form a fringe and truncate outline to base of chambers, which overhang preceeding ones. Aperture terminal, round, with lip or very short neck.

Remarks: The present specimens taper more gradually than d'Orbigny's types, and the hispid chamber surface also differs slightly. There are too few specimens to allow one to say they constitute a new form beyond the range of variation of d'Orbigny's species.

Genus Siphogenerina Schlumberger, 1882

Siphogenerina costulata Cushman

Siphogenerina raphana (Parker and Jones) var. costulata CUSHMAN, 1917b, p. 662.---CUSHMAN, 1921, p. 281, pl. 56, fig. 6.

Test elongate, cylindrical, with rapidly tapering and very slightly compressed initial biserial stage, base rounded. Chambers thereafter a few in biserial fashion, then low, broad uniserial chambers in parallel-sided stage of test. Sutures limbate, flush. Surface with about 10 longitudinal costae which are very low, like angles on the test rather than plate-like, and are somewhat oblique and anastomosing in early stage. Aperture terminal, round, on a ragged neck without lip or evident tooth.

Remarks: Dimorphina striata Schwager has many more and finer costae, and a long thin neck with lip. Siphogenerina striata (Schwager) var. curta Cushman has continuous costae, and a rounded aperture with no neck but a prominent lip.

Siphogenerina pacifica Cushman

Siphogenerina dimorpha (Parker and Jones). CUSHMAN, 1913a, p. 106, pl. 45, figs. 3,4.---CUSHMAN, 1921, p. 279, pl. 56, fig. 8.

Siphogenerina dimorpha (Parker and Jones) var. pacifica CUSHMAN, 1926a, p. 13, pl. 2, fig. 9; pl. 3, fig. 6.---CUSHMAN, 1942, p. 53, pl. 15, fig. 4.

Rectobolivina dimorpha (Parker and Jones) var. pacifica Cushman. BARKER, 1960, p. 158, pl. 76, figs. 1-3.

Test elongate, subcylindrical, somewhat lobulate and irregular in outline. Chambers initially biserial, test so irregular as to suggest possibility of very small triserial stage, tapering very rapidly, thereafter uniserial, chambers uninflated, not much broader than high becoming as high as broad at final chamber. Sutures completely obscured due to basal overhang of large strong processes alternating with irregular deep excavations of chamber bases. Surface very coarsely pitted, perforations sunk in pits. Aperture terminal, round, neck just long enough to separate very broad and thick lip from upper chamber surface.

Remarks: The coarsely pitted surface distinguishes this species from all but Uvigerina (Sagrina) dimorpha Parker and Jones, which has straight depressed sutures and chambers without basal processes and excavations.

Siphogenerina raphana (Parker and Jones)

Uvigerina (Sagrina) Raphanus PARKER AND JONES, 1865, p. 364, pl. 18, figs. 16,17.

Siphogenerina raphanus (Parker and Jones). CUSHMAN, 1913a, p. 108, pl. 46, figs. 1-5.---CUSHMAN, 1921, p. 280, pl. 56, fig. 7.---BARKER, 1960, p. 156, pl. 75, figs. 21,23,24, ?not 22.

Siphogenerina raphana (Parker and Jones). CUSHMAN, 1942, p. 55, pl. 15, figs. 8,9, ?not 6,7.

Test elongate, cylindrical, apparently biserial (not discernible in present specimens) then uniserial. Chambers broader than high, sutures flush and outline

entire. Surface ornamented with 8 to 10 or 11 costae that run the length of test, except for uppermost surface of final chamber. Aperture terminal, round, on short neck with thin lip, situated occasionally in slight depression of upper chamber surface.

Remarks: There are several similar species which need to be distinguished from the present one. Dimorphina striata Schwager is lobulate in outline, Siphogenerina costata Schlumberger and S. striata var. curta Cushman have no neck, while S. raphanus var. costulata Cushman has no lip. In S. senni Cushman and Renz, the costae project basally, otherwise the two species are indistinguishable. The specimen illustrated by Barker as pl. 75, fig. 22 has no lip, while Cushman's (1942) specimens illustrated as pl. 15, figs. 6,7 have no neck, the latter form also being slightly lobulate. For these reasons those specimens have been tentatively excluded from synonymy.

Family BULIMINIDAE Jones, 1875

Genus Bulimina d'Orbigny, 1826

Bulimina aculeata d'Orbigny

Bulimina aculeata d'ORBIGNY, 1826, p. 269.---CUSHMAN, 1911, p. 86, fig. 139.---CUSHMAN, 1921, p. 161, pl. 31, fig. 5.---BARKER, 1960, p. 104, pl. 51, figs. 7-9.---PFLUM AND FRERICHs, 1976, pl. 1, fig. 8.---BURKE, 1981, pl. 1, fig. 13.---POAG, 1981, p. 48, pl. 21, fig. 1; pl. 22, fig. 1.---HERMELIN AND SCOTT, 1985, p. 204, pl. 3, fig. 7.---MEAD, 1985, p. 228, pl. 1, fig. 4.

Bulimina elongata subulata Cushman and Parker. ?CUSHMAN, 1942, p. 11, pl. 3, fig. 13.

Test triserial, flaring. Chambers inflated, margins acute with spines obscuring all but final whorl, spines not directed strictly toward base, but splayed noticeably outward as well. Sutures depressed, straight, obscured in earlier stages by ornament. Aperture an interiomarginal loop, with tooth.

Remarks: The illustrated specimen in Cushman (1942) of B. elongata d'Orbigny var. subulata Cushman and Parker is not distinguishable from the present form, although types of that subspecies have 2 or more whorls without spines, and are

elongate.

Bulimina alazanensis Cushman

Bulimina alazanensis CUSHMAN, 1927b, p. 161, pl. 25, fig. 4. ---POAG, 1981, n. 49, pl. 21, fig. 3; pl. 22, fig. 3.

Bulimina rostrata Brady. CUSHMAN, 1942, p. 10, pl. 3, fig. 12.---INGLE et al., 1980, p. 131, pl. 7, fig. 2.---MEAD, 1985, p. 228, pl. 1, figs. 3,5,6.

Bulimina sp. nov. BARKER, 1960, p. 104, pl. 51, figs. 18,19.

NOT **Bulimina** cf. **B. alazanensis** Cushman. MURRAY, 1971, p. 115, pl. 47, figs. 1-7.

Bulimina rostrata alazanensis Cushman. PFLUM AND FRERICHS, 1976, pl. 1, fig. 9.

Bulimina sp. 1 BELANGER AND BERGGREN, 1986, p. 334, pl. 2, fig. 6.

Test elongate, triserial, greatest breadth near apertural end. Chambers obscure, sutures limbate and flush to only slightly depressed. Continuous costae run from base of test onto lower 1/3 to 1/4 of final whorl, which is otherwise smooth. Aperture an interiomarginal loop, with tooth.

Remarks: The very similar **Bulimina rostrata** Brady has costae which cover all but the extreme distal or apertural end, the greatest breadth is near the middle, and the costae, as well as the test in some instances, are twisted. Boltovskoy (1978) was correct in referring his specimens to that species. **Bulimina** cf. **B. alazanensis** of Murray had discontinuous costae that often terminated in spinose projections, and does not represent this species. Cushman's type figures indicated some broken costae, which may account for Barker opting to place Brady's specimens in a new species. The SEM illustrations of Poag are outstanding for their representation of the costae. **Bulimina buchiana** d'Orbigny has a distinctly lobulate outline, and final chambers distinctly higher than broad, while **B. semicostata** Nuttall has irregular costae and a slightly lobulate outline.

Bulimina ampliapertura Belford

Bulimina ampliapertura BELFORD, 1966, p. 65, t.f. 5:10, pl. 5, figs. 18-21.

Test elongate, triserial, over twice as long as broad, base rounded but spinose. Chambers inflated, higher than broad, final whorl comprising over half of test.

Sutures distinct, gently depressed. Wall with fine longitudinal spinose costae from lower margin of upper whorl to base, forming a fringe on the lower part rather than continuous as figured by Belford. Aperture interiomarginal, a very broad opening with outer margin flared out to side, and a folded inner margin to produce toothplate.

Remarks: The aperture is characteristic, and unusually large for the genus. The slight difference between the surface sculpture of the present forms and those of Belford is not regarded herein as of specific rank.

Bulimina inflata Seguenza

Bulimina inflata SEGUENZA, 1862a, p. 109, pl. 1, fig. 10.---CUSHMAN, 1911, p. 84, fig. 137.---CUSHMAN, 1921, p. 160, pl. 31, fig. 6.---BOLTOVSKOY, 1978, p. 154, pl. 1, figs. 36,37.---WESTON, 1985, pl. 1, fig. 9 (as *B. inflata* end-member of *B. inflata* - *striata* group).

Bulimina striata 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, fig. 4.

Bulimina mexicana Cushman. BELANGER AND BERGGREN, 1986, p. 334, pl. 2, figs. 4,5.

Test triserial, flaring rapidly. Chambers inflated, lower margins acute, with longitudinal costae that run across 1/2 to 1/3 of chamber above lower margin, resulting in crenulate appearance; costae also project below margin as spines. Aperture an interiomarginal loop, with tooth.

Remarks: This species is not apparently as elongate or distinctly stepped in outline as is either of *B. costata* d'Orbigny or *B. striata* d'Orbigny, neither of which has a proper type description. *Bulimina inflata* Seguenza var. *mexicana* Cushman (note this is a subspecies of *B. inflata*, not *B. striata* as was implied by both Barker and Poag) is perhaps slightly more elongate and definitely more heavily costate than *B. inflata*. Barker did not explain why he tentatively referred the present form to *B. mexicana*.

Bulimina marginata d'Orbigny

Bulimina marginata d'ORBIGNY, 1826, p. 269, pl. 12, figs. 10-12.---CUSHMAN, 1911, p. 83, fig. 136.---BARKER, 1960, p. 104, pl. 51, figs. 3-5.---MURRAY, 1971, p.

119, pl. 49, figs. 1-7.---POAG, 1981, p. 49, pl. 21, fig. 2; pl. 22, fig. 2.---SEJRUP *et al*, 1981, p. 290, pl. 1, fig. 8.---WESTON, 1985, pl. 1, fig. 8.

Test triserial, slightly elongate. Chambers highly inflated with acute lower margin that is serrate to spinose, spines directed basally; upper surfaces smooth. Aperture an interiomarginal loop, with tooth.

Remarks: Bulimina aculeata has longer spines completely covering preceding chambers, whereas the spines are restricted to the acute chamber margins in B. marginata. The somewhat crenulate chamber margins and short costae on the upper chamber surfaces distinguish B. inflata from the present species. The specimen illustrated by Weston has chambers that are lower and somewhat flat-topped, and the cross-section is more triangular than the rounded section typical of B. marginata.

Bulimina subornata Brady

Bulimina subornata BRADY, 1884, p. 402, pl. 51, fig. 6.---CUSHMAN, 1911, p. 88, fig. 141.---BARKER, 1960, p. 104, pl. 51, fig. 6.---BELFORD, 1966, p. 64, t.f. 5:11; t.f. 7:4,5, pl. 5, figs. 15-17.

Test elongate, triserial, base with fairly long spine. Chambers globular, inflated. Sutures distinct, depressed. Wall with numerous longitudinal costae on the basal portion only, passing into basal spine. Aperture an interiomarginal loop, with fine lip and tooth.

Remarks: There is but a single specimen with a large proloculus and one whorl of chambers, and so no comment with regard to taper or such features is given. The ornament is distinctive of this species.

Bulimina translucens Parker (Plate 7, Figures 11,12)

Bulimina elongata d'Orbigny. CUSHMAN, 1911, p. 79, fig. 131.

Bulimina translucens PARKER, in PHLEGER *et al*, 1953, p. 33, pl. 6, figs. 30,31.---BOLTOVSKOY, 1978, p. 154, pl. 2, fig. 8.

Bulimina gibba/elongata Fornasini and d'Orbigny respectively. MURRAY, 1971, p. 117 (*pars*), pl. 48, figs. 1,5-8, not 2-4.

Test triserial, tending to be loosely triserial in adult stages, elongate, nearly parallel-sided, greatest breadth 1/2 to 2/3 of way from base, which is rounded.

Chambers inflated, sutures distinct, gently depressed. Lower few whorls with very fine, indistinct costae, upper whorls smooth. Aperture an interiomarginal loop, with tooth.

Remarks: There are many closely similar species. It is important to note that Parker's type description included the observation that the costae were usually or often present, but not universally, and that when present, were difficult to detect and only reached halfway up the test. The limited extent of the costae distinguishes this species from B. alazanensis. Bulimina semicostata Nuttall is very similar, having a blunt point at the base instead of being rounded there. It may be that the pointed base is merely an expression of stronger development of the costae, in which case Boltovskoy's (1978) B. semicostata (pl. 2, figs. 9-11) would represent a complete range of ornament for the present species. The chambers of B. elongata d'Orbigny are more strongly inflated, B. gibba Fornasini flares too rapidly, and B. elegans d'Orbigny is too regularly and distinctly triserial.

Genus Globobulimina Cushman, 1927

Globobulimina australiensis Collins

Globobulimina australiensis COLLINS, 1958, p. 389, pl. 4, fig. 10.

Test elongate ovate to blunt fusiform, triserial, circular in section, base well rounded. Chambers barely inflated, quite strongly embracing, final whorl over 3/4 of test length, final chamber barely over 1/2. Sutures distinct, very slightly depressed, strongly oblique except at base of chambers, where subhorizontal. Wall distinctly and more heavily perforate on lower 1/3 to 1/2 of chamber surface, upper part barely perforate. Aperture a narrow interiomarginal loop, with lip and tooth.

Remarks: Globobulimina ovata is narrower, with more acute ends, while other species are either stout and more strongly embracing, or else more elongate with more strongly inflated chambers.

Globobulimina glabra Cushman and Parker

Globobulimina glabra CUSHMAN AND PARKER, 1947, p. 134, pl. 29, figs. 35,36.

Globobulimina pacifica Cushman?. BARKER, 1960, p. 102, pl. 50, figs. 7-10.

Globobulimina pacifica (Cushman). ?INGLE *et al.*, 1980, p. 136, pl. 2, figs. 7,8.

Test ovate, triserial, greatest breadth toward base, rounded and more nearly circular in section as chambers added. Chambers very strongly embracing, very slightly inflated, reaching nearly to base but leaving even the pre-penultimate chamber exposed on both sides of test. Sutures distinct, very slightly depressed, strongly oblique to subvertical. Aperture an interiomarginal loop, with lip, and toothplate connected to previous aperture.

Remarks: Bulimina pyrula d'Orbigny is pointed at both ends and broadest in the middle, as is B. ovula d'Orbigny, which is also basally apiculate and less strongly embracing. Globobulimina pacifica Cushman completely embraces even the base, and thus the pre-penultimate chamber is visible from only the one side. This distinction has led to the reassignment of the specimens illustrated by Barker (1960) and Ingle *et al.* (1980). Although these latter authors provided views of only the one side, the specimens appear nevertheless to incompletely embrace the length of the test.

Globobulimina ovata (d'Orbigny)

Bulimina ovata d'ORBIGNY, 1846, p. 185, pl. 11, figs. 13,14.

Bulimina pupoides d'Orbigny. CUSHMAN, 1911, p. 80, fig. 132.---CUSHMAN, 1921, p. 161, pl. 31, fig. 8.

Protoglobobulimina ovata (d'Orbigny). BELFORD, 1966, p. 68, t.f. 5:15,16; t.f. 7:9, pl. 6, figs. 6-9.

Globobulimina affinis (d'Orbigny). INGLE *et al.*, 1980, p. 136, pl. 4, figs. 10,11.

Test triserial, elongate, subfusiform, base and apertural end narrowly rounded, greatest breadth near middle. Chambers distinctly higher than broad, embracing, such that final whorl occupies 2/3 to 3/4 of test length, final chamber approximately 1/2; chambers mildly inflated. Aperture loop-shaped, with prominent projecting tooth plate.

Remarks: Bulimina pupoides, to which Cushman (1911, 1921) assigned the

present form, has inflated chambers barely higher than broad and barely embracing, such that the final whorl accounts for only 1/3 of the test length. Ingle *et al* placed the present species in Bulimina affinis, which differs in having an acute base, rapidly tapering test, and an excavated apertural face. Bulimina notovata Chapman has a much more ovate test with even more strongly embracing chambers than the current species.

Family BULIMINELLIDAE Hofker, 1951

Genus Buliminella Cushman, 1911

Buliminella sp. cf. B. elegantissima d'Orbigny

Bulimina elegantissima d'ORBIGNY, 1839c, p. 51, pl. 7, figs. 13,14.

Buliminella elegantissima (d'Orbigny). BARKER, 1960, p. 104, pl. 50, figs. 20-22.---MURRAY, 1971, p. 105, pl. 42, figs. 1-4.---POAG, 1981, p. 50, pl. 33, fig. 2; pl. 34, fig. 2.

Buliminella cf. B. turbinata (Terquem). WARD AND WEBB, 1986, p. 190, pl. 4, fig. 2.

Test elongate, high trochospiral, 2 times longer than broad, fusiform, base and apertural end broadly rounded. Chambers much higher than broad, 6 or 7 touching final chamber in apertural view. Sutures distinct, flush, strongly limbate, even spiral suture flush, and all but final whorl obscured by large clear boss which produces rounded base. Aperture a subcircular opening in depressed apertural face

Remarks: The type figures show a form with a strongly depressed spiral suture, with lobulate outline to the test, and depressed sutures. This tendency is much reduced in Murray's specimens, while those illustrated by Barker and Poag have nearly flush sutures (strongly limbate in Poag) and entire outlines, save the reentrant at the lower margin of the final chamber. There may be a legitimate series, the present specimens, with limbate flush sutures and entire outlines, forming the extreme end-member opposite d'Orbigny's forms. The specimen illustrated by Ward and Webb has a rounded base and entire outline, and should not be referred to Bulimina turbinata Terquem, which is much less elongate, with an acute base and depressed sutures. Buliminella obtusata Cushman is similar, but has 10 chambers or

more in the last coil and only slightly limbate sutures.

Buliminella spicata Cushman and Parker

**Buliminella madagascariensis (d'Orbigny) var. spicata CUSHMAN AND PARKER
in CUSHMAN, 1942, p. 8, pl. 3, figs. 5,6.**

Buliminella cochlea Wiesner. ?WARD AND WEBB, 1986, p. 190, pl. 4, fig. 1.

Test elongate, subfusiform, base acute with short, stout spine, apertural end rounded. Chambers high but also quite broad, oblique, slightly inflated if at all, approximately 7 visible in apertural view in contact with final chamber. Sutures flush, only slightly limbate. Aperture interiomarginal, edges ragged due to projections of previous chambers, and 7 or more radial striae curving out over surface of final chamber.

Remarks: The aperture of Bulimina madagascariensis was illustrated by d'Orbigny as radiate, and Cushman and Parker did not note an exception to this when they described the present form. This may be an apparent feature, produced by the ragged edges noted in the present material. D'Orbigny's species differs in lacking a basal spine. The illustration in Ward and Webb is from an SEM, hence the sutures and chamber shape cannot be properly evaluated. It would appear, however, that the test is neither elongate nor irregular enough to be assigned to Wiesner's species.

Family UVIGERINIDAE Haeckel, 1894

Subfamily UVIGERININAE Haeckel, 1894

Genus Euvigerina Thalmann, 1952

Euvigerina aculeata (d'Orbigny)

Uvigerina aculeata d'ORBIGNY, 1846, p. 191, pl. 11, figs. 27,28.---CUSHMAN, 1913a, p. 100, pl. 43, fig. 4.---CUSHMAN, 1921, p. 273, pl. 55, fig. 6.---BARKER, 1960, p. 156, pl. 75, figs. 1,2,3.---BOLTOVSKOY, 1978, p. 171, pl. 8, figs. 2,3.

Test large, elongate, triserial throughout, base acute, greatest breadth near aperture. Chambers increasingly inflated as added and sutures increasingly depressed. Surface of test coarsely spinose (not hispid), spines well spaced, large, and

apparently aligned in longitudinal rows, these rows often developed as costae on earliest chambers. Aperture terminal, round, on neck with phialine lip.

Remarks: The specimen illustrated in Barker, pl. 75, fig. 3 is markedly costate, to a degree not shown by any specimens in the present study.

Euvigenerina proboscidea (Schwager)

Uvigerina proboscidea SCHWAGER, 1866, p. 250, pl. 7, fig. 96.---CUSHMAN, 1913a, p. 94, pl. 42, fig. 2.---CUSHMAN, 1942, p. 49, pl. 14, figs. 1-4.---BELANGER AND BERGGREN, 1986, p. 334, pl. 2, fig. 7.

Uvigerina asperula Czjzek. CUSHMAN, 1913a, p. 101 (pars), pl. 43, fig. 1.---CUSHMAN, 1921, p. 274, pl. 54, fig. 5; not pl. 55, fig. 8.---BARKER, 1960, p. 156, pl. 75, figs. 6,7 only.---BURKE, 1981, pl. 1, fig. 15.

Uvigerina senticosa Cushman. PFLUM AND FRERICHS, 1976, pl. 8, figs. 11,12.

Uvigerina proboscidea Schwager, forma typica. BOLTOVSKOY, 1978, p. 171, pl. 8, fig. 23 only.

Test elongate, somewhat fusiform in outline, initial portion triserial, rounded in section, with acute base. Chambers become inflated, especially after first 3 or more whorls, irregular in arrangement, such that test diameter eventually diminishes. Sutures very gently depressed initially, later more strongly so, producing lobulate test outline. Surface hispid throughout. Aperture terminal, rounded, on elongate tapering neck, with phialine lip.

Remarks: The similar species U. senticosa and U. auberiana forma laevis Goes are both hispid becoming smooth, and so Pflum and Frerichs's specimens need to be reassigned. Uvigerina asperula is identical except for the fact that the spines are aligned in definite longitudinal rows, rather than scattered as in the present species. Several forms with random arrangement of the spines have been referred to Czjzek's species, and they have been referred herein to U. proboscidea. Cushman's (1913a) description of U. asperula included both possibilities, and so only part of his group should be reassigned, while Barker's pl. 75, fig. 8 is a true U. asperula, and fig. 9 is either U. hispida Schwager or U. auberiana d'Orbigny. Boltovskoy illustrated in pl. 8, fig. 22 a form with a base that is too rounded, and which should not be referred

to the present species.

Euvigerina sp. A

Test elongate, triserial, tapering quite rapidly from rounded base, greatest breadth $2/3$ of way from base. Chambers strongly inflated, distinctly broader than high, upper surface convex, with shoulder near base, and lower surface more truncate than excavated. Upper surface perforate and variably covered with very fine hispid ornament, strongest near shoulder and becoming heavier as subsequent chambers added, lower truncate surface smooth and imperforate, glassy. Sutures distinct, deeply depressed. Aperture terminal, round, on short neck with phialine lip.

Remarks: The combination of the shouldered chambers, with truncate lower surfaces, and the discrepancy between sculpture and perforation above and below the shoulders, is distinctive. **Uvigerina selsevensis** Heron-Allen and Earland has a strongly concave basal edge to the chambers, which become somewhat removed and set spirally about the axis, and it is also smooth.

Euvigerina sp. B

Test elongate triserial, tapering substantially from narrowly rounded apiculate base, test just over twice as long as broad, greatest breadth above midline, outline highly lobulate. Chambers well inflated, significantly higher than broad, triangular in outline. Sutures distinct, strongly depressed. Wall with very fine scattered hispid ornament, particularly on lower half of chamber surface, on lower margin developed as extremely fine short spines directed laterally or somewhat retrally. Aperture terminal, round, on neck with lip.

Remarks: This is distinguished from other hispid species by the increased ornament toward the base, developed as spines but not a true fringe on the lower chamber margins.

Genus **Neovigerina** Thalmann, 1952

Neovigerina ampullacea (Brady)

Uvigerina asperula Czjzek var. **ampullacea** BRADY, 1834, p. 579, pl. 75, figs. 10,11.

Uvigerina ampullacea Brady. CUSHMAN, 1913a, p. 102, pl. 42, fig. 3.---CUSHMAN, 1921, p. 274, pl. 55, fig. 7.---CUSHMAN, 1942, p. 46, pl. 13, figs. 2-6.

Uvigerina asperula Czjzek. CUSHMAN, 1921, pl. 55, fig. 8.

Neouvigerina ampullacea (Brady). BARKER, 1960, p. 156, pl. 75, figs. 10,11.

Uvigerina proboscidea Schwager, forma ampullacea Brady. BOLTOVSKOY, 1978, p. 171, pl. 8, figs. 24,25.

Test elongate, base rounded, with subglobose coil of 4 chambers, at least in megalospheric form, thereafter becoming irregularly uniserial, chambers alternating sides with respect to test axis. Initial coil larger in diameter than rest of test, chambers rather strongly inflated. Surface hispid throughout, and may have single basal spine as well. Aperture terminal, rounded, on long hispid neck with phialine lip.

Remarks: Those specimens whose initial coil is not so large in proportion to the rest of the test may easily be confused with Siphouvigerina interrupta (Brady), which is otherwise similar. The specimens illustrated by Cushman (1942) as pl. 13, figs. 2 and 3 would appear to be the microspheric form, and there is a strong possibility that these two species are really just the megalospheric (ampullacea) and microspheric (interrupta) forms of the same species, which would be S. interrupta on the basis of priority.

Genus Siphouvigerina Parr, 1950

Siphouvigerina interrupta (Brady)
(Plate 1, Figures 3,4;
Plate 6, Figures 7,8)

Uvigerina interrupta BRADY, 1879, p. 274, pl. 8, figs. 17,18.---CUSHMAN, 1913a, p. 103, pl. 44, fig. 1.

Neouvigerina interrupta (Brady). BARKER, 1960, p. 156, pl. 75, figs. 12-14.

Uvigerina proboscidea Schwager, forma interrupta Brady. BOLTOVSKOY, 1978, p. 171, pl. 8, figs. 31,32.

Siphouvigerina interrupta (Brady). BURKE, 1981, pl. 1, fig. 16.

Test elongate, initially triserial, rapidly becoming biserial then irregularly uniserial, base rounded, greatest test width approximately 1/3 of way from base, at

last occurrence of clearly biserial chambers. Chambers inflated, subglobular but produced in direction of aperture, last 2 to 3 or more connected only to immediately preceeding chamber, removed from basal end rather than appressed, previous apertural neck clearly visible on axial (not marginal) chamber wall of last chamber. Surface hispid throughout. Aperture terminal, round, on quite long neck with phialine lip.

Remarks: The very loosely appressed chambers and hispid surface serve to distinguish this species.

Siphouvigerina porrecta (Brady)

Uvigerina porrecta BRADY, 1879, p. 274, pl. 8, figs. 15,16.---CUSHMAN, 1913a, p. 99, pl. 44, fig. 2.---CUSHMAN, 1942, p. 48, pl. 13, figs. 7,8.---BOLTOVSKOY, 1978, p. 171, pl. 8, fig. 20.

Neouvigerina porrecta (Brady). BARKER, 1960, p. 156, pl. 74, figs. 21-23.

Siphouvigerina porrecta (Brady). BURKE, 1981, pl. 1, fig. 17.

Test elongate, initially obscurely triserial and compact, later becoming irregularly or alternating uniserial, and quite delicate in appearance. Chambers most unusual, lower surfaces concave or excavated, upper surfaces convex to produce somewhat mushroom-shaped chambers, with upper surfaces costate. Aperture terminal, rounded, on thin neck with phialine lip.

Remarks: This species is distinguished from U. porrecta Brady var. fimbriata Sidebottom, which has more angular, gently serrate peripheral edges to the chambers, and no costae or other surface markings.

Genus Uvigerina d'Orbigny, 1826

Uvigerina canariensis d'Orbigny

Uvigerina canariensis d'ORBIGNY, 1839b, p. 138, pl. 1, figs. 25-27.---CUSHMAN, 1913a, p. 92, pl. 42, fig. 6.---BARKER, 1960, p. 154, pl. 74, figs. 1-3.---HERMELIN AND SCOTT, 1985, p. 218, pl. 3, fig. 9.

Test elongate, triserial, base rather broadly rounded, with single spine. Chambers initially globular and quite closely appressed, later becoming higher than broad, less regularly triserial. Sutures distinct, depressed. Wall smooth, polished.

distinctly perforate. Aperture terminal, on short tapering neck with lip.

Remarks: The smooth test, with basal spine and chambers which become elongate after being globular in the early stages, is distinctive.

Uvigerina dirupta Todd

**Uvigerina peregrina Cushman var. dirupta TODD, 1948, p. 267, pl. 34, fig. 3.---
PFLUM AND FRERICHS, 1976, pl. 8, figs. 4,5.---INGLE *et al.*, 1980, p. 146, pl. 5, figs. 16,17.**

Test elongate, initially triserial, then chambers alternating in clear biserial fashion, only rarely so uncoiled as to appear nearly uniserial. Chambers strongly inflated, sutures depressed. Earliest whorls typically coarsely hispid, then becoming strongly costate through mid portion, then final few chambers hispid again, hispid portions with spines aligned longitudinally. Costae often interleaved, discontinuous along length of chamber and discontinuous across sutures. Development highly variable, costae may only be ragged, aligned spines, and spines on final chambers may be scattered rather than aligned. Aperture terminal, rounded, on neck with well developed lip.

Remarks: This particular subspecies was chosen for the degree of variability of the ornament allowed by the type description (from near 0 to 100% spines as opposed to costae, and from total randomness to total alignment of the spines), as well as the biserial or alternating, rather than uniserial, terminal stage. In addition to its uniserial terminal stage, U. peregrina Cushman has costae which are continuous along the full chamber length to distinguish it from the present form. Uvigerina spinicostata Cushman and Jarvis is more raggedly costate than hispid, and the adult form is more costate than spinose, with a uniserial terminal stage. Uvigerina hispidicostata Cushman and Todd is remarkably similar, perhaps being more stout and closer to uniserial in its final stage. The principal difference from the present form, however, lies in the fact that the adult chambers are more strongly hispid than the juvenile ones, which is the reverse of the situation in U. dirupta. There are several other forms in the literature which are quite similar, but they are

too numerous to discuss at length. In most cases they differ either in the style of ornament or the tendency to uniserial chamber arrangement in the adult.

Uvigerina flintii Cushman

Uvigerina flintii CUSHMAN, 1923, p. 165, pl. 42, fig. 13.---PFLUM AND FRERICHS, 1976, pl. 7, fig. 9.---POAG, 1981, p. 86, pl. 27, fig. 5; pl. 28, fig. 5.

Test ovate to subfusiform, stout, outline undulose but not lobulate, base rounded. Chambers obscure, gently inflated; sutures obscure, gently depressed. Surface ornamented by numerous fine, low, rounded costae that are in varying degrees continuous, rather than terminated or interrupted at sutures. Aperture terminal, round, on neck with phialine lip, neck with 3 ring-like projections.

Remarks: According to Poag, the projections on the neck are in fact a single spiral costa. The test outline and form of the costae are distinctive.

Uvigerina isidroensis Cushman and Renz

Uvigerina isidroensis CUSHMAN AND RENZ, 1941, p. 20, pl. 3, fig. 16.

Test delicate in appearance, triserial, tending to biserial (alternating), fusiform, twice as long as broad. Chambers inflated, elongate, slightly excavated at lower margin, less so in later stages, wherein they are produced or drawn out toward the apertural end. Numerous high, fine costae on each chamber are independent of other chambers, project basally at lower chamber margin to produce spinose or fringed appearance. Aperture terminal, round, on thin neck with phialine lip.

Remarks: The closely similar U. acuminata Hosius has inflated globular chambers in the later stages, unlike those of the current species, which are drawn out and resemble a garlic bulb in shape.

Uvigerina shiwoensis Asano

Uvigerina peregrina Cushman subsp. shiwoensis ASANO, 1958, p. 35, pl. 6, figs. 5-8.

Uvigerina sp. A BELANGER AND BERGGREN, 1986, p. 336, pl. 2, fig. 12; ?pl. 3, figs. 1-3.

Test triserial, nearly as broad as long, base broadly rounded, appears somewhat truncate due to ornament. Chambers strongly inflated, increasing rapidly in size and

strongly embracing, overhanging preceeding margins of test. All chambers covered with numerous high, thin, plate-like costae that are occasionally disrupted into serrations or spines on upper surfaces of chambers. Costae do not continue across sutures, but project basally as spines, resultant test outline distinctly stepped and fringed or spinose. Aperture terminal, round, on short neck with phialine lip.

Remarks: Most other species that are otherwise similar have smooth upper surfaces to the chambers. Uvigerina nigmea [sic] d'Orbigny var. curticosta Cushman differs in having costae that do not project so much as spines, nor are the costae evidently serrate/spinose in certain cases. Cushman's type figure illustrates a specimen that is purely costate except for a coarsely spinose central final chamber. The present specimens agree very well with figs. 5 and 6 of Asano, while his figs. 7 and 8 depict a later stage, perhaps, with a tendency to test elongation, uniserial chamber arrangement, and spinose rather than costate chambers. It is this latter form which may be represented by pl. 3, figs. 1-3 of Belanger and Berggren.

Uvigerina sp. A

Test elongate, triserial, tapering very rapidly, base apiculate and also with many fine spines. Chambers inflated, increasing rapidly in size as added, but very closely appressed. Sutures distinct but only gently depressed. Wall ornamented with several (as many as 10 or more) widely spaced, low rounded costae that are usually slightly elevated toward the base of the chamber, where they project as very fine spines, but without giving the chamber base a truncate or angled look. Aperture terminal, round, on short neck with phialine lip.

Remark : This species is distinguished from U. peregrina and related species by the failure of the costae to become broken and serrate, as well as being much finer. It is quite similar to U. miozea Finlay, which is characterized by a blunt base, polished surface, and apparent lack of basal projection of the ribs.

Subfamily ANGULOGERININAE Galloway, 1933

Genus Angulogerina Cushman, 1927

Angulogerina angulosa (Williamson)

Uvigerina angulosa WILLIAMSON, 1858, p. 67, pl. 5, fig. 140.---CUSHMAN, 1913a, p. 98, pl. 44, fig. 4.

Angulogerina angulosa (Williamson). BARKER, 1960, p. 154, pl. 74, figs. 15,16.

Trifarina angulosa (Williamson) MURRAY, 1971, p. 123, pl. 51, figs. 1-6.---INGLE *et al.*, 1980, p. 144, pl. 3, figs. 1,4.---HERMELIN AND SCOTT, 1985, p. 217, pl. 3, fig. 11.---MEAD, 1985, p. 229, pl. 1, figs. 11-13.---BELANGER AND BERGGREN, 1986, p. 336, pl. 3, fig. 4.

Test elongate, nearly parallel-sided, triangular in section, base somewhat pointed, not acute. Chambers triserial, initially in distinct whorls, later tending to irregular arrangement. Sutures distinct, gently depressed, producing undulose outline. Each angle of test with strong carina, undulose along length of test and interrupted at sutures, faces with numerous finer discontinuous longitudinal costae. Aperture terminal, round, on short neck with lip, neck with continuation of marginal carinae.

Remarks: This species is distinguished from most by the combination of costate faces and carinate angles, and from A. earlandi by its interrupted continuous angles.

Angulogerina carinata Cushman

Triplasia tricarinata (d'Orbigny). ?CUSHMAN, 1913a, p. 62, pl. 39, fig. 2a only.

Angulogerina carinata CUSHMAN, 1927a, p. 159, pl. 4, fig. 3.

Trifarina carinata (Cushman). INGLE *et al.*, 1980, p. 146, pl. 3, figs. 2,3.---HERMELIN AND SCOTT, 1985, p. 217, pl. 3, figs. 12,13.

Test elongate, triserial becoming irregularly uniserial, initially increasing rapidly in width then essentially parallel-sided, base nearly acute. Lower portion of chambers quite noticeably excavated, and test outline lobulate. Earliest portion of test with or without numerous short, coarse costae, producing stepped outline, later with strong peripheral costae to produce triangular section. Aperture terminal, rounded, on neck.

Remarks: Trifarina bradyi has continuous peripheral costae and no

irregularities in the outline of the test, particularly at the base. Vaginulina tricarinata d'Orbigny evidently has a regular outline as well, although there is no type description to confirm this. The irregular outline of Cushman's (1913a) pl. 39, fig. 2a is consistent with the present species, rather than d'Orbigny's.

Angulogerina earlandi Parr

Angulogerina occidentalis (Cushman). ?CUSHMAN, 1942, pl. 15, fig. 12 only.

Angulogerina earlandi PARR, 1950, p. 341, pl. 12, fig. 21.

Trifarina earlandi (Parr). WARD AND WEBB, 1986, p. 190, pl. 4, figs. 12,13.

Test elongate, triserial becoming irregularly so with chambers increasingly removed from preceeding ones, triangular in section. Angles of chambers narrowly rounded, with 2 to 3 costae on each, costae also cover entire test, but are discontinuous across earliest whorls at least. Resultant test outline is somewhat stepped, until test reaches maximum width, thereafter test width decreases and outline is smoother, essentially lobulate. Aperture terminal, rounded, on short neck with phialine lip.

Remarks: Angulogerina angulosa has a more continuous outline, the angles are marked by a single prominent and discontinuous costa, and the chamber surfaces generally have but few widely spaced, discontinuous costae. Uvigerina occidentalis supposedly lacks costae on the final chamber, but this is not true of Cushman's (1942) figured specimen.

Angulogerina sp. A

Test elongate, triserial, initially tapering very rapidly from rounded base, later almost parallel-sided, but extremely undulose in outline, triangular in section. Chambers quite high as compared to breadth, strongly inflated, removed from base quite early in development, with strongly sunken lower margins. Angles carinate, but strongly undulose and sinuate from chamber to chamber. Sutures distinct, deeply depressed. Wall coarsely but rather sparsely hispid. Aperture terminal, round, on short neck, lip presumably broken off.

Remarks: The combination of a trifacial, tricarinate test and hispid chambers is distinctive.

Genus Trifarina Cushman, 1923

Trifarina bradyi Cushman
(Plate 1, Figures 7,8)

Trifarina bradyi CUSHMAN, 1923, p. 99, pl. 22, figs. 3-9.---CUSHMAN, 1942, p. 59, pl. 15, fig. 13.---BARKER, 1960, p. 140, pl. 67, figs. 1-3.---MURRAY, 1971, p. 125, pl. 52, figs. 1-6.---BOLTOVSKOY, 1978, p. 171, pl. 8, fig. 1.---WESTON, 1985, pl. 1, fig. 5.

Test elongate, triserial becoming uniserial, triangular in section throughout. Chambers barely inflated, sutures very gently depressed, obscure. Angles of test carinate, carinae continuous, outline of test entire. Walls coarsely perforate, unornamented. Aperture terminal, round, on blunt neck.

Remarks: The continuous marginal carinae, entire outline, and smooth chamber surfaces distinguish this species.

Family REUSSELLIDAE Cushman, 1933

Genus Fijiella Loeblich and Tappan, 1962

Fijiella simplex (Cushman)

Trimosina simplex CUSHMAN, 1929, p. 158, t.f. 2.---CUSHMAN, 1942, p. 44, pl. 12, fig. 7.

Reussella spinulosa (Reuss). CUSHMAN, 1942, p. 44, pl. 11, figs. 5-8.

NOT Reussella simplex (Cushman)? BARKER, 1960, p. 96, pl. 47, fig. 1.

Fijiella simplex (Cushman). LOEBLICH AND TAPPAN, 1964, p. 563, fig. 444:5.---BURKE, 1981, pl. 1, fig. 14.

Test triserial and triangular throughout, flaring quite rapidly. Chambers not at all inflated, sutures distinct, limbate, arched and flush. Wall hyaline, with coarse perforations concentrated near sutures. Margins of test acute, with irregularly developed spines. Aperture a ragged interiomarginal slit running nearly entire length of inner margin, with supplementary perforations and gashes in terminal face, which is gently convex and subhorizontal. No evident tooth plate.

Remarks: Reussella aculeata Cushman has long, curving spines, a more

gradually tapering test, and a less complex aperture, while R. spinulosa has a restricted semilunar or loop-shaped aperture. For this reason the specimen illustrated by Barker has been referred herein to this latter species. The specimens assigned by Cushman (1942) to this latter genus and species are all characterized by broken terminal chambers, which makes definite assignment to that species or the present one difficult, on account of their otherwise identical form. Nevertheless, Cushman described the aperture as "elongate without a lip, and with a few supplementary openings in the center of the terminal face" (ibid., p. 44), which would seem to indicate the present species.

Genus Reussella Galloway, 1933

Reussella spinulosa (Reuss)

Verneuilina spinulosa REUSS, 1850, p. 374, pl. 47, fig. 12.---CUSHMAN, 1911, p. 55, fig. 88.---CUSHMAN, 1921, p. 141, pl. 27, fig. 5.

NOT Reussella spinulosa (Reuss). CUSHMAN, 1942, p. 44, pl. 11, figs. 5-8.

Reussella simplex (Cushman)? BARKER, 1960, p. 96, pl. 47, fig. 1.

Test triangular and triserial throughout, quite rapidly tapering, margins acute, somewhat ragged looking, with irregular poorly developed spines at sutures. Chambers uninflated, sutures distinct, flush, limbate, quite strongly oblique, gently curved. Wall hyaline, with coarse perforations concentrated just below sutures. Aperture a small high interiomarginal arch, in recessed high hooded apertural face, backed by upper chamber surface which is quite convex and narrowly rounded in outline.

Remarks: This species is distinguished from Fijiella simplex solely on the basis of its neat compact hooded aperture, connected by internal toothplates to previous apertures. Reussella aculeata Cushman tapers more gradually, and has longer marginal spines.

Family TRIMOSINIDAE Saidova, 1981

Genus Mimosina Millett, 1900

Mimosina echinata Heron-Allen and Earland

Mimosina echinata HERON-ALLEN AND EARLAND, 1915, p. 651, pl. 50, figs. 12-18.

Test flaring, about as broad as high, initially triserial, eventually biserial. Chambers inflated, increasing quite rapidly in size as added. Sutures obscure due to ornament. Wall covered in fine hispid ornament aligned in longitudinal rows, may fuse to form fine rough costae, which project at acute lower margins of chambers, the which may be produced as large acute spines, generally where hispid ornament is less strongly developed. Basal surface of chambers also furnished with numerous fine spines, and base of test apiculate, all of which creates a test with fringed margins, either with much finely spinose ornament or else with rather coarse spines. Aperture bipartite, a low interiomarginal arch and a subterminal or areal curved slit or arch, bordered by lip.

Remarks: The present specimens are noteworthy for their range of development of spines. Mimosina pacifica Cushman has spines restricted to the lower chamber margins, and although he did not mention either the presence or alignment of hispid ornament, there is a possibility that his species is synonymous with the present one, which is rather variable. The present species is generally more stout and spinose than others of the genus.

Mimosina sidebottomi Dollfus

Mimosina hystrix Millett [var.]. SIDEBOTTOM, 1905, p. 16, pl. 3, fig. 9.

Mimosina sidebottomi DOLLFUS, 1905, p. 223.

Test elongate, tapering gradually, over twice as long as broad, base apiculate. Chambers initially and briefly triserial, but rapidly becoming biserial, inflated and with slightly truncate or excavated lower surfaces, also slightly flattened on one side of test, especially final pair. Sutures depressed. Surface finely hispid, with basal fine spines, particularly at periphery and as one or two median rows projecting from the convex rather than flattened face of test. Aperture bipartite, an

interiomarginal arch and adjacent subterminal areal oval, with bordering lips.

Remarks: This species is completely distinct from M. hystria, wherein the test is inflated on both sides, with chambers having a single prominent lateral spine that is much coarser than those of M. sidebottomi. It is much more elongate and compressed, and becomes biserial much sooner in the ontogeny than does M. echinata.

Superfamily FURSENKOINACEA Loeblich and Tappan, 1961

Family FURSENKOINIDAE Loeblich and Tappan, 1961

Genus Cassidella Hofker, 1951

Cassidella earlandi (Parr)

Bolivina earlandi PARR, 1950, p. 339, pl. 12, fig. 16.---BARKER, 1960, p. 106, pl. 52, figs. 18,19.

NOT Fursenkoina earlandi (Parr). WARD AND WEBB, 1986, p. 194, pl. 6, fig. 8.

Test elongate, biserial, slender, parallel-sided, not much compressed, not twisted about axis, outline non-lobulate, periphery rounded, base narrowly rounded. Chambers distinctly higher than broad, very gently inflated, plaited and increasing slowly in size as added. Sutures distinct, very fine and very gently depressed. Aperture a high narrow loop, from inner margin, with lip or tooth projecting slightly along forward margin.

Remarks: The untwisted parallel-sided test with plaited chambers is distinctive. Ward and Webb's form is subfusiform, with depressed sutures and a lobulate outline, and the chambers increase quite rapidly as added, making it referable to C. fusiformis. Bulimina compressa Bailey has oblique rather than plaited chambers, while Bolivina seminuda Cushman has coarsely punctate lower chamber surfaces.

Cassidella fusiformis (Williamson)

Bulimina pupoides d'Orbigny var. fusiformis WILLIAMSON, 1858, p. 63, pl. 5, figs. 129,130.

Fursenkoina fusiformis (Williamson). ?MURRAY, 1971, p. 185, pl. 77, figs. 1-5.---COLE, 1981, p. 105, pl. 14, fig. 1.

Cassidella fusiformis (Williamson). ?LAGOE, 1977, p. 127, pl. 4, fig. 5.

NOT Fursenkoina fusiformis (Williamson). HERMELIN AND SCOTT, 1985, p. 210, pl. 4, fig. 14.

Fursenkoina earlandi (Parr). WARD AND WEBB, 1986, p. 194, pl. 6, fig. 8.

Test elongate, subfusiform, greatest breadth $2/3$ of way from base which is rounded; very slightly compressed but ovate in section. Chambers biserial, twisted about axis, almost twice as high as broad, inflated. Sutures distinct, depressed. Aperture a narrow interiomarginal loop, without evident external tooth.

Remarks: The present species is distinguished from Virgulina pontoni Cushman which has a distinct triserial initial stage. Murray's form appears to have too nearly terminal and wide an aperture, the greatest breadth is well below the midline, and it is quite strongly compressed. Lagoe's form appears to have too little chamber inflation, and is also rather parallel-sided and more nearly fusiform. The problems with Hermelin and Scott's form have already been discussed under Stainforthia complanata, to which it has been referred herein.

Cassidella sp. A

Test elongate, fusiform, about 4 times as long as broad, both ends pointed and narrowly rounded, circular in section, not compressed. Chambers at least twice as high as broad, embracing half of preceding chamber with final pair occupying just less than half test length; not much inflated, broadest at base and narrowing toward aperture. Sutures distinct, very slightly depressed. Aperture a fairly high narrow interiomarginal loop, with internal folded tooth.

Remarks: This species is distinguished from C. fusiformis by being truly fusiform, with the greatest breadth at the midline, and in having uninflated chambers and acute extremities.

Genus Coryphostoma Loeblich and Tappan, 1962

Coryphostoma clippertonensis McCulloch

Coryphostoma clippertonensis McCULLOCH, 1977, p. 266, pl. 105, figs. 23,24.

Test elongate, biserial, over 3 times as long as broad, compressed and parallel-sided; periphery, base and apertural end all broadly rounded. Chambers initially about as high as broad, later slightly higher than broad, becoming alternating and nearly uniserial, initially only slightly inflated, later more strongly so, and may be twisted about axis. Sutures gently depressed. Aperture an areal, subterminal oval, clearly without interiomarginal component, apex without lip, lip added and increasing in height as opposite margin approached, lips infolded at apex to produce toothplate connected to previous aperture.

Remarks: The present specimens agree well with fig. 23 of McCulloch, while fig. 24 illustrates a form with a more restricted and produced aperture. Loxostoma rostrum Cushman is similar in every respect except it is perhaps more strongly compressed, and has a simple oval aperture without lip or tooth. Virgulina bradyi Cushman has alternating biserial cuneate chambers throughout, while Bolivina nobilis Hantken has a narrow slit-like aperture, and more fully developed uniserial stage.

Genus Fursenkoina Loeblich and Tappan, 1961

Fursenkoina texturata (Brady)

Virgulina texturata BRADY, 1884, p. 415, pl. 52, fig. 6.---?CUSHMAN, 1911, p. 95, fig. 147.---BARKER, 1960, p. 106, pl. 52, fig. 6.---BOLTOVSKOY, 1978, p. 173, pl. 8, figs. 36,37.

Test elongate, slender, biserial, twisted about axis, barely compressed, tapering steadily from narrowly rounded base, outline lobulate. Chambers slightly inflated, as high as or finally higher than broad, increasing steadily in size as added. Sutures distinct, gently depressed. Aperture a very narrow, restricted interiomarginal loop, with internal toothplate.

Remarks: Brady's type was not twisted about the axis, and was perhaps more strongly inflated and lobulate than the present specimen. Cushman (1911) illustrated a form that was parallel-sided and without chamber inflation, and thus is questioned. This species is distinguished primarily by the tapering form with

inflated chambers.

Genus Neocassidulina McCulloch, 1977

Neocassidulina sp. A

Test biserial, somewhat ovate in outline and strongly compressed, broadly rounded at apertural end, sides nearly parallel but distinctly convex for much of length, tapering rapidly to rounded base, periphery rounded and slightly indented at sutures. In all specimens, there is a small globular proloculus followed by 3 chambers, very gently inflated, increasing quite rapidly in size, strongly embracing anteriorly and less so laterally, to produce plaited or overlapping appearance, being strongly oblique and slightly arched. Sutures distinct, gently depressed, oblique and well over 45° to horizontal, and curved convex upward. Wall smooth. Aperture interiomarginal, a long curved slit parallel to periphery and up toward apex but not in peripheral plane, rather is well inboard of periphery on one of the faces; it is unknown, due to the low number of chambers, whether the face on which the aperture appears alternates with successive chambers, or remains the same in the manner of Ehrenbergina.

Remarks: This species is distinguished from N. evoluta McCulloch, which is very elongate, has at least four pairs of chambers which are nearly as high as broad, and a different suture pattern, with a less oblique orientation.

Genus Sigmavirgulina Loeblich and Tappan, 1957

Sigmavirgulina tortuosa (Brady)
(Plate 3, Figures 9,10)

Bolivina tortuosa BRADY, 1881, p. 57.---BRADY, 1884, pl. 52, figs. 31,32 only.---
CUSHMAN, 1942, p. 20, pl. 7, fig. 1.

Sigmavirgulina tortuosa (Brady). BARKER, 1960, p. 108, pl. 52, figs. 31,32.---
BURKE, 1981, pl. 2, figs. 4,8.

Test biserial, compressed except for initial portion which is as thick as broad, twisted, flaring rapidly, base rounded, margins carinate or acute. Chambers low and broad, increasing more rapidly in breadth than height to produce flaring, kite-

shaped test whose lower margins are concave, while upper margins are convex. Sutures distinct, limbate and flush. Aperture a subterminal slit parallel to compression of test.

Remarks: Bolivina tortuosa var. atlantica Cushman is more elongate, with several more chambers, and has a lobulate rather than smooth outline.

Superfamily DELOSINACEA Parr, 1950

Family CAUCASINIDAE N.K. Bykova, 1959

Subfamily CAUCASININAE N.K. Bykova, 1959

Genus Francesita Loeblich and Tappan, 1963

Francesita torta (Cushman)

Bulimina torta CUSHMAN, 1911, p. 81, fig. 133.

Francesita advena (Cushman). PFLUM AND FRERICHS, 1976, pl. 4, figs. 6,7.---
BOLTOVSKOY, 1978, p. 160, pl. 4, figs. 6-8.

Test elongate, triserial in earliest portion, later biserial and slightly twisted. Chambers higher than broad, strongly overlapping such that final pair comprises 2/3 test length. Sutures barely depressed, indistinct, hence chamber arrangement somewhat obscure. Aperture an elongate narrow slit from inner margin of strongly embracing final chamber up to top of test and part of way across, but essentially invisible from other side of test. No evident toothplate.

Remarks: Fursenkoina has a visible toothplate and is biserial throughout, while Cassidella, which is triserial becoming biserial, also has a toothplate. Virgulina advena Cushman evidently has less strongly embracing chambers that individually do not comprise so much of the test length.

Family TREMACHORIDAE Lipps and K.L. Lipps, 1967

Genus Tremachora Lipps and K.L. Lipps, 1967

Tremachora arga Lipps and Lipps

Tremachora arga LIPPS AND LIPPS, 1967, p. 497, t.f. 1.

Test fairly high trochospiral, stout, about as broad as high, base small but

rounded. Chambers inflated, initially as many as 5 per whorl, terminally with but 3. Sutures distinct, very gently depressed. Primary aperture areal, almost interiomarginal, a slightly sinuate slit with strong bordering lip above, and hint of one below; secondary apertures developed at base of intercameral sutures where they meet spiral suture, very small, bordered by semicircular rim or lip.

Remarks: This form is unique. The single specimen of the current study lacks secondary apertures along the sutures removed from the spiral suture, and so differs slightly from the type. The difference is not considered to be of significance, particularly in view of the single specimen. Tosaja Takayanagi lacks the secondary or supplementary apertures.

Superfamily PLEUROSOMELLACEA Reuss, 1860

Family PLEUROSOMELLIDAE Reuss, 1860

Subfamily PLEUROSOMELLINAE Reuss, 1860

Genus Pleurostomella Reuss, 1860

Pleurostomella sp. cf. P. acuminata Cushman

Pleurostomella acuminata CUSHMAN, 1922a, p. 50, pl. 19, fig. 6.---BARKER, 1960, p. 106, pl. 51, fig. 22.---BOLTOVSKOY, 1978, p. 164, pl. 5, figs. 43,44.

Test elongate biserial, over 3 times as long as broad, somewhat sinuate fusiform in side view, in apertural or face view nearly parallel-sided, base rounded, apertural end rounded in face view, acute in side view. Chambers cuneate, alternating but not with uniserial appearance, much higher than broad, increasing rapidly in height but not so much in other dimensions, virtually uninflated. Sutures distinct, nearly flush, strongly oblique. Wall smooth. Aperture subterminal, rather small, hooded, base of aperture with slight ridge becoming two tiny teeth, passing in to tooth structure connecting with previous aperture.

Remarks: The fusiform shape, high cuneate chambers, and nearly flush sutures distinguish this species. The present material lacks the apical spine of the type and synonymous references, this difference possibly being an expression of the

megalospheric versus microspheric form.

Pleurostomella obtusa Berthelin

Pleurostomella obtusa BERTHELIN, 1880, p. 29, pl. 1, fig. 9.---BOLTOVSKOY, 1978, p. 164, pl. 6, fig. 4,5.

Pleurostomellina (?) sp. nov. BARKER, 1960, p. 106, pl. 52, figs. 12,13.

Test elongate, essentially circular in section, bent but not consistently arcuate, outline usually lobulate but rarely smooth, base broadly rounded. Chambers somewhat cuneate but distinctly 4-sided in side view, gently inflated, added in distinct but not extreme alternating biserial fashion. Sutures distinct, depressed, oblique at 30° or more to horizontal. Apertural end rounded in face view but acute in edge view, aperture a large arched opening set in slight depression of apertural face, often but not always with 2 fine pointed teeth at the base, and with upper margin infolded.

Remarks: This species differs from P. subnodosa, in which the sutures are subhorizontal, and from P. alternans Schwager, which has truly cuneate chambers that are 3-sided in side view.

Pleurostomella recens Dervilleux

Pleurostomella rapa Gumbel. BRADY, 1884, pl. 51, fig. 21.

Pleurostomella rapa Gumbel var. recens DERVIEUX, 1899, p. 76.---BARKER, 1960, p. 104, pl. 51, fig. 21.

Test elongate, fusiform and very thick in middle, about 2 to 2 1/2 times as long as broad, base and apertural end narrowly rounded. Chambers added in alternating biserial fashion, increasing very rapidly in size as added, inflated and strongly embracing, final pair comprising about 2/3 of test, or rarely final chamber may be very much reduced in size. Sutures distinct, very slightly depressed. Aperture subterminal, eccentric, on inner face, an arch with no teeth evident, due in most cases to infilling by sediment.

Remarks: Pleurostomella rapa has its greatest breadth very near the aperture, and the chambers are not so strongly embracing. Pleurostomella bierigi Palmer and

Bermúdez is much more stout, being less than twice as long as broad, P. acuta Hantken is much more slender, and P. brevis Schwager has a more lobulate and less fusiform outline, with subequant chambers.

Pleurostomella schuberti Cushman and Harris

Pleurostomella schuberti CUSHMAN AND HARRIS, 1927, p. 133, pl. 25, fig. 29.

Test elongate, biserial and compressed, tapering quite markedly, outline lobulate, periphery and base rounded. Chambers inflated, elongate cuneate, at least twice as high as broad, in full contact not only with penultimate but pre-penultimate chamber as well, i.e. fully biserial, not alternating. Sutures distinct, depressed, surface smooth. Aperture well up long apertural face, an oval opening with undulose flap-like or thin lower margin, and infolded upper margin.

Remarks: Pleurostomella bolivinoides Schubert is too elongate, narrow and fusiform, with an acute base, while P. sapperi Schubert is striate on its lower half, with an acute base also.

Pleurostomella subnodosa Reuss

Pleurostomella subnodosa REUSS, 1860, p. 204, pl. 8, fig. 2.---CUSHMAN, 1911, p. 51, fig. 82.

Test elongate, subcylindrical, proloculus large and base rounded. Chambers inflated, quite strongly embracing, added in barely perceptible alternating fashion, so that only preceeding and succeeding chambers in contact. Sutures depressed, subhorizontal. Apertural end rounded in face view, acute in edge view, aperture oval to elliptical, no tooth evident, with upper margin infolded circumferentially.

Remarks: The subhorizontal sutures distinguish this species from P. obtusa.

Pleurostomella sp. A

Test elongate, well over 3 times as long as broad, biserial but alternating and so arranged as to appear almost uniserial, outline strongly lobulate, apertural end rounded in face view and acute in side view, base rounded. Chambers strongly inflated, cuneate but almost as broad as high, and unusual in that the greatest

breadth is very near base, well below midline. Sutures distinct, strongly depressed, distinctly curved and not too strongly inclined to horizontal, well under 45°. Wall smooth. Aperture subterminal, subcircular, facing inward and virtually without hood, slightest rim at base but no distinct teeth.

Remarks: The peculiarly shaped chambers and strongly depressed sutures distinguish this species from all others in the present study.

Superfamily STILOSTOMELLACEA Finlay, 1947

Family STILOSTOMELLIDAE Finlay, 1947

Genus Nodogenerina Cushman, 1927

Nodogenerina antillea (Cushman)

Nodosaria antillea CUSHMAN, 1923, p. 91, pl. 14, fig. 9.

Stilostomella antillea (Cushman). BARKER, 1960, p. 158, pl. 76, figs. 9,10.---
HERMELIN AND SCOTT, 1985, p. 217, pl. 3, fig. 5.

Orthomorphina aff. O. antillea (Cushman). BOLTOVSKOY, 1978, p. 162, pl. 5, figs. 12-15.

Stilostomella ex. gr. S. lepidula (Schwager). BOLTOVSKOY, 1978, p. 170, pl. 7, figs. 32-46.

Stilostomella aculeata (Cushman and Renz). BELANGER AND BERGGREN, 1986, p. 332, pl. 1, figs. 12-14.

Test elongate, uniserial. Megalospheric form rather stout, large proloculus furnished with numerous short spines, chambers thereafter few, of comparable and nearly constant diameter, subglobular to pyriform, widest below midline, only slightly angled at this point, with one or more rows of irregularly developed short coarse spines below this. Microspheric form tapering, chambers often as broad as or broader than high, angled margins and excavated lower surfaces more apparent. Sutures distinct, limbate, depressed and later somewhat extended. Aperture terminal, round, with simple tooth or slight irregularity in opening, with flared lip on heavy neck, exceptional specimens with extremely fine, long retral spines arising from underside of rim, preserved even after addition of subsequent chambers.

Remarks: Nodosaria lepidula Schwager has a definite fringe on each chamber,

created usually by short costae, while Cushman's form has, by implication of the type description, a more variable and sporadic development of lower chamber ornamentation. Boltovskoy encountered a great deal more variability than did the present author, to the point of having forms with multiple rows of spines, and single basal spines. Ellipsonodosaria nuttalli Cushman and Jarvis var. aculeata Cushman and Renz is supposed to have a toothed frill well below the lip around the neck, and an everted lip. Neither of these features is seen in Belanger and Berggren's illustration. This particular feature, supposed to be diagnostic of this latter species and its related variants, may in fact be the ragged remnant of the succeeding chamber, because the chambers are not added to the lip, but below it. These may not in fact be valid species and subspecies, but no conclusion can be reached without reference to the type material.

Genus Orthomorphina Stainforth, 1952

Orthomorphina sp. cf. O. haueriana (Neugeboren)

Nodosaria haueriana NEUGEBOREN, 1852, p. 39, pl. 1, figs. 8,9.---CUSHMAN, 1913a, p. 54, pl. 25, fig. 4.

The specimen consists of a single elongate, slender, smooth, almost parallel-sided but slightly pyriform (i.e. broader near base) chamber, with, at its base, the upper portion only of the preceeding one. Aperture evidently terminal, round, with slight rim or lip, which is apparent on penultimate chamber, as final one has the top broken.

Remarks: The long slender chamber distinguishes this form from Dentalina guttifera d'Orbigny and Nodosaria pyrula d'Orbigny, both of which have more strongly inflated chambers, while Dentalina consobrina d'Orbigny has thicker or less elongate chambers.

Genus Siphonodosaria A. Silvestri, 1924

Siphonodosaria abyssorum (Brady)

Nodosaria abyssorum BRADY, 1881, p. 63.---CUSHMAN, 1913a, p. 51, pl. 28, fig. 7.

Nodosaria? abyssorum Brady. BRADY, 1884, pl. 63, figs. 8,9.

Stilostomella abyssorum (Brady). BARKER, 1960, p. 132, pl. 63, figs. 8,9.---
BOLTOVSKOY, 1978, p. 169, pl. 7, fig. 16.

Test stout, uniserial, proloculus globular and larger than succeeding chambers, base with a few stout, i. regular spines. Chambers globular to somewhat pyriform, increasingly removed or non-appressed as added, smooth. Sutures depressed, limbate, and increasingly broad as formed. Aperture terminal, rounded, with small tooth and everted lip.

Remarks: The chamber shape and smooth test with basal spines distinguish this from most species. Ellipsonodosaria nuttalli Cushman and Jarvis has numerous short basal spines, while E. nuttalli var. gracillima Cushman and Jarvis has but one basal spine. In both cases the apertural neck is supposed to be surrounded by a toothed frill, and furnished with an everted lip. The validity of this feature has already been discussed under Nodogenerina antillea.

Genus Stilostomella Guppy, 1894

Stilostomella subspinosa (Cushman)

Ellipsonodosaria subspinosa CUSHMAN, 1943, p. 92, pl. 16, figs. 6,7.

Stilostomella subspinosa (Cushman). BOLTOVSKOY, 1978, p. 170, pl. 7, figs. 24-28

Test elongate, uniserial, gently tapering. Chambers 7 or more in adult, generally broader than high, except for final few, becoming subglobular and inflated, final chamber may be smaller than penultimate. Sutures distinct, initially flush, later strongly depressed. Surface covered with short to fairly long spines, usually directed basalward, with apparent longitudinal alignment, especially of shorter ones, may coalesce to produce short costae across sutures. Aperture terminal, nearly round, on short neck with phialine lip, no tooth evident.

Remarks: Nodosaria papillosa Silvestri has a very long, slender neck and fewer chambers, while Sagrina virgula Brady is very finely hispid, the chambers are more elongate, and there are fine spines directed basalward from the underside of the wide everted lip.

Superfamily DISCORBACEA Ehrenberg, 1838

Family PLACENTULINIDAE G.K. Kasimova, Poroshina, and
Geodakchan, 1980

Subfamily ASHBROOKIINAE Loeblich and Tappan, 1984

Genus Patellinella Cushman, 1928

Patellinella carinata Collins

Patellinella carinata COLLINS, 1958, p. 407, t.f. 2, pl. 5, fig. 8.---TODD, 1965, p. 9,
pl. 1, figs. 5,6.

Test low conical, triangular in outline and as broad as high, compressed, with acute and carinate margins, base obtusely angled. Chambers uninflated, initially an obscure trochoid coil of 3 chambers, later added 2 per whorl, low and broad. Sutures limbate and flush to raised, drawn out into spines at periphery. Wall perforate, with coarser pores concentrated immediately below sutures. Aperture an arch or loop at inner margin, remaining open until second successive chamber added, whence covered by thin flap, leaving 2 narrow openings, one on each side of inner margin.

Remarks: The test shape, carinate spinose margins, and apertural characteristics are diagnostic.

Patellinella hanzawai Asano

Patellinella hanzawai ASANO, 1936a, p. 613, pl. 31, fig. 3.---ASANO, 1951, pt. 14, p. 1, figs. 3-5.

Test conical, high spired, very gently compressed, dorsal side high convex and evolute, with narrowly rounded apex, ventral side gently concave, periphery triangular ovate in equatorial view, acute and carinate. Chambers uninflated, initially several in whorl, almost immediately 2 per whorl, annular and embracing, breadth of test increasing markedly with each chamber, and greatest breadth not coincident with diameter. Sutures distinct, thin flush. Aperture a fairly clear c ate arch at interiomarginal depression of sunken ventral face.

Remarks: This species is distinguished from most by its smooth wall, and from P. fijiana Cushman which has a sharply pointed apex and spines on the dorsal or

convex side.

Patellinella jugosa (Brady)

Textularia jugosa BRADY, 1884, p. 358, pl. 42, fig. 7.

Patellinella jugosa (Brady). BARKER, 1960, p. 86, pl. 42, fig. 7.

Test elongate, initial whorl trochospiral, remainder of test biserial, flaring quite rapidly, base narrowly rounded, apertural end truncate, periphery rounded. Chambers rectangular in side view, twice as broad as high, not inflated, upper edge furnished with wide, thin, imperforate keel or flange which projects beyond edge of test in outline. Aperture indeterminate due to broken specimens, appears to be confined to final chamber.

Remarks: The nature of the aperture is crucial to the proper assignment of this species. Unfortunately Brady's type figures are heavily shaded and do not show the aperture clearly. Loeblich and Tappan (1964) explicitly stated that this species did not belong to Patellinella because both chambers in the final whorl open into the umbilicus, although this is not apparent in the present specimens. Recognition of the initial trochospiral whorl as such was not possible.

Family BAGGINIDAE Cushman, 1927

Subfamily BAGGININAE Cushman, 1927

Genus Baggina Cushman, 1926

Baggina indica (Cushman)

Pulvinulina indica CUSHMAN, 1921, p. 332.

Cancris indicus (Cushman). ASANO, 1951, pt. 14, p. 20, figs. 146, 147.---BARKER, 1960, p. 218, pl. 106, fig. 6.

Baggina indica (Cushman). BELFORD, 1966, p. 96, pl. 15, figs. 10-14.

Test low trochospiral, somewhat auriculate in outline, not quite twice as long as broad, and about as thick as broad at final chamber, periphery very broadly rounded and strongly lobulate. Chambers 5 in outer whorl, increasing extremely rapidly in size as added, not too strongly inflated on dorsal side, neither on ventral,

but chambers are very much thickened on that side, tumid and inflated ventralward. Sutures very gently depressed on dorsal side and rather obliquely curved, more strongly depressed and essentially radial on ventral side. Wall densely and distinctly perforate, but not coarsely so, with oval hyaline imperforate area on ventral side adjacent to umbilicus. Aperture: a fairly high slit, running for full ventral interiomarginal extent of final chamber, with distinct lipped chamber surface.

Remarks: The very broadly rounded periphery, extremely rapid increase in chamber size and ventral thickness, and pattern of perforations is distinctive.

Genus Canceris de Montfort, 1808

Canceris auriculus (Fichtel and Moll)

Nautilus auricula var. α FICHTEL AND MOLL, 1798, p. 108, pl. 20, figs. a-c.

Pulvinulina auricula (Fichtel and Moll). CUSHMAN, 1915, p. 53, pl. 22, fig. 1.---
CUSHMAN, 1921, p. 329, pl. 69, fig. 3.

Canceris oblongus (Williamson)? BARKER, 1960, p. 218, pl. 106, figs. 4,5.

Canceris auriculus (Fichtel and Moll). TODD, 1965, p. 22, pl. 5, fig. 3.---BELFORD, 1966, p. 96, pl. 15, figs. 1-5.---ROGL AND HANSEN, 1984, p. 67, t.f. 28, pl. 26, figs. 3-8.

Canceris auricula (Fichtel and Moll). MURRAY, 1971, p. 137, pl. 57, figs. 1-7.

Test low trochospiral, auriculate in outline, periphery slightly lobulate in later stages, initially very narrowly rounded, later acute, in either case with very fine imperforate carina. Chambers increase very rapidly in size as added, almost as high as broad, on dorsal side uninflated, on ventral side gently inflated, with imperforate umbilical flap, successive flaps partially resorbed to leave chambers with raised and rounded triangular surfaces bordering the umbilical region, separated for a short distance by deep sutural depressions. Sutures distinct, on dorsal side flush and very strongly curved but not oblique, on ventral side radial, straight and depressed. Aperture interiomarginal, a low arch covered by broad umbilical flap.

Remarks: Rotalina oblonga Williamson has chambers very much broader than high, and lacks the rounded triangular umbilical shoulders so characteristic of the

present species and evident in Barker's figures.

Genus Cibicorbis Hadley, 1934

Cibicorbis sp. A

Test low trochospiral, ovate to broad auriculate in outline, biconvex, dorsal side more strongly so and evolute, ventral side with excavated narrow umbilical region where inner whorls barely discernible, periphery very slightly lobulate, acute, with thin and fairly narrow ragged keel. Chambers 6 to 7 in outer whorl, increasing rapidly in size as added, surfaces very gently convex, arched triangular in outline except for final chamber which is petaloid on both sides. Sutures distinct, limbate, very slightly raised and smooth on ventral side, on dorsal side raised into strong ridges with additional rugae along their length. Wall coarsely perforate on dorsal side, on ventral side outer 1/3 to 1/2 coarsely perforate, while inner portion clear and imperforate, all perforate surfaces with coarse rugae. Aperture ventral, interiomarginal, a low arch opening into umbilicus under rather broad, thin umbilical flap which is extension of imperforate part of chamber.

Remarks: Pulvinulina oblonga (Williamson) var. scabra Brady is very similar in many respects, but is smooth on the ventral side, has depressed sutures on both sides, and these are limbate and radial ventrally, and non-limbate dorsally. Discorbis bodjongensis LeRoy is smooth throughout, and typically but not universally has depressed sutures on both sides. The lack of a prominent apertural face distinguishes the present species from Cibicorbis sp. B.

Cibicorbis sp. B

Test low trochospiral, ovate to broad auriculate in outline, biconvex but barely so, dorsal side more strongly convex and evolute, ventral side almost flat, with excavated narrow umbilical region wherein inner whorls barely discernible; periphery slightly lobulate, acute, with thin and fairly narrow ragged keel, which bifurcates at final chamber to run along both margins of inflated triangular apertural face. Chambers 6 to 7 in outer whorl, increasing rapidly in size as added,

surfaces very gently convex and arched triangular except for final chamber, which is petaloid on the ventral side only. Sutures distinct, limbate, on dorsal side raised into strong ridges with additional scattered rugae, on ventral side very slightly raised and smooth. Wall on dorsal side coarsely perforate, on ventral side only outer 1/2 coarsely perforate, while inner portion clear and imperforate, all perforate surfaces with sparse coarse rugae. Aperture ventral, interiomarginal, a low arch opening into umbilicus under thin broad imperforate flap which is umbilical extension of final chamber.

Remarks: It is distinguished from other similar species in the same manner as is Cibicorbis sp. A, and is distinguished from that species by its inflated, triangular ventral apertural face.

Genus Valvulineria Cushman, 1926

Valvulineria sp. cf. V. arctica Green

Nonionella sp. (?). CUSHMAN, 1933d, p. 46, pl. 11, fig. 3.

Valvulineria arctica GREEN, 1960, p. 71, pl. 1, fig. 3.---LAGOE, 1977, p. 126, pl. 4, figs. 9,13,18.---COLE, 1981, p. 97, pl. 12, fig. 3.

Nonionella sp. A BELFORD, 1966, p. 160, pl. 31, figs. 21-23.

Test very low trochospiral, somewhat flattened, periphery very gently lobulate and well rounded. Chambers 8 in outer whorl, very gently inflated, increasing steadily but not rapidly in size as added, not very much broader than high. Sutures distinct, gently depressed, somewhat oblique and nearly straight on both sides. Aperture interiomarginal, extending almost from dorsal side across periphery to umbilicus, obscured by umbilical extensions of chambers which are separated from rest of chamber by distinct furrow, and are fused to form a rather ragged raised rim, circling but not closing umbilicus.

Remarks: The present specimens agree very well with the type, although the type figure has a dashed-in reconstruction of a broken umbilical flap. Neither the present material nor any other in synonymy has preserved umbilical flaps proper.

The number of chambers, their slow increase in size, and style of umbilical chamber extensions are unknown from any other form in the literature. The unnamed forms referred by Cushman (1933d) and Belford (1966) to Nonionella are considered to be identical, on the assumption that the narrow flaps of their specimens are the broken remnants of chamber extensions as seen in the current study. The chambers are evidently insufficiently elongate to place this form in that genus, and the furrow separating the extensions from the chamber proper is also unknown in that genus.

Valvulineria inaequalis (d'Orbigny)

Valvulina inaequalis d'ORBIGNY, 1839c, p. 48, pl. 7, figs. 10-12.

Valvulineria inaequalis (d'Orbigny). INGLE *et al.*, 1980, p. 146, pl. 6, figs. 2-4.

Test low trochospiral, somewhat auriculate in outline, biconvex, ventral side more strongly so, periphery lobulate, angled and perhaps imperforate, but not carinate. Chambers 5 in outer whorl, on dorsal side inner whorl very small because chambers increase very rapidly in size as added, inflated on both sides, more so ventrally. Sutures distinct, on dorsal side strongly curved and very gently depressed, on ventral side radial and depressed. Aperture unknown due to broken final chamber, presumed interiomarginal and umbilical-extraumbilical, under small flap

Remarks: The angled lobulate periphery and auriculate test distinguish this species from most, as does the very rapid increase in chamber size.

Valvulineria minuta (Schubert)
(Plate 4, Figures 5-7)

Discorbina rugosa (d'Orbigny). BRADY, 1884, pl. 91, fig. 4

Discorbina rugosa (d'Orbigny) var. minuta SCHUBERT, 1904, p. 420.

Valvulineria rugosa var. minuta (Schubert). BARKER, 1960, p. 188, pl. 91, fig. 4.

Rotamorphina minuta (Schubert). BELFORD, 1966, p. 156, pl. 37, figs. 11-15.

Valvulineria araucana (d'Orbigny). ?INGLE *et al.*, 1980, p. 146, pl. 8, figs. 9, 10, not 11

Test low trochospiral, somewhat ovate in outline, periphery rounded and gently lobulate. Chambers usually 6 or 7, rarely 8, in final whorl, increasing

gradually in size as added, gently inflated. Sutures flush to gently depressed, radial and curved on dorsal side; depressed and straight, somewhat oblique on ventral side. Aperture interiomarginal, ventral, opening into umbilicus under thin and rather broad flap of final chamber that does not completely cover umbilical area, so that final 4 or more flaps are visible in oblique view of umbilical area.

Remarks: Several species need to be distinguished from the present one.

Rosalina rugosa d'Orbigny and Discorbina bradvana Fornasini lack the umbilical flaps, while the former species, V. vilardoboana var. glabra Cushman and V. laevigata Phleger and Parker have 5 chambers at most in the outer whorl. Valvulina inflata d'Orbigny is flat on the dorsal side and strongly convex ventrally, with chambers thicker than high in axial view. Rosalina araucana d'Orbigny is conical dorsally, concave ventrally, and has a subacute periphery. Without an axial view, it is not possible to confidently refer pl. 8, figs. 9 and 10 of Ingle *et al* to the present species. The dorsal surface appears flat, which rules it out of V. araucana, while the ventral side appears less strongly convex than that of V. inflata. The specimen in fig. 11 has too few chambers to belong to the present species.

Valvulineria sp. A

Nonionellina atlantica (Cushman). PATTERSON, 1986a, p. 238, pl. 56, figs. 8-10 (given in plate caption as Nonionella atlantica Cushman).

Test very low trochospiral, auriculate in outline, biconvex with ventral side more strongly so, but the whole somewhat compressed, dorsal side wholly evolute, ventral side involute, with deep and rather broad umbilicus, periphery non-lobulate and well rounded. Chambers approximately 10 in outer whorl, twice as broad as high, increasing fairly rapidly in size as added, inflated gently on ventral side only. Sutures distinct, nearly straight to gently curved, somewhat oblique, limbate. Aperture interiomarginal, running from periphery back under umbilical flap, which is a rather ragged hooked projection leaving much of umbilicus and previous flaps exposed.

Remarks: This species is distinguished from V. arctica by its broader chambers and auriculate outline, and from both Valvulina auris d'Orbigny and Nonionella miocenica Cushman which are thicker, lobulate, and have well developed large circular flaps covering the umbilicus. Nonionella atlantica Cushman is not so auriculate in outline, the chambers are much broader on the ventral side and close the umbilicus, and they lack the small umbilical flaps. The form of Patterson (1966a) is therefore referred herein to the present species.

Valvulineria sp. B

Test very low trochospiral, flattened, dorsal side evolute, with inner whorls depressed, ventral side somewhat involute, but inner whorls faintly visible in fairly deep and wide umbilicus which has well-rounded shoulder, periphery very gently lobulate and broadly rounded, and the test outline, exclusive of the lobulation, is rather irregular or wavy, in the manner of a hand-drawn curve. Chambers 8 in outer whorl, gently inflated, increasing slowly in size as added. Sutures distinct, finely limbate, nearly straight, radial on ventral side, and barely oblique on dorsal. Wall unusually coarsely perforate for the genus. Aperture interiomarginal, from umbilicus to dorsal limit of periphery, with small rough triangular projections of chambers into, but not covering, umbilicus.

Remarks: The coarse perforation, high number of chambers, and irregular test outline are quite distinctive. This species, as well as V. arctica and others in the present study, may well represent some genus that is not truly Valvulineria, as it is highly unlikely that so many specimens should be missing umbilical chamber flaps.

Valvulineria sp. C

Test low trochospiral, nearly auriculate in outline, evolute dorsal side gently convex, involute ventral side strongly so, chambers tumid and so thick as to be nearly equal to test breadth, periphery non-lobulate and rounded. Chambers 5 1/2 in outer whorl, expanding extremely rapidly in size and thickness as added, uninflated though strongly convex on ventral side. Sutures limbate, flush to very slightly

depressed, radial and straight on both sides. Aperture an interiomarginal slit from tiny umbilicus out to periphery.

Remarks: The extremely rapid chamber expansion and great thickness, as well as flush sutures, are diagnostic. This form too may not be a true Valvulineria.

Valvulineria sp. D

Test low trochospiral, somewhat oval in outline, dorsal side evolute, gently, convex, ventral side involute, with very narrow, fairly deep umbilicus, strongly convex, periphery gently lobulate and broadly rounded. Chambers 6 in outer whorl, inflated gently and increasing quite rapidly in size as added, particularly in thickness on ventral side. Sutures distinct, gently depressed, limbate, barely curved and nearly radial. Wall quite coarsely perforate. Aperture a low interiomarginal slit, from dorsal side of periphery to umbilicus.

Remarks: The oval outline and rapid thickness increase distinguish this species from most, and its depressed sutures from Valvulineria sp. C. Again, there are no umbilical flaps.

Valvulineria sp. E

Test low trochospiral, very gently biconvex, dorsal side wholly evolute, ventral side wholly involute, with minute umbilicus, periphery gently lobulate, slightly angled but rounded. Chambers 7 in outer whorl, gently inflated but more strongly so on ventral side, increasing slowly in size as added, on dorsal side not much broader than high and somewhat curved, on ventral side fairly narrow triangular. Sutures distinct, depressed, on dorsal side slightly limbate, curved and nearly oblique, on ventral side curved and radial. Aperture an interiomarginal slit, running from dorsal extremity of periphery and visible from that side as a notch, to umbilicus, which is not open and has no flap.

Remarks: The complete lack of an umbilicus and flaps distinguishes this species from Valvulineria sp. cf. V. arctica and Valvulineria sp. A, and the flattened form and slow increase in chamber size from Valvulineria spp. C and D.

Valvulineria sp. B has coarse perforations, an irregular outline, and an open umbilicus as the principal differences.

Valvulineria? sp. F

Test low trochospiral, biconvex, dorsal side evolute and inner whorls flush with outer one, ventral side more strongly convex, involute, with small umbilicus, periphery broadly rounded and lobulate. Chambers 8 in outer whorl, inflated, increasing steadily in size as added, on dorsal side quadrate subglobose, on ventral side broad triangular. Sutures distinct, depressed, on dorsal side nearly radial and very gently curved, on ventral side radial and straight, initially limbate. Aperture interiomarginal, a low slit running from umbilicus to dorsal extreme of periphery, with very fine bordering lip.

Remarks: As is the case with Valvulineria sp. E, the umbilicus is not open. The present species is more nearly circular in outline, with radial sutures and less broad chambers.

Valvulineria sp. G

Test low trochospiral, somewhat flattened and nearly circular in outline, dorsal side evolute and flat, ventral side somewhat evolute, with very broad, deep umbilicus that is usually covered, otherwise previous whorls visible; periphery broadly rounded, non-lobulate to slightly incised at sutures. Chambers 7 or 8 in final whorl, increasing very slowly in size as added, on dorsal side almost as high as broad, nearly uninflated, on ventral side equant triangular in outline, with broad thin flap covering umbilicus completely, all previous flaps evidently resorbed and missing, leaving sharply shouldered, rounded inner terminations of chambers surrounding umbilicus when final flap removed. Sutures distinct, barely depressed, limbate, nearly radial and very gently curved on dorsal side, on ventral side radial, straight, incised, becoming more deeply and broadly so toward umbilicus. Wall very heavily and quite coarsely perforate, except for ventral surface of chambers within the umbilical region and at the shoulders. Aperture a low interiomarginal slit, from

periphery to umbilicus, under flap.

Remarks: The outline and rounded periphery distinguish this species from Caneris, but the shouldered umbilicus and incised ventral sutures are similar. These latter features, as well as the coarse perforations and near radial dorsal sutures, distinguish this from other species of Valvulineria.

Family EPONIDIDAE Hofker, 1951

Subfamily EPONIDINAE Hofker, 1951

Genus Alabaminella Saidova, 1975

Alabaminella pusilla (Parr)

Eponides pusillus PARR, 1950, p. 360, pl. 14, fig. 16.

Test low trochospiral, lenticular to inequally biconvex, dorsal side evolute and more strongly convex, with several very narrow whorls, ventral side wholly involute, low rounded convex; periphery entire, distinctly angled but narrowly rounded. Chambers just over 4 in outer whorl, increasing slowly in size as added, on dorsal side uninflated, higher than broad, and curved quadrate in outline, on ventral side triangular, very gently inflated. Sutures distinct, on dorsal side slightly limbate, flush and oblique, on ventral side depressed, radial, gently sinuate. Wall polished, not hyaline. Aperture a very fine interiomarginal slit between, but not reaching either of, umbilicus and periphery.

Remarks: This species differs from A. weddellensis in having an angled rather than rounded periphery.

Alabaminella weddellensis (Earland)
(Plate 9, Figures 4-6)

Eponides weddellensis EARLAND, 1936, p. 57, pl. 1, figs. 65-67.

Eilohedra levicula (Resig). INGLE *et al*, 1980, p. 134, pl. 2, figs. 2,3.

Eilohedra weddellensis (Earland). THOMAS, 1985, p. 676, pl. 13, figs. 5,6.

Nuttallides weddellensis (Earland). PATTERSON, 1986a, p. 173, pl. 39, figs. 7-10.

Test low trochospiral, small, compact, unequally biconvex, dorsal side more

strongly so; periphery lobulate and well rounded. Chambers 5 or 6 in final whorl, rhomboid on dorsal side, with as many as 4 whorls visible, triangular and slightly inflated on ventral side. Sutures distinct, essentially flush, oblique and straight on dorsal side; radial, straight to occasionally curved or slightly sigmoid, depressed on ventral side. Aperture an interiomarginal arch, of considerable lateral extent, bordered above by prominent flap, skewed toward periphery, in depression of apertural face which is reflexed forward at periphery.

Remarks: Thomas placed Epistominella levicula Resig in synonymy with the present species, but Resig's form has an "L"-shaped aperture, with a linear component up the apertural face, which causes it to be placed in the genus Eilohedra Lipps. Eponides pusillus Parr differs by having a low apertural face and slit-like aperture, as well as a angled periphery.

Alabaminella sp. A

Test low trochospiral, circular in outline, inequally biconvex, dorsal side quite strongly convex, evolute, and exhibiting over 3 narrow whorls, ventral side gently convex, rounded, involute with fine umbilicus; periphery mildly lobulate, and acutely angled but slightly rounded to sharp. Chambers 8 or so in outer whorl, increasing slowly in size as added, on dorsal side a bit higher than broad, uninflated, whole dorsal side smooth and may be slightly undulose, on ventral side gently inflated and rather narrow triangular. Sutures distinct, on dorsal side flush, thinly limbate and oblique, on ventral side gently depressed, nearly radial, with distinctly curved peripheral ends. Wall on dorsal side very finely perforate, on ventral side quite coarsely perforate. Aperture a small interiomarginal slit, extraumbilical and stopping short of periphery.

Remarks: This species is distinguished from A. weddellensis by its acutely angled periphery, flatter ventral side, and more flush dorsal sutures, and from A. pusilla in having many more chambers per whorl.

Genus Eponides de Montfort, 1808

4

Merced

Eponides parantillarum Galloway and Heminway

Eponides parantillarum GALLOWAY AND HEMINWAY, 1941, p. 374, pl. 18, fig. 1.

Neoeponides parantillarum (Galloway and Heminway). BELFORD, 1966, p. 118, pl. 17, figs. 13-15; pl. 18, figs. 1-3.

Test low trochospiral, thick and almost equally biconvex, ventral side slightly moreso, periphery circular and nearly entire to very slightly lobulate, furnished with a thick, somewhat rounded keel. Chambers 7 in outer whorl, increasing slowly in size as added, on dorsal side somewhat narrow, uninflated, all but outer whorl covered by thick boss, on ventral side triangular and inflated, with inner or umbilical margins heavily thickened and raised or inflated. Sutures on dorsal side obscure, thinly limbate, oblique and flush, on ventral side radial, depressed, and gently sigmoid. Aperture interiomarginal, running almost from umbilicus to a point about halfway to periphery, a fairly high arch with fine bordering lip.

Remarks: The thickened umbilical margins of the chambers are not to be confused with the foliar chamberlets of Neoeponides Reiss. Most otherwise similar forms are inequally biconvex with the dorsal side strongly so, while Rotalina antillarum d'Orbigny is highly lobulate, with depressed sutures on both sides, and petaloid chambers on the dorsal side.

Eponides punctulatus (d'Orbigny)

Rotalia (Rotalia) punctulata d'ORBIGNY, 1826, p. 273.

NOT Pulvinulina punctulata (d'Orbigny). CUSHMAN, 1915, p. 52, pl. 24, fig. 1.

NOT Eponides punctulatus (d'Orbigny). BARKER, 1960, p. 214, pl. 104, fig. 17.

Test low trochospiral, very low biconvex to planoconvex, dorsal side quite strongly convex, evolute with innermost whorls covered by translucent boss, ventral side flat to very gently convex, involute, with closed to narrow open umbilicus, periphery angled, acute to very narrowly rounded, non-lobulate and apparently imperforate. Chambers 9 or more in outer whorl, very gently inflated on both sides but moreso on ventral, quite strongly curved. Sutures distinct to obscure, gently

depressed, strongly curved. Aperture a very low ventral interiomarginal slit, stopping short of periphery.

Remarks: The shape, number of chambers, and strongly curved, gently depressed sutures combine to distinguish this species, as does the very small to rarely absent umbilicus. Cushman (1915) and Barker illustrated forms with well rounded periphery, and only 7 strongly inflated petaloid to globose chambers per whorl, which seem to belong to another species.

Eponides turgidus Phleger and Parker

Eponides turgidus PHLEGER AND PARKER, 1951, p. 22, pl. 11, fig. 9.---POAG, 1981, p. 65, pl. 1, fig. 4; pl. 2, fig. 4.

Eponides tumidulus (Brady). TODD, 1965, p. 21, pl. 7, fig. 1.

Test nearly high trochospiral, inequally biconvex, dorsal side more strongly so and evolute, ventral side flattened and wholly involute, periphery well rounded, not so much lobulate as angulate in outline, a pentagon with rounded corners and slightly concave sides at the sutures. Chambers $4\frac{1}{2}$ to 5 in outer whorl, increasing slowly in size as added, on dorsal side strongly curved, much higher than broad, and barely inflated, on ventral side triangular and inflated. Sutures distinct, on dorsal side radial and nearly flush, spiral suture depressed somewhat, ventral sutures radial, straight, depressed. Aperture a fairly high and broad interiomarginal arch, between periphery and umbilicus but closer to latter, bordered above by fine lip.

Remarks: This species is distinguished from Ioanella tumidula which has a distinct umbilicus, a more lobulate periphery, and depressed dorsal sutures. Todd's form was insufficiently lobulate, and too smooth and compact to be referred to that species. Epistominella levicula Resig is very similar, but has an "L"-shaped aperture, while Alabaminella weddellensis is less robust, lower-spired, and has more chambers per whorl.

Eponides sp. A

Test small, low trochospiral, biconvex to planoconvex, dorsal side convex and

evolute, ventral side lower convex to nearly flat, involute but with very shallow open umbilical region, periphery non-lobulate and entire, with fairly broad acute hyaline keel. Chambers 7 or so in outer whorl, increasing steadily in size as added, on dorsal side uninflated, on ventral side very gently inflated and curved triangular. Sutures distinct, on dorsal side flush, strongly curved and limbate, as thick as keel is broad and merging with it, on ventral side limbate, initially flush and later very gently depressed, quite strongly curved and merging with keel. Aperture interiomarginal, a fairly high short arch well inboard from periphery, and thinning out as umbilical extremity of final chamber is reached.

Remarks: The principal distinguishing features are the broad keel and merging limbate sutures, as well as the nearly planoconvex shape and short, high arched aperture.

Genus Ioanella Saidova, 1975

Ioanella tumidula (Brady)
(Plate 9, Figures 11-13)

Truncatulina tumidula BRADY, 1884, p. 666, pl. 95, fig. 8.---CUSHMAN, 1915, p. 38, pl. 15, fig. 3.

Eponides tumidulus (Brady). BARKER, 1960, p. 196, pl. 95, fig. 8.---PFLUM AND FRERICH, 1976, pl. 2, figs. 4,5.---POAG, 1981, p. 64, pl. 1, fig. 2; pl. 2, fig. 2.

NOT Eponides tumidulus (Brady). TODD, 1965, p. 21, pl. 7, fig. 1.

Eponides bradyi Earland. ?HERMELIN AND SCOTT, 1985, p. 208, pl. 4, figs. 5,6.

Test trochospiral, periphery rounded and lobulate, dorsal side a fairly high spire of 3 whorls. Chambers 5 to 6 in final whorl, inflated and subglobular. Sutures depressed, straight and radial on ventral side, straight and slightly oblique on dorsal side. Aperture interiomarginal, short, bordered above by lip, completely removed from both the periphery and narrow, excavated umbilicus, which is surrounded by small perforations which are distinctly larger than the normal perforations of the wall.

Remarks: The specimens referred by Hermelin and Scott to E. bradyi are not

that species, which has flush sutures and an acute or angled periphery. They appear to be referable to the present species, although without an axial view, it is impossible to be certain. The other possibility is that they belong to Alabaminella weddellensis, but the sutures appear to be too strongly depressed and the outline too lobulate for that species. The exclusion of Todd's form has been discussed under Eponides turgidus, to which it has been referred herein.

Family HELENINIDAE Loeblich and Tappan, 1987

Genus Rhaptohelenina Clark (in press,a)

Rhaptohelenina papuanensis Clark

Rhaptohelenina papuanensis CLARK, in press,a.

Test low trochospiral, nearly lenticular, dorsal side evolute and the more strongly convex, ventral side involute, with very narrow, deep umbilicus, somewhat sunken in low convex face; outline rounded, nearly entire, and almost non-lobulate. Chambers 7 in outer whorl, increasingly but gently inflated and increasing steadily in size as added, on dorsal side triangular petaloid, on ventral side triangular. Sutures distinct, gently depressed, on dorsal side quite strongly oblique and very gently curved to almost straight, on ventral side radial and straight. Wall in adult heavily calcified and thick, finely perforate. Aperture multiple; primary aperture an interiomarginal slit running into umbilicus and about 2/3 of distance to periphery, whence it curves somewhat obliquely a short distance up the inflated apertural face, bordered above by extremely low lip, apertural face reflexed forward beyond aperture to join periphery almost at second chamber in outer whorl; secondary aperture consists of multiple sutural openings on both sides of test, with thin flaps bridging the sutures, often reduced in adult by the heavy calcification to leave fine sutural pores or mere frosted pinpoint traces. Rarely juveniles may have a few large openings in outer shell layer on chamber surface independent of sutures.

Remarks: Discorbina polystomelloides Parker and Jones has radial sutures on both sides, is more nearly equally biconvex, strongly lobulate, and has more

chambers per whorl. The apertural style, suture orientation and lack of ventral chamberlets is distinctive.

Family BUENINGIIDAE Saidova, 1981

Genus Bueningia Finlay, 1939

Bueningia creeki Finlay

Bueningia creeki FINLAY, 1939, p. 123, pl. 14, figs. 82-84.

Bueningia creeki Finlay. TODD, 1965, p. 28, pl. 8, fig. 4.---BELFORD, 1966, p. 99, pl. 13, figs. 6-11.

Test rather globose, very low trochospiral, ventral side tumid, strongly convex, wholly involute, dorsal side flattened to concave, very slightly evolute and deeply umbilicate, periphery almost entire, with thick blunt imperforate keel producing truncate dorsal side, last chamber with keel barely developed and periphery broadly rounded. Chambers 5 in outer whorl, increasing very rapidly in size as added, most of thickness increase in ventral direction, latterly slightly inflated. Sutures distinct, on ventral side radial, curved slightly, and gently depressed, on dorsal side heavily limbate, flush, radial. Wall very thick, hyaline, with fine pores of appreciable depth. Aperture dorsal, extraumbilical, a large broad arch from edge of peripheral carina to a point on tangent to umbilicus proper, with heavy bordering lip, which is produced as somewhat triangular flap closer to periphery; preceeding flaps apparent, and penultimate aperture may be discernible.

Remarks: There is nothing quite like this species. Loeblich and Tappan (1964, 1987) referred to the convex side as the dorsal, likely due to the apertural location on the flat side. All other authors, including Finlay, have said the dorsal side is umbilicate, and this is particularly clear on juvenile specimens from the present study.

Family DISCORBIDAE Ehrenberg, 1838

Genus Neoeponides Reiss, 1960

Neoeponides auberii (d'Orbigny)

Rosalina auberii d'ORBIGNY, 1839a, p. 94, pl. 4, figs. 5-8.

Discorbis turbo (d'Orbigny). CUSHMAN, 1915, p. 10, t.f. 9, pl. 11, fig. 2

Discorbis mira CUSHMAN, 1922b, p. 39, pl. 6, figs. 10, 11.

Discorbina (?) mira (Cushman). BARKER, 1960, p. 180, pl. 87, fig. 8.

Rotorbinella mira (Cushman). TODD, 1965, p. 18, pl. 8, fig. 2.

Neoeponides auberii (d'Orbigny). LOEBLICH AND TAPPAN, 1987, p. 558, pl. 605, figs. 5-7.

Test low trochospiral, about equally biconvex, dorsal side evolute, ventral side involute, periphery with quite broad, thin keel, lobulate. Chambers 5 or 6 in outer whorl, increasing quite rapidly in size as added, on dorsal side uninflated, curved quadrangular, on ventral side triangular petaloid, inflated, with elongate chamberlet arising at the umbilical extremity, running along posterior margin, often lapping onto chamber, separated by nearly incised suture, those of all but final few chambers fuse to form umbo or flat plate. Sutures distinct, on dorsal side limbate, strongly curved and flush, on ventral side quite strongly curved and strongly incised, quite broad. Wall on dorsal side highly polished and thick on inner whorls, outer whorls with very sparse coarse pores, ventral side with fairly coarse perforations on primary chambers, chamberlets and umbilical plate mildly translucent. Aperture a fairly large slit or low arch from umbilicus to near periphery, with fairly broad lip developed, and a small posterior sutural component as well.

Remarks: The present forms correspond very closely to Cushman's (1922b) type description and figures, though not obviously to d'Orbigny's (1839a), which show a more lobulate outline, and no evident chamberlets, umbilical flap, or incised sutures. The synonymy of the two species is based solely on Loeblich and Tappan (1987).

Genus Streblroides Bermúdez and Seiglie, 1963

Streblroides sp. A

Test low trochospiral, nearly circular in outline, biconvex, evolute dorsal side more strongly so, ventral side involute with fairly large, deep umbilicus, periphery

well rounded, essentially non-lobulate. Chambers 6 in outer whorl, increasing quite rapidly in size as added, on dorsal side petaloid/triangular in outline, barely inflated in later stages, on ventral side rather triangular to rounded triangular, inflation prominent toward umbilicus, where rounded lobe with distinct reentrant notch on posterior intercameral suture is developed. Sutures distinct, on dorsal side depressed oblique, on ventral side radial, increasingly depressed toward umbilicus. Wall on dorsal side densely and coarsely perforate, on ventral side barely perforate. Aperture ventral, primarily interiomarginal, a fairly high arch from near periphery to umbilicus, bordered above in its extraumbilical portion by a very strong but narrow lip, successive apertures remain open at umbilicus.

Remarks: This species differs from Strebloides sp. B in having a high arched aperture, nearly circular outline, and a non-lobulate periphery.

Strebloides sp. B

Test low trochospiral, both faces flattened, dorsal side evolute but inner whorls obscured by boss, ventral side partially evolute, umbilicus fairly broad, with prominent high free-standing plug; periphery lobulate, well rounded but slightly angled. Chambers 6 or 7 in outer whorl, increasing steadily in size as added, inflated on both sides, more so ventrally, and especially around umbilicus, where chamber extremity is produced as a rounded retrally directed lobe, with a strong reentrant along the posterior margin at the intercameral suture. Sutures distinct, depressed, well curved dorsally and slightly so ventrally. Aperture an interiomarginal opening from ventral side of periphery under umbilical lobe, and into posterior reentrant.

Remarks: This species is distinguished from Strebloides sp. A in being flatter, having more pronounced depression of the sutures, and lacking a well arched extraumbilical apertural component.

Genus Trochulina d'Orbigny, 1839

Trochulina turbo (d'Orbigny)

Rotalia (Trochulina) turbo d'ORBIGNY, 1826, p. 274.

NOT Discorbis turbo (d'Orbigny). CUSHMAN, 1915, p. 10, t.f. 9, pl. 11, fig. 2.

Trochulina turbo (d'Orbigny). LOEBLICH AND TAPPAN, 1987, p. 559, pl. 607, figs. 1-3.

Test low trochospiral, planoconvex to unequally biconvex, dorsal side more strongly convex and evolute, with heavy polished boss on surface, ventral side nearly flat, involute, periphery circular and entire, with broad imperforate acute carinal band that is not produced as keel. Chambers 6 or 7 in outer whorl, increasing steadily in size as added, on dorsal side uninflated and rhomboidal, on ventral side gently inflated and triangular, with very slightly sunken umbilical chamberlets. Sutures distinct, on dorsal side limbate, flush and gently oblique, on ventral side radial, depressed, gently curved. Wall polished and coarsely but sparsely perforate on dorsal side, on ventral side with dense perforations except on chamberlets, which fuse at umbilicus. Aperture a primary extraumbilical interiomarginal slit or low arch, with fine lip, and a secondary component as intercameral sutural slits.

Remarks: The apertural characteristics, entire carinate periphery, and style of perforations distinguish this species. Cushman's figures clearly show the hooked chamberlets of Neoponides auberii, as well as the deeply incised sinuate sutures of that species.

Family ROSALINIDAE Reiss, 1963

Genus Gavelinopsis Hofker, 1951

Gavelinopsis lobatulus (Parr)

Discorbis lobatulus PARR, 1950, p. 354, pl. 13, figs. 23-25.

Gavelinopsis lobatulus (Parr). BARKER, 1960, p. 182, pl. 88, fig. 1.---

BOLTOVSKOY, 1978, p. 160, pl. 4, figs. 12,13.---WESTON, 1985, pl. 2, figs. 2,3.

Gavelinopsis praegeri (Heron-Allen and Earland). TODD, 1965, p. 18, pl. 8, fig. 1.

Eponides repandus (Fichtel and Moll). ?HERMELIN AND SCOTT, 1985, p. 208, pl. 4, figs. 7,8.

Test low trochospiral, almost equally biconvex, ventral side with well developed umbo covering umbilical region, periphery lobulate and carinate, keel

occasionally becoming wide and thin. Chambers 6 or sometimes 7 in final whorl, on ventral side inflated, triangular in outline, on dorsal side petaloid, only slightly inflated for final few chambers. Sutures limbate, curved, nearly oblique and usually flush, later very slightly depressed on dorsal side; on ventral side radial, depressed, very gently curved. Aperture interiomarginal, gently arched, from umbilical plug to near periphery, bordered above by fine lip.

Remarks: Gavelinopsis praegeri is flat on the ventral side, and the chambers are petaloid on both faces of the test, in contrast to Todd's specimen. Nautilus repandus Fichtel and Moll is involute on both faces, with triangular chambers numbering 9 in the outer whorl, and differs from the figured specimen of Hermelin and Scott. They did not furnish a ventral view, but from the other views and description it seems likely that their specimen is identical to those of the present species. Rosalina isabelleana d'Orbigny has a deep umbilicus without covering plug, and strongly inflated equant chambers on the ventral side.

Gavelinopsis praegeri (Heron-Allen and Earland)

Discorbina praegeri HERON-ALLEN AND EARLAND, 1913, p. 122, pl. 10, figs. 8-10.

NOT Gavelinopsis praegeri (Heron-Allen and Earland). TODD, 1965, p. 18, pl. 8, fig. 1.

Gavelinopsis praegeri (Heron-Allen and Earland). MURRAY, 1971, p. 133, pl. 55, figs. 1-5.---COLE, 1981, p. 95, pl. 19, figs. 52,53.

Test low trochospiral, nearly planoconvex, dorsal side evolute, showing 3 full whorls, undulose and strongly convex, ventral side involute, very slightly convex, periphery gently lobulate, acute, with narrow imperforate keel. Chambers 5 in outer whorl, petaloid on dorsal side, broad triangular and inflated on ventral side. Sutures distinct, on dorsal side limbate, flush, curved and oblique, on ventral side depressed, nearly radial to distinctly curved and slightly oblique. Wall on dorsal side polished, on ventral side coarsely perforate almost to the peripheral edge of chambers. Aperture a low interiomarginal arch, may continue beyond umbilical extension of

chamber as a slit, umbilicus with irregular umbo of clear material.

Remarks: This species differs from G. lobatulus in being almost planoconvex, with a less well-defined umbo and coarse ventral perforations. The reasons for referring Todd's (1965) illustrated specimen to that species have been discussed. The chamber shape and suture style distinguish it from Gavelinopsis sp. A.

Gavelinopsis sp. A

Test low trochospiral, equally biconvex, dorsal side evolute, ventral side involute except for large clear umbilical plug, periphery nearly entire, acute and carinate. Chambers 7 or rarely 6 in outer whorl, uninflated on dorsal side, on ventral side gently to quite strongly inflated. Sutures distinct, on dorsal side limbate, flush, strongly curved and radial, on ventral side curved and radial, depressed. Wall smooth, imperforate, with heavy clear calcification on dorsal side, but on ventral side coarsely perforate. Aperture incompletely known, interiomarginal and likely a low slit between umbo and periphery.

Remarks: The sutures on G. lobatulus are dorsally oblique and ventrally radial, and that species does not have the coarsely perforate ventral side that characterizes the present form. Gavelinopsis praegeri is flat on the ventral side, in addition to other differences already noted for that species.

Genus Neoconorbina Hofker, 1951

Neoconorbina circularis (Sidebottom)

Discorbina circularis SIDEBOTTOM, 1918, p. 253, pl. 6, figs. 4,5.

Planodiscorbis circularis (Sidebottom). BARKER, 1960, p. 186, pl. 90, fig. 4.

Test low trochospiral, planoconvex, dorsal side evolute and strongly convex, ventral side involute and flat, outline circular, periphery entire and acute, with very wide, thin keel. Chambers 3 in outer whorl, on dorsal side narrow crescentic and slightly inflated, on ventral side curved and slightly inflated, embracing. Sutures somewhat obscure, oblique, curved, and slightly depressed on both sides. Aperture an interiomarginal slit or low arch between umbilicus and periphery,

under a very irregular chamber margin.

Remarks: Discorbina tubercapitata Chapman has a narrower keel, and a very swollen, rounded set of inner whorls on the dorsal side, such that it looks almost like a bowler hat in profile.

Neoconorbina floridensis (Cushman)

Discorbis bertheloti (d'Orbigny) var. floridensis CUSHMAN, 1930, p. 364, pl. 33, fig. 13.

Neoconorbina floridensis (Cushman). TODD, 1965, p. 15, pl. 2, fig. 4.

Rosalina floridensis (Cushman). POAG, 1981, p. 81, pl. 41, fig. 2; pl. 42, fig. 2.

Test low trochospiral, very low concavo-convex and thin, dorsal side evolute, convex, with few whorls, ventral side involute, concave, periphery nearly entire, narrow, with imperforate keel of significant width and thickness. Chambers 4 in outer whorl, increasing very rapidly in size as added and inner whorl consequently very small in diameter, on dorsal side very broad petaloid, uninflated, on ventral side very gently inflated and subpetaloid. Sutures distinct, on dorsal side oblique, curved, limbate and flush, on ventral side very slightly depressed, nearly radial and curved, except for final chamber, where posterior portion has an umbilical lobe and a posterior reentrant. Aperture interiomarginal, a low slit or arch in reentrant ahead of umbilical chamber lobe, bordered by irregular flap, passing out to periphery.

Remarks: This species is distinguished by its low number of rapidly enlarging chambers, its thin low concavo-convex test, and the prominent entire keel.

Neoconorbina pacifica Hofker

Neoconorbina pacifica HOFKER, 1951, p. 438, p. 441, t.f. 302; p. 442, t.f. 303.

Neoconorbina terquemi (Rzehak) et sp. ?BARKER, 1960, p. 182, pl. 88, fig. 4 only.

Test low trochospiral, low conical, dorsal side evolute, quite strongly convex but with irregular profile, ventral side flat, involute, with deeply excavated umbilicus, periphery barely lobulate, with thick, rounded imperforate keel. Chambers 4 in outer whorl, on dorsal side uninflated, narrow crescentiform, on

ventral side slightly inflated, embracing and broad triangular, final chamber nearly but less than 1/2 circumference. Sutures distinct, on dorsal side very narrowly limbate and very slightly depressed, oblique and curved, on ventral side depressed, nearly radial, and curved especially near periphery. Wall on ventral side evenly perforate, on dorsal side with a few scattered coarse pores, and densely packed fine pores in crescentic patches just behind imperforate margins and sutural areas. Aperture a fairly large interiomarginal opening under thin anterior sinuate chamber margin.

Remarks: Discorbina concinna Brady is evenly perforate with no evident imperforate keel, while Neoconorbina marginata Hofker has a broad keel that is turned over toward the dorsal side. The other figured specimens referred by Barker to N. terquemi properly belong there.

Neoconorbina terquemi (Rzehak)

Rosalina orbicularis TERQUEM, 1876, p. 75, pl. 9, fig. 4.

Discorbina terquemi RZEHAKE, 1888a, p. 228.

Discorbis orbicularis (Terquem). CUSHMAN, 1915, p. 16, t.f. 18, pl. 11, fig. 1.

Discopulvinulina orbicularis (Terquem). ASANO, 1951, pt. 14, p. 6, figs. 41-43.

Neoconorbina terquemi (Rzehak). BARKER, 1960, p. 182, pl. 88, figs. 5-8, not 4.

Test low trochospiral, concavo-convex, dorsal side evolute and low convex, ventral side involute and concave, outline circular, periphery entire, acute, with thin, narrow imperforate keel. Chambers 3 in outer whorl, on dorsal side very low crescentiform, uninflated, on ventral side quite strongly curved, embracing, broad crescentiform, barely inflated. Sutures distinct, on dorsal side oblique, curved, and thin limbate, essentially flush, on ventral side strongly curved, gently depressed. Wall with coarse perforations on both sides, dorsally as a single row at both anterior and posterior chamber margins, on ventral side occurring near periphery. Aperture interiomarginal, large, sunken into umbilicus, bordered by thin chamber margin with large angular lobe and reentrants.

Remarks: This form was originally described by Terquem, but renamed by Rzehak because of the priority of a species erected by d'Orbigny. It is distinguished from N. pacifica by being concave ventrally, less convex dorsally, and by having a different pore distribution. The well developed peripheral keel and the pore distribution serve to distinguish this species from Tretomphaloides concinnus (Brady).

Neoconorbina sp. A

Test low trochospiral, planoconvex, dorsal side evolute and convex, but inner whorls obscured by thick smooth boss, ventral side involute and flat, gently excavated umbilicus with fairly thick plug surrounded by very shallow groove. outline circular, periphery entire, with rather heavy narrow keel. Chambers 3 or so in outer whorl, increasing rapidly in size as adward, on dorsal side crescentiform and uninflated, on ventral side strongly embracing, arcuate, not much inflated, inner margins with many small lobes and reentrants surrounding plug. Sutures on dorsal side limbate, flush, strongly oblique, and rather obscure, on ventral side slightly limbate, essentially flush except where final chamber overlaps beginning of final whorl. Wall with coarse sunken perforations on ventral side, on dorsal side finely perforate. Aperture very obscure, apparently a very fine extraumbilical interiomarginal slit.

Remarks: This species is distinguished by the very heavily calcified dorsal side, and the flat ventral side with coarse pitted perforations, umbilical plug, and nearly contiguous small lobes.

Neoconorbina sp. B

Test low trochospiral, planoconvex, dorsal side evolute and gently convex, with barely rounded apex, ventral side involute and flat to very gently convex with excavated umbilicus, outline circular, periphery entire, with narrow but thick imperforate keel. Chambers 3 in outer whorl, on dorsal side very low crescentiform, uninflated, on ventral side narrow curved to crescentic and embracing, distinctly

inflated. Sutures distinct, on dorsal side limbate, flush and oblique, on ventral side depressed and strongly curved to oblique. Wall on ventral side finely perforate, on dorsal side covered with coarse perforations except for narrow keel. Aperture interiomarginal and extraumbilical, a low opening under forward projecting flap with two bordering reentrants of final chamber on ventral side.

Remarks: The inflated chambers on the ventral side distinguish this species from N. terquemi, N. floridensis, and Tretomphaloides concinnus, while N. pacifica is much more strongly convex on the dorsal side, with a different pore distribution.

Genus Planodiscorbis Bermúdez, 1952

Planodiscorbis rarescens (Brady)

Discorbina rarescens BRADY, 1884, p. 651, pl. 90, figs. 2,3 only.

Discorbis rarescens (Brady). CUSHMAN, 1915, p. 20, t.f. 24, pl. 7, fig. 4.

Planodiscorbis rarescens (Brady). BARKER, 1960, p. 186, pl. 90, figs. 2,3.

Test low trochospiral, low planoconvex, dorsal side flat to very slightly depressed, evolute, ventral side convex, involute, periphery very slightly lobulate, acute with narrow imperforate keel. Chambers 4 in outer whorl, increasing very rapidly in size as added, final chamber comprising almost 1/2 of circumference, on dorsal side uninflated and petaloid to crescentic, on ventral side triangular and embracing, gently inflated. Sutures distinct, on dorsal side limbate, strongly curved posteriorward, on ventral side depressed, radial and sinuate. Aperture a very low slit on curved concave margin of chamber between periphery and central inflection point on dorsal side.

Remarks: The only similar species which needs to be distinguished is Truncatulina tenuimargo Brady, which has more chambers per whorl, a continuous, well defined keel, and the aperture occurs as a notch in the outline.

Genus Rosalina d'Orbigny, 1826

Rosalina sp. cf. R. bahamaensis Todd and Low

Rosalina bahamaensis TODD AND LOW, 1971, p. 14, pl. 3, fig. 2.---POAG, 1981, p.

80, pl. 41, fig. 3; pl. 42, fig. 3.

Test low trochospiral but with protruding inner whorls on convex evolute dorsal side, ventral side with very deep, steep-sided and fairly broad umbilicus, periphery rounded and strongly lobulate. Chambers 6 in outer whorl, strongly inflated and subglobular in outer whorl, increasing quite rapidly in size as added. Sutures distinct, on dorsal side nearly flush and slightly curved, becoming nearly radial, straight and deeply incised, especially toward periphery, the which trend carries across on ventral side, where by halfway point toward umbilical extremity a distinct deep gap exists, which broadens toward umbilicus, leaving inflated triangular umbilical chamber margins, steeply sided. Wall on ventral side with scattered fairly coarse perforations, on dorsal side with hyaline boss on inner whorls, outer whorl with frosted, distinctly perforate surfaces to bulk of chamber, but sutural borders hyaline and imperforate. Aperture a fairly high interiomarginal extraumbilical arch, with a very thin flap hanging down off inner extremity to obscure umbilical component.

Remarks: The present material differs from the type in being more lobulate and globular, with more sparse and coarse perforations.

Rosalina globularis d'Orbigny

Rosalina globularis d'ORBIGNY, 1826, p. 271, pl. 13, figs. 1-4.---BARKER, 1960, p. 178, pl. 86, fig. 13.---TODD, 1965, p. 11, pl. 3, fig. 4.---MURRAY, 1971, p. 35, pl. 56, figs. 1-6.---WARD AND WEBB, 1986, p. 190, pl. 5, figs. 1-4.---LOEBLICH AND TAPPAN, 1987, p. 561, pl. 610, figs. 1-5; pl. 611, figs. 1-3.

Discorbis globularis (d'Orbigny). CUSHMAN, 1915, p. 11, t.f. 10, 11, pl. 9, fig. 4.

Test low trochospiral, planoconvex to concavo-convex, dorsal side evolute and uniformly convex, ventral side involute with excavated umbilical region, periphery nearly entire, rounded. Chambers 5 in outer whorl, increasing slowly in size as added, petaloid on dorsal side and gently inflated on both. Sutures distinct, depressed, on dorsal side oblique and curved, on ventral side nearly radial but curved. Aperture bipartite, interiomarginal and extraumbilical, a low arch as well as

a posterior component behind triangular flap projecting from chamber into umbilicus.

Remarks: Rosalina vilardeboana d'Orbigny has inner whorls which project in a narrow acute fashion on the dorsal side, while Discorbis globularis (d'Orbigny) var. bradyi Cushman has limbate dorsal sutures, and chambers which are less petaloid on the dorsal side.

Rosalina isabelleana d'Orbigny

Rosalina isabelleana d'ORBIGNY, 1839c, p. 43, pl. 6, figs. 10-12.

Discorbis isabelleana (d'Orbigny). CUSHMAN, 1915, p. 15, pl. 6, fig. 1.

Discopulvinulina cf. isabelleana (d'Orbigny). ?ASANO, 1951, pt. 14, p. 5, figs. 32-34.

Test low trochospiral, concavo-convex, dorsal side convex and evolute, ventral side flattened with excavated umbilical region which may be somewhat open, periphery almost non-lobulate, with narrow acute hyaline keel. Chambers 6 in outer whorl, inflated on both sides, more strongly so on ventral, curved quadrangular on dorsal, triangular on ventral. Sutures distinct, depressed, on dorsal side curved, slightly oblique and slightly limbate, on ventral side gently curved, tangential to umbilicus. Wall very coarsely perforate on ventral side, less so on dorsal, although anterior half of final chamber on ventral side hyaline, without coarse perforations. Aperture interiomarginal and ventral, a low largely extraumbilical arch, bordered above by lip, which is produced into a rough flap at apex of umbilical extremity of final chamber, aperture persists in umbilicus for several chambers.

Remarks: The carinate periphery and ventral chamber surfaces, which are inflated and coarsely perforate, are distinctive. The identity of Asano's forms is questioned because of their rather strongly lobulate periphery, which is subacute and without a keel.

Rosalina subaraucana (Cushman)

Discorbis subaraucana CUSHMAN, 1922b, p. 41, pl. 7, figs. 1,2.

Rosalina subaraucana (Cushman). POAG, 1981, p. 81, pl. 41, fig. 1; pl. 42, fig. 1.

Test low trochospiral, planoconvex to concavo-convex, dorsal side wholly evolute, quite roundly convex, inner whorls may have slight boss, ventral side usually somewhat excavated with fairly large spiralled umbilicus and flattened chamber surfaces; periphery asymmetrically rounded, with thickened rounded margin, nearly non-lobulate. Chambers typically 6 in outer whorl, increasing steadily in size as added, not much inflated. Sutures distinct, depressed throughout, on dorsal side initially limbate, later thin, well curved, on ventral side nearly radial, slightly sinuate; dorsal spiral suture also depressed. Aperture an open interiomarginal arch from just inside periphery to slight projection of chamber at umbilicus, with minor component posterior to this flap as well.

Remarks: The flattened ventral chamber surfaces and low number of chambers, with nearly radial ventral sutures, are quite distinctive, as is the rather bluntly rounded imperforate carina.

Rosalina subvilardeboana (Rzehak)

Discorbina sub-vilardeboana RZEHAKE, 1888b, p. 263, pl. 11, fig. 6.

Discorbis subvilardeboanus (Rzehak). BOLTOVSKOY, 1978, p. 157, pl. 3, figs. 26-30.

Test low trochospiral, inequally biconvex with evolute dorsal side more strongly convex, inner whorls covered by boss, ventral side with gently and broadly excavated umbilical region, which may have a low boss or plug distinct from outer whorl, periphery rounded and lobulate. Chambers 6 or 7 in outer whorl, inflated on both sides but more strongly so on ventral, on dorsal side petaloid, on ventral side a bit more triangular, increasing fairly rapidly in size as added. Sutures distinct, depressed and limbate but decreasingly so as increasingly depressed, on dorsal side oblique and gently curved, on ventral side more nearly radial but gently curved. Wall unusually coarsely perforate to punctate on both sides. Aperture interiomarginal, a fairly high arch from near periphery to umbilical extremity of chamber, thence under this posteriorward a slight distance.

Remarks: The number of chambers, very coarse perforations on both sides, and

rounded lobulate periphery are quite distinctive, as is the degree of inflation and the ventral umbilical plug when developed.

Rosalina sp. A

Test low trochospiral, more or less planoconvex, dorsal side strongly convex and evolute, with all but last 2 whorls covered in smooth projecting boss, ventral side involute, with gently convex chamber surfaces but sunken umbilicus; periphery strongly lobulate, sharp, with very narrow imperforate keel. Chambers 4 to 4 1/2 in outer whorl, increasing rapidly in size as added, on dorsal side petaloid/crescentiform, with last few barely inflated, on ventral side broad triangular/petaloid, gently inflated. Sutures distinct for most part, on dorsal side very thin limbate, oblique and curved, on ventral side depressed, slightly sinuate and nearly radial. Wall fairly evenly and finely perforate on both sides. Aperture a very low interiomarginal slit from periphery to umbilicus, with short component up intercameral suture behind small irregular umbilical projection of final chamber.

Remarks: This species is distinguished by the low number of broad chambers, acute carinate periphery, and even perforation.

Genus **Tretomphaloides** Banner, Pereira, and Desai, 1985

Tretomphaloides concinnus (Brady)

Discorbina concinna BRADY, 1884, p. 646, pl. 90, figs. 7,8.

Discorbis concinna (Brady). CUSHMAN, 1915, p. 16, t.f. 17, pl. 5, fig. 3.

Rosalina concinna (Brady). BARKER, 1960, p. 186, pl. 90, figs. 7,8.---POAG, 1981, p. 80, pl. 41, fig. 4; pl. 42, fig. 4.

Tretomphaloides concinnus (Brady). LOEBLICH AND TAPPAN, 1987, p. 562, pl. 613, figs. 1-6.

Test low trochospiral, concavo-convex, dorsal side evolute and low convex, ventral side involute and excavated, outline circular, periphery nearly entire, very narrowly rounded but not carinate. Chambers 3 per whorl, increasing very rapidly in size as added, on dorsal side long crescentic, on ventral side subpetaloid to crescentic, strongly embracing, first 2 chambers in outer whorl look curved, gently

inflated. Sutures distinct, on dorsal side thin, gently depressed, a composite of 2 intersecting, nearly coincident arcs, on ventral side strongly curved, depressed. Wall on ventral side coarsely perforate, on dorsal side more finely so, evenly distributed across chamber surfaces. Aperture a low interiomarginal slit in gentle anterior reentrant, with ragged edge. In rare instances, ventral side furnished with large, irregular and fragile sac-like chamber, so-called float chamber, of same diameter and comparable dimensions to whole of test.

Remarks: This species is distinguished from most by the circular outline and concavo-convex form, without imperforate carina, and from Neoconorbina pacifica which has perforations on the dorsal side concentrated just interior to the imperforate margin and sutures. The globular float chamber was observed on a single specimen from sample NOVA-H 12G.

Family SPHAEROIDINIDAE Cushman, 1927

Genus Sphaeroidina d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny

Sphaeroidina bulloides d'ORBIGNY, 1826, p. 267.---CUSHMAN, 1914, p. 18, pl. 10, fig. 7; pl. 12, fig. 1.---BARKER, 1960, p. 174, pl. 84, figs. 1,2,4,5, possibly 2, not 3,6,7.---LOEBLICH AND TAPPAN, 1964, p. 547, fig. 432:1-3.---TODD, 1965, p. 49, pl. 18, fig. 4.---CORLISS, 1979, p. 7, pl. 2, figs. 1,2.---INGLE et al, 1980, p. 144, pl. 9, fig. 16.---MEAD, 1985, p. 228, pl. 1, fig. 2.---BELANGER AND BERGGREN, 1986, p. 332, pl. 1, fig. 18.

Test subglobular to subquadrate in outline, streptospiral, periphery rounded. Chambers inflated, strongly embracing, 4 in outer whorl, final chamber occupies approximately half of test. Sutures straight to very gently curved, depressed. Aperture an arch, bordered by lip or rim, with squat or blunt tooth at lower margin. Aperture always centered over smallest or first-formed chamber in final whorl, never at a sutural "triple junction".

Remarks: Cushman (1914) and Todd (1965) illustrated this species with the aperture located at a sutural "triple junction". This is not observed in any of the present specimens. Barker's pl. 84, fig. 3 shows a form with a slit-like aperture, while

figs. 6 and 7 show a form that is much too high-spired and has too many chambers in the outer whorl. Most species of this genus differ from the present one in having more than 4 chambers in the outer whorl and an outline that is something other than subquadrate. Sphaeroidina bulloides d'Orbigny var. chilostomata Galloway and Morrey has 5 chambers per whorl, and has no apparent tooth. The tooth and/or the bordering rim are frequently broken out of S. bulloides, which will give the aperture the appearance of a large, smooth arch, with or without a tooth.

Superfamily GLABRATELLACEA Loeblich and Tappan, 1964

Family GLABRATELLIDAE Loeblich and Tappan, 1964

Genus Discorbinoides Saidova, 1975

Discorbinoides sp. A

Test trochospiral, conical, height of cone less than diameter, dorsal side evolute and highly convex, with broadly rounded apex, ventral side flat to very slightly depressed, periphery very slightly lobulate, with blunt imperforate carina that is raised slightly above ventral chamber faces. Chambers 6 1/2 or more in outer whorl, obscure but somewhat petaloid on dorsal side, and uninflated, on ventral side triangular with flat surfaces, these covered with widely spaced, fine radial grooves, inner ends with raised extraumbilical knob or thickening, and a distinctly separate small umbilical plug. Sutures on dorsal side oblique, limbate and flush, on ventral side radial, almost straight but curved gently backward, depressed. Aperture a low extraumbilical interiomarginal arch.

Remarks: The species of this genus, with its combination of radial grooves, conical test, and umbilical plug and/or nodes at the inner ends of the chambers on the ventral side, are distinct from other similar-shaped species, most now assigned to Neoeponides. None of its species from the present study correspond to any of Saidova's species, nor do either of Discorbinoides spp. A or B correspond to any species of Sabinoides McCulloch, the which genus was placed by Loeblich and Tappan (1987) in synonymy with the present one. The species of this latter genus are

either too acute at the apex, lack the umbilical plug, and/or have too few chambers per whorl. The present species differs from others in this study by having a conical test of greater diameter than height and a barely lobulate, bluntly carinate periphery.

Discorbinoides sp. B

Test high trochospiral, high conical, height much greater than diameter, base pointed but rounded, dorsal side evolute and highly convex, ventral side involute and flat to very slightly depressed, periphery barely lobulate, with blunt imperforate carina. Chambers apparently 6 in outer whorl, obscure on both sides, on dorsal side low crescentic and uninflated, on ventral side triangular, uninflated, with numerous fine radial grooves, terminating short of umbilicus and distinctly separate from small sharp umbilical plug. Sutures obscure, on dorsal side limbate, flush and oblique, on ventral side completely obscured by grooves except where deeply channelled near groove which surrounds plug, leaving thickened and rounded triangular projections of chambers toward umbilical plug. Aperture a fairly high. Interiomarginal slit, running most of length of suture, bordered by thin ragged chamber surface.

Remarks: This species is distinguished by its very high conical test, and radial ventral sutures.

Discorbinoides sp. C

Test trochospiral, low rounded conical, dorsal side evolute and convex, with clear boss covering inner whorls, ventral side flat, outline circular, periphery acute with fairly wide, sparsely perforate hyaline keel, with prominent notches at sutures which cut entire width of keel. Chambers 8 or so in outer whorl, occasionally with single chambers reduced in size relative to preceeding chamber, on dorsal side crescentiform to petaloid, uninflated, on ventral side with surfaces flattened but very slightly raised above sutures, inner ends thickened, and separated from small sharp umbilical plug by a circular trough as well as deeply excavated sutures of the

last 4 or 5 chambers, also with slightly curved grooves following trend of sutures. Sutures on dorsal side distinct, limbate, flush, oblique, on ventral side nearly radial but well curved, especially toward periphery, and very slightly depressed. Wall on dorsal side highly polished, nearly imperforate on boss, but otherwise with narrow, deep perforations. Aperture ventral, a low interiomarginal slit.

Remarks: Sabinoides scrupulosa McCulloch is distinguished from this species and Discorbinoides sp. D by its radial straight sutures on both sides, and the absence of an umbilical plug. In S. ambiguus McCulloch the keel is not evident from the ventral side, the surfaces are rather inflated, and it has a large, open umbilicus surrounded by a ring of nodes, rather than simple thickenings of the umbilical extremities of the chambers.

Discorbinoides sp. D

Test low trochospiral, low conical, dorsal side evolute, convex, with rounded apex and flaring rapidly, ventral side involute and flat, periphery acute, with fairly wide, thin and perforate keel, which is notched for its full width at the sutures and everted toward dorsal side. Chambers 7 in outer whorl, increasing steadily in size as added, on dorsal side almost as broad as high, quadrangular, uninflated, on ventral side curved triangular, essentially flat, with numerous strong curved radial grooves, and thickened into nodes at inner ends, separated from raised umbilical plug of comparable size. Sutures somewhat obscure on dorsal side, flush and slightly oblique, may be non-limbate, on ventral side strongly curved radial and depressed below raised margins of chambers, which overlap slightly to produce false impression of curved stellate limbate style. Aperture a low interiomarginal arch or slit, running length of somewhat ragged ventral margin.

Remarks: This species is distinguished from Discorbinoides sp. C by its flaring dorsal side and consequent everted keel.

Genus Glaboratella Dorreen, 1948

Glaboratella sp. A

Test low trochospiral, ovate in outline, dorsal side low convex and evolute, ventral side with deeply depressed rounded umbilical region, periphery very broadly rounded and gently lobulate. Chambers 2 in outer whorl, very strongly inflated, increasing extremely rapidly in size as added, each an arc or crescent of almost 270° that embraces almost 2/3 of penultimate chamber in the peripheral plane and dwarfs it. Sutures distinct, on dorsal side a strongly depressed arc, on ventral side a subtle depressed radial line. Wall smooth, except for distinct, widely spaced grooves radiating from umbilicus. Aperture a very low slit opening under roughened lip or edge into umbilicus.

Remarks: The extremely rapid increase in chamber size, and manner of embracing in the peripheral plane only, is distinctive.

Genus Schackoinella Weinhandl, 1958

Schackoinella sp. A

Test low trochospiral, somewhat flattened but with inner whorls on dorsal side projecting, ventral side deeply and broadly umbilicate, periphery well rounded, nearly entire and outline circular in adults, somewhat lobulate on juveniles. Chambers elongate, crescentic, and inflated on both sides of test, 3 per whorl. Sutures depressed, on dorsal side strongly oblique and curved, on ventral side radial and obscure. Aperture small, umbilical. Dorsal side with pair of spines or less commonly nodes on each chamber, aligned along coiling direction, and projecting dorsalward rather than toward periphery. Aperture a small umbilical arch, ventral surface of chambers with radial grooves.

Remarks: Schackoinella sp. of Ward and Webb (1986) has spines which project peripherally, and the chambers are not so long and overlapping as they are in the present specimens.

Family HERONALLENIIDAE Loeblich and Tappan, 1986

Genus Heronallenia Chapman and Parr, 1931

Heronallenia crosbyi (McCulloch)

Subheronallenia crosbyi McCULLOCH, 1977, p. 323, pl. 124, figs. 18,19,21.

Test low trochospiral, dorsal side convex, ventral side with excavated umbilical region, may show inner whorls, periphery with imperforate band visible from both sides, lobulate and rounded to slightly angled. Chambers 4 per whorl, increasing quite rapidly in size as added, inflated on both sides but particularly on dorsal, where they are petaloid and may be slightly imbricated. Sutures distinct, depressed, on dorsal side limbate, curved, and oblique, on ventral side radial and straight. Aperture a small umbilical arch, below broad apertural face with numerous fine radiating grooves.

Remarks: The low number of chambers, which are imbricated on the dorsal side, and the imperforate peripheral band, are distinctive. McCulloch identified only forms with a closed umbilicus, but in the present study there are specimens identical in every respect except for their open umbilicus. This species differs from Discorbis subfilosa Cushman, in which the sutures are indistinct, the outline less lobulate, and there are large radiating gaps rather than grooves.

Heronallenia gordabankensis (McCulloch)

Subheronallenia gordabankensis McCULLOCH, 1977, p. 324, pl. 124, fig. 20; pl. 125, fig. 4.

Test low trochospiral, biconvex, dorsal side evolute, highly polished and undulose, with acute periphery raised above surface of test, ventral side involute, with umbilicus offset toward final chamber, rarely with protruding proloculus occupying central position, and ventral surface rounded at slightly everted periphery, which is non-lobulate. Chambers 4 or 5 in outer whorl, on dorsal side petaloid, uninflated, on ventral side somewhat inflated. Sutures on dorsal side distinct, thin limbate, oblique and curved, flush to very slightly depressed to accentuate undulose surface, on ventral side nearly radial, somewhat sinuate, very gently depressed to obscure. Aperture umbilical, a fairly large semicircular opening ringed by convex rounded half-coil apertural face, which has radiating fine grooves.

Remarks: The entire outline and highly polished, undulose dorsal surface are very distinctive. Several authors, particularly Boltovskoy (1978), Hermelin and Scott (1985), and Ward and Webb (1986) have referred specimens of this genus to Heronallenia wilsoni (Heron-Allen and Earland, described under Discorbina). That species has raised limbate dorsal sutures and an acute carinate periphery visible even in ventral view. The form illustrated by Ward and Webb has raised dorsal sutures and may be referable to that species. The forms illustrated by Boltovskoy in pl. 24, figs. 23 and 24 look like that species, having a distinct carinate periphery, but figs. 22 and 25 are very much open to question. The specimen illustrated by Hermelin and Scott in pl. 6, fig. 8 looks very much like the present species, but a dorsal view was not provided, and so their forms are not referred herein to the present species.

Heronallenia milesi (McCulloch)

Neoheronallenia (?) milesi McCULLOCH, 1977, p. 321, pl. 124, fig. 4.

Test low trochospiral, auriculate, strongly compressed, both sides gently convex, ventral side with gently excavated umbilical area, periphery almost entire, rounded. Chambers 5 or so in outer whorl, increasing fairly rapidly in size as added, very mildly inflated, tending to uncoil, and on dorsal side thickly arched; umbilical region apparently surrounded by chamberlets. Sutures distinct, very gently depressed, on ventral side radial and straight, on dorsal side arched and somewhat oblique, final few with small "exogenous bead" which is internal thickening at midpoint and anterior in position, in succeeding chamber. Aperture umbilical, a very elongate, rather wide slit running up into apertural face parallel to test axis, with loop-shaped upper termination, apertural face with numerous fine radiating grooves.

Remarks: The test shape is quite distinctive, and the species is distinguished from other species defined by McCulloch under Neoheronallenia by its very elongate aperture, rounded periphery, and depressed, non-limbate dorsal sutures.

Discorbina lingulata Burrows and Holland has a final chamber that is linguiform, that is, much broader with respect to its height.

Heronallenia sp. cf. H. parva Parr

Heronallenia parva PARR, 1950, p. 358, pl. 14, fig. 10.

Test low trochospiral, rather thin and somewhat flattened, dorsal side evolute and low convex, ventral side lower convex to flat, with depressed umbilical region, periphery strongly lobulate, with narrow acute keel. Chambers 5 in outer whorl, increasing quite rapidly in size as added, on dorsal side very gently inflated, petaloid, on ventral side slightly inflated and somewhat triangular. Sutures distinct, on dorsal side fine limbate, raised, oblique and curved, on ventral side nearly radial and somewhat sinuate, gently depressed. Aperture an umbilical arch, with fine radiating grooves on ventral face of final chamber, if not more.

Remarks: This species is distinguished from others in the study by its very thin flat test, with a narrow keel and acute periphery.

Heronallenia sp. A

Test very low trochospiral, bievolute, strongly flattened, small excavated umbilicus on ventral side at central margin of final chamber, rather than over inner whorls; outline rounded angulate, periphery rather rounded, but turned over onto dorsal side, so that ventral side lacks keel, dorsal side has thick imperforate margin. Chambers typically 5 in outer whorl, increasing steadily in size as added, on dorsal side uninflated, more crescentiform than petaloid, on ventral side gently inflated, highly complex, with posterior peripheral margin swollen but still narrow in outline, then with reentrant and inflated lobe before reaching umbilicus. Sutures distinct, on dorsal side heavily limbate, raised and oblique, with additional swelling, both in thickness and height, at the midpoint, marking position of aperture at basal margin of succeeding chamber, on ventral side very slightly depressed, nearly tangential and curved strongly forward from periphery, thence posteriorward and finally anteriorward to umbilicus. Aperture a narrow but high umbilical arch, accompanied

by strong radial grooves on apertural face.

Remarks: The form of the sutures is completely distinctive, particularly as compared to the otherwise similar Planoheronallenia albemarlana McCulloch, which has simple radial ventral sutures, and petaloid rather than crescentiform chambers on the dorsal side.

Heronallenia sp. B

Test very low trochospiral, flattened, dorsal side wholly evolute, with acute peripheral edge, ventral side rather evolute, convex, inner whorls exposed in broad shallow umbilicus, peripheral edge convex, rounded over toward dorsal side, periphery lobulate. Chambers 6 in outer whorl, increasing quite rapidly in size as added, on dorsal side petaloid, strongly inflated, bulging above test surface, and well separated by limbate, very wide depressed oblique sutures that merge with fairly broad peripheral margin, on ventral side very gently inflated. Sutures on ventral side very gently depressed, nearly radial and very gently curved, except at umbilical extremity, where the suture curves strongly posteriorward to produce narrow retral lobe at chamber margin. Aperture unknown in broken specimen, though penultimate chamber indicates some low remnant slit under a lip-like elongate chamber border.

Remarks: There is no species like it, with bulging dorsal chamber surfaces distinguishing it from most, and the simpler ventral sutures from Heronallenia sp.A.

Family BULIMINOIDIDAE Seiglie, 1970

Genus Buliminoides Cushman, 1911

Buliminoides williamsonianus (Brady)

Bulimina williamsoniana BRADY, 1881, p. 56.---BRADY, 1884, pl. 51, figs. 16,17.

Buliminoides williamsoniana (Brady). CUSHMAN, 1911, p. 90, fig. 144.---
CUSHMAN, 1942, p. 8, pl. 1, figs. 7-9.

Buliminoides williamsonianus (Brady). BARKER, 1960, p. 104, pl. 51, figs. 16,17.

Test elongate, cylindrical, triserial arrangement not readily apparent, base

broadly rounded, apertural end obliquely truncate. Chambers and sutures almost completely obscured by longitudinal costae that are closely spaced, covering entire length of test, with additional costae added by insertion and/or bifurcation, producing characteristic twisting of costae. Aperture terminal and round, in depression on upper truncate surface.

Remarks: The single specimen in this study apparently has the upper face if not the entire upper chamber broken away, as the costae do not run across the upper edge, and the circular opening is larger than would seem typical for the aperture proper.

Superfamily SIPHONINACEA Cushman, 1927

Family SIPHONINIDAE Cushman, 1927

Subfamily SIPHONININAE Cushman, 1927

Genus Siphonina Reuss, 1850

Siphonina tubulosa Cushman

Siphonina reticulata (Czjzek). CUSHMAN, 1921, p. 322, pl. 60, fig. 3.

Siphonina tubulosa CUSHMAN, 1924, p. 40, pl. 13, figs. 1,2.---TODD, 1965, p. 22, pl. 15, fig. 4.

NOT Siphonina tubulosa Cushman. BARKER, 1960, p. 198, pl. 96, figs. 5-7.

Test low trochospiral, compressed, lenticular, periphery carinate, very slightly lobulate. Chambers 4 or 5 in outer whorl, triangular and only slightly inflated on ventral side, obscure but petaloid to subcrescentic on dorsal side. Sutures straight, radial and very gently depressed on ventral side, on dorsal side oblique. Aperture peripheral, elliptical, on short neck with lip. Periphery also furnished with closely spaced projecting tubules producing fringed appearance, and surface of test irregularly and variably decorated with projecting tubules as well.

Remarks: Rotalina reticulata Czjzek lacks tubules on the surface of the test, in contrast to Cushman's (1921) figured specimen, while Parker assigned smooth-chambered forms to S. tubulosa. In the present study there are specimens with very

few tubules save those on the periphery, and it may be possible that both these species represent end-members of a single highly variable species.

Superfamily DISCORBINELLACEA Sigal, 1952

Family PARRELLOIDIDAE Hofker, 1956

Genus Cibicidoides Thalmann, 1939

Cibicidoides bradyi (Trauth)

Truncatulina bradyi TRAUTH, 1918, p. 235.

Cibicides bradyi (Trauth). BARKER, 1960, p. 196, pl. 95, fig. 5.

Cibicidoides bradyi (Trauth). CORLISS, 1979, p. 9, pl. 3, figs. 1-3.---INGLE *et al.*, 1980, p. 132, pl. 6, figs. 11,12.---MEAD, 1985, p. 242, pl. 7, figs. 1,2,4.---BELANGER AND BERGGREN, 1986, p. 344, pl. 6, fig. 4.

Test low trochospiral, biconvex, ventral side more strongly so, periphery rounded and slightly lobulate. Chambers 6 or more in final whorl, gently inflated; inner whorls may protrude slightly on dorsal side, ventral side with very narrow umbilicus and no plug or umbo. Sutures nearly straight, somewhat oblique and gently depressed on dorsal side, straight, radial and depressed on ventral side. Wall very finely perforate on ventral side, scattered coarse pores on dorsal side. Aperture interiomarginal, essentially peripheral, bordered above by distinct lip.

Remarks: This species has somewhat oblique sutures on the spiral side rather than the radial curved type so common in Cibicides. Rotalina akneriana d'Orbigny differs in having a large umbilical depression and evenly distributed and sized perforations.

Cibicidoides mundulus (Brady, Parker and Jones)

Truncatulina mundula BRADY *et al.*, 1888, p. 228, pl. 45, fig. 25.---CUSHMAN, 1915, p. 41, pl. 13, fig. 4.

Cibicidoides mundulus (Brady, Parker and Jones). BARKER, 1960, p. 196, pl. 95, fig. 6.

Test low trochospiral, essentially equally biconvex, periphery non-lobulate, acute and usually with thick carina, may rarely have wider, thin keel. Chambers 9 or more in final whorl, wedge-shaped on ventral side, rhomboid on dorsal. Sutures

flush, limbate, slightly oblique and tapering toward periphery from clear central umbo on ventral side, on dorsal side limbate and oblique. Heavy secondary calcification on dorsal side almost completely covers inner whorls, which remain discernible only by spiral trail of single or twin coarse punctae per chamber, outer whorl typically with 5 to 8 coarse perforations per chamber; ventral side very finely perforate. Aperture a thin interiomarginal slit essentially restricted to the periphery, with thin bordering lip.

Remarks: Cibicides kullenbergi is more strongly convex on the ventral side, and its aperture extends along the spiral suture for a few chambers. Rotalina ungeriana d'Orbigny is strongly compressed, with chambers broader than high on the dorsal side, while Heterolepa dutemplei is flat on the dorsal side with protruberant inner whorls, and it has a regular and uniform distribution of pores.

Cibicidoides? praecinctus (Karrer)

Rotalia praecincta KARRER, 1868, p. 189, pl. 5, fig. 7.

Truncatulina praecincta (Karrer). CUSHMAN, 1915, p. 39, t.f. 42, pl. 26, fig. 2.

Cibicides praecinctus (Karrer). BARKER, 1960, p. 196, pl. 95, figs. 1-3.

"Eponides" praecinctus (Karrer). BELFORD, 1966, p. 125, pl. 16, figs. 1-6.

Test low trochospiral, almost planoconvex, ventral side very strongly convex, almost rounded conical, dorsal side slightly convex because successive whorls are translated ventralward; periphery very slightly lobulate and narrowly rounded, with a slightly produced keel. Chambers 9 or so in outer whorl, increasing little in size as added, only very gently inflated on the ventral side for final few chambers. Sutures limbate, radial and curved, on ventral side very gently depressed in later stages, on dorsal side flush to very slightly raised, and spiral suture also limbate and raised, producing a slight shoulder to inner whorls. Wall quite uniformly perforate on ventral side, perforations on dorsal side obscure. Aperture interiomarginal, barely on ventral side and crossing periphery but confined to first chamber on dorsal side.

Remarks: The test shape, with heavy limbate sutures on both sides and a raised

shoulder along the spiral suture, is distinctive. The pattern of perforations on the dorsal side is not obviously that of Cibicidoides, hence the uncertainty in assignment of the species.

Cibicidoides subhaidingerii (Parr)

Truncatulina haidingeri (d'Orbigny). CUSHMAN, 1915, p. 35, pl. 13, fig. 5; pl. 28, fig. 1, not t.f. 37.---CUSHMAN, 1921, p. 315, pl. 64, fig. 3.

Cibicides subhaidingerii PARR, 1950, p. 364, pl. 15, fig. 7.---BARKER, 1960, p. 196, pl. 95, fig. 7.

"Eponides" subhaidingeri (Parr). BELFORD, 1966, p. 129, pl. 16, figs. 7-13.

NOT "Eponides" sp. cf. "E." subhaidingeri (Parr). BELFORD, 1966, p. 130, pl. 16, figs. 14-22.

Test low trochospiral, thick lenticular, ventral side more strongly convex, periphery nearly entire, and acute to sharply angled, not rounded. Chambers 8 in outer whorl, increasing steadily in size as added, on ventral side triangular and last few slightly inflated, on dorsal side low rectangular and slightly arcuate. Sutures distinct, limbate and flush becoming gently depressed, on dorsal side oblique, on ventral side radial and gently sinuate to curved, becoming narrow. Wall with quite coarse perforations on both sides, evenly distributed and not sunken. Aperture a high interiomarginal slit, running from ventral side across periphery and along spiral suture for over half of final chamber, with strong bordering lip especially at periphery.

Remarks: Rotalina haidingerii d'Orbigny is much more strongly convex on the dorsal side, and the ventral chamber surfaces are well inflated. The exceptions noted in the synonymy for the present species both belong in d'Orbigny's species.

Cibicidoides sp. A

Test planoconvex, low trochospiral, dorsal side evolute and almost perfectly flat, ventral side strongly convex, involute, with very fine, deep umbilicus, periphery almost square in outline, with rounded corners, barely lobulate, and acute with narrow imperforate keel. Chambers 4 in outer whorl, sinuate triangular in

outline and very gently inflated on ventral side, on dorsal side petaloid, slightly undulose but not truly inflated. Sutures distinct, on ventral side very slightly depressed, radial and sinuate, on dorsal side limbate and strongly curved, flush to very slightly raised. Wall on ventral side very finely perforate, dorsal side with coarse, evenly distributed perforations. Aperture interiomarginal, confined to a very narrow peripheral region and visible from both sides of test, with a pronounced lip, the traces of previous apertural notches being clearly preserved in the dorsal sutures.

Remarks: This form has been assigned to the present genus on the basis of its apertural restriction, although reduction in perforation with addition of subsequent chambers is not seen. It is somewhat similar to both Planodiscorbis rarescens and Truncatulina tenuimargo Brady, but these have wider distinct keels, the former is more flattened ventrally, and the latter has some 6 chambers in the outer whorl.

Cibicidoides sp. B

Test low trochospiral, planoconvex, dorsal side flat and evolute, with clear boss covering inner whorls, ventral side low conical with large heavy flush umbo, periphery very mildly lobulate with heavy blunt imperforate keel. Chambers 8 or so in outer whorl, increasing steadily in size as added, mildly inflated on both sides, somewhat rhomboid dorsally, on ventral side triangular. Sutures distinct, on dorsal side limbate, gently depressed and slightly oblique, on ventral side heavy limbate, thinning from very great thickness at umbo out to periphery, where gently depressed, radial and barely curved. Wall heavily calcified and finely perforate ventrally, dorsal side with very coarse perforations in outer whorl, and a few isolated ones in boss. Aperture interiomarginal, equatorial, a low slit or arch crossing periphery from ventral to dorsal side, along spiral suture for 1/2 chamber at most, with distinct bordering lip on ventral side.

Remarks: The planoconvex form and low number of chambers, along with the pattern of perforations, distinguish this species from others in this study.

Family PSEUDOPARRELLIDAE Voloshinova, 1952
 Subfamily PSEUDOPARRELLINAE Voloshinova, 1952
 Genus Alexanderina McCulloch, 1977

Alexanderina sp. A

Test very low trochospiral, compressed, dorsal side evolute and flattened to very gently convex, ventral side partially evolute and slightly excavated, both sides with inner whorls covered by opaque deposits, more heavily so on dorsal side; periphery rounded and barely lobulate. Chambers 7 in outer whorl, barely inflated, increasing slowly in size as added, somewhat cuneate. Sutures distinct, limbate, straight and oblique, not much depressed. Wall coarsely perforate. Aperture a very elongate, narrow interiomarginal arch or slit, occupying most of apertural face, which is elongate and has rounded borders.

Remarks: The single specimen is completely distinctive.

Genus Epistominella Husezima and Maruhasi, 1944

Epistominella exigua (Brady)
 (Plate 7, Figures 3-5)

Pulvinulina exigua BRADY, 1884, p. 696, pl. 103, figs. 13,14.---?CUSHMAN, 1915, p. 60, pl. 23, fig. 5.

NOT Pulvinulina exigua Brady. CUSHMAN, 1921, p. 340, pl. 68, fig. 3.

Epistominella exigua (Brady). BARKER, 1960, p. 212, pl. 103, figs. 13,14.---TODD, 1965, p. 30, pl. 10, fig. 1.---BOLTOVSKOY, 1978, p. 158, pl. 3, figs. 37,38.---CORLISS, 1979, p. 7, pl. 2, figs. 7-9.---INGLE *et al.*, 1980, p. 134, pl. 2, fig. 4.---BURKE, 1981, pl. 2, figs. 1,2.---POAG, 1981, p. 63, pl. 5, fig. 4; pl. 6, fig. 4.---SEJRUP *et al.*, 1981, p. 293, pl. 1, fig. 11.---HERMELIN AND SCOTT, 1985, p. 208, pl. 4, fig. 1.---MEAD, 1985, p. 230, pl. 2, figs. 1-4.---BELANGER AND BERGGREN, 1986, p. 336, pl. 3, fig. 6.

Test low trochospiral, usually biconvex and more strongly so on dorsal side, but test may have flat dorsal and convex ventral sides, or nearly flat ventral and markedly convex dorsal sides. Periphery acute to subacute or rarely narrowly rounded, usually only slightly lobulate. Chambers 5 to 6 in outer whorl, only slightly inflated. Sutures distinct, straight and oblique on dorsal side, radial and straight to gently recurved or sigmoid on ventral side, which produces distinctive stellate

pattern on hyaline tests. Aperture an elongate opening subparallel to peripheral margin of apertural face, bordered below by a lip, and above by somewhat ragged projecting flap of chamber.

Remarks: Epistominella vitrea typically has more numerous and strongly inflated chambers per whorl, dorsal sutures which are radial and curved, and more strongly recurved or sigmoid ventral sutures that are more strongly depressed than is the case for E. exigua. The specimen illustrated by Cushman (1915) is rather more lobulate than is typical, while the specimen illustrated by Cushman (1921) is lobulate, has petaloid chambers and limbate sutures on the dorsal side, and clearly should not be referred to the present species.

Epistominella vitrea Parker

Epistominella vitrea PARKER, in PHLEGER et al, 1953, p. 9, pl. 4, figs. 34-36, not 40,41.---MURRAY, 1971, p. 131, pl. 54, figs. 1-6.---POAG, 1981, p. 63, pl. 5, fig. 3; pl. 6, fig. 3.---WARD AND WEBB, 1986, p. 190, pl. 4, figs. 15,16.

Test low trochospiral, biconvex, periphery rounded, somewhat lobulate. Chambers 6 or 7 in outer whorl, inflated, more strongly so on ventral side. Sutures distinct, radial and depressed on ventral side, almost radial on dorsal side, depressed and well curved. Aperture elongate, subparallel to periphery, bordered below by lip and above by projecting flap of chamber.

Remarks: The chamber inflation and style of sutures serve to distinguish this species from E. exigua.

Epistominella sp. A
(Plate 7, Figures 6-8)

Test subglobular, trochospiral, periphery gently lobulate and broadly rounded except for apertural face which may be produced. Chambers inflated, globular, 3 or at most 4 per whorl, increasing quite rapidly in size as added. Sutures depressed and curved slightly forward on ventral side; on dorsal side very slightly depressed, essentially straight and radial. Aperture opening toward periphery in produced apertural face, bordered below by extremely fine lip, and above by a wider,

somewhat ragged lip projecting from depressed upper face.

Remarks: This species is distinguished from the very similar E. arctica Green, which has a rounded periphery throughout and no produced apertural area. It is evidently not a juvenile form of E. exigua, whose juveniles retain the distinctive morphology of that species, no matter how small. There is some possibility that the present form is a megalospheric one, as it never attains as great a size or number of chambers as E. exigua, but this is highly speculative at best. This species could easily be missed as it bears a remarkable superficial resemblance to forms such as Globocassidulina rarilocula. However, the trochospiral, rather than biserial enrolled, chamber arrangement and characteristic Epistominella-type aperture are unmistakable.

Epistominella sp. B

Test low trochospiral, rather angulate in outline but with well rounded corners, dorsal side evolute and fairly high convex, ventral side somewhat flattened, but with inflated faces, periphery lobulate, almost narrowly rounded. Chambers 5 in outer whorl, increasing fairly rapidly in size as added, on dorsal side virtually uninflated, on ventral side increasingly inflated as added. Sutures distinct, on dorsal side nearly flush, distinctly curved and tending to gently oblique, on ventral side nearly radial and straight. Wall finely perforate, smooth. Aperture ventral, a lipped oblong slit originating at inner margin near umbilicus, running obliquely up apertural face, neither parallel to peripheral outline nor inner margin.

Remarks: The lobulate, rather angulated outline and flattened test are quite distinct, as are the non-oblique dorsal sutures.

Family DISCORBINELLIDAE Sigal, 1952

Subfamily DISCORBINELLINAE Sigal, 1952

Genus Carlfranklinoides McCulloch, 1977

Carlfranklinoides prociduus McCulloch

Carlfranklinoides procidua McCULLOCH, 1977, p. 295, pl. 128, figs. 14,16.

Test low trochospiral, evolute on both sides, dorsal side convex and somewhat conical, but biconcave in profile due to everted carina, thus ventral side flat with excavated umbilical region, and inflated surfaces out to extreme acute edge of carina, which is imperforate. Chambers $3\frac{1}{2}$ to 4 in outer whorl, petaloid on both sides of test, somewhat inflated ventrally. Sutures distinct, on dorsal side oblique, limbate and almost flush, merging with entire carina, on ventral side oblique, gently curved and slightly depressed. Aperture umbilical, centered on final chamber, rather obscure, with few and faint radiating grooves extending to periphery.

Remarks: The low number of chambers, shape of test with everted periphery, and the limbate dorsal sutures which merge with the periphery are distinctive. The final chamber is usually broken off, and so the aperture is not fully known. It may doubtfully be distinguished from C. prociduaformis McCulloch by this latter species's less petaloid chambers on the ventral side, and diagonal posterior umbilical flaps which are visible even on the dorsal side.

Genus Laticarinina Galloway and Wissler, 1927

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.

Pulvinulina pauperata Parker and Jones. CUSHMAN, 1915, p. 61, t.f. 58, pl. 23, figs. 2, 3.---CUSHMAN, 1921, p. 340, pl. 68, fig. 2.

Laticarinina halophora (Stache). BARKER, 1960, p. 214, pl. 104, figs. 3-11.---COLE, 1981, p. 96, pl. 10, fig. 11.---HERMELIN AND SCOTT, 1985, p. 212, pl. 4, figs. 2, 3.

Laticarinina pauperata (Parker and Jones). TODD, 1965, p. 51, pl. 21, fig. 6.---BELFORD, 1966, p. 92, pl. 14, figs. 9-13.---PFLUM AND FRERICHS, 1976, pl. 1, fig. 10.---BOLTOVSKOY, 1978, p. 162, pl. 4, fig. 32.---INGLE et al. 1980, p. 140, pl. 9, fig. 12.---BURKE, 1981, pl. 2, fig. 3.---MEAD, 1985, p. 230, pl. 2, fig. 5.---BELANGER AND BERGGREN, 1986, p. 338, pl. 3, fig. 7.

Test planispiral but not bilaterally symmetrical, with wide, thin keel traversed by fine lines, recurved forward, that mark previous forward extent of keel.

Chambers typically 10 or more in outer whorl, more strongly inflated on one side of test, the which side typically has a clear boss covering inner whorls, which are not

involute. Sutures distinct, depressed, straight. Aperture a small irregular or ragged slit or arch on flatter side near peripheral margin of test.

Remarks: Stache's species, defined originally as Cristellaria (Robulina) halophora, is clearly a bilaterally symmetrical form, completely involute, with fewer chambers, different form of sutures, and a robuline aperture. Barker (1960) and Cole (1981) apparently based their assignment of these forms on a paper by Finlay (not cited herein), which concluded that the two species were synonymous. However, Belford (1966) and Mead (1985), following the reports by Hornibrook (1963, and a later paper not cited herein, respectively), concluded as does this paper that Stache's species belongs in Planularia Defrance.

Superfamily PLANORBULINACEA Schwager, 1877

Family PLANULINIDAE Bermúdez, 1952

Genus Planulina d'Orbigny, 1826

Planulina ariminensis d'Orbigny

Planulina ariminensis d'ORBIGNY, 1826, p. 280, pl. 14, figs. 1-3.---BARKER, 1960, p. 192, pl. 93, figs. 10,11.

Anomalina ariminensis (d'Orbigny). CUSHMAN, 1915, p. 44, t.f. 49, pl. 19, fig. 1.

NOT Planulina ariminensis d'Orbigny. POAG, 1981, p. 75, pl. 43, fig. 3; pl. 44, fig. 3.

Test extremely low trochospiral, almost planispiral, both sides evolute but ventral side incompletely so, both sides flattened. Periphery initially entire, later somewhat lobulate, furnished in early stages of final whorl with thick, imperforate, bluntly rounded keel, which later becomes truncate with 2 raised margins. Chambers strongly arched, 9 or so in outer whorl, surfaces below level of sutures, which are strongly arched, very thick limbate and raised. Aperture interiomarginal, bordered across periphery by lip, then running along "spiral suture" or umbilical margins of chambers on ventral side.

Remarks: The flattened test with heavy sutures and a truncate to bluntly rounded periphery is distinctive. Poag referred forms with strongly depressed

sutures, coarsely pitted walls, and a keeled but subacute periphery to this species.

Planulina caribaea Cushman

Planulina caribaea CUSHMAN, 1931, p. 112, pl. 20, fig. 1.

Test strongly flattened, nearly planispiral, bievolute, dorsal side slightly convex, ventral side gently concave, periphery slightly lobulate, with rounded thick imperforate keel. Chambers from 5 to 7 or more in outer whorl, essentially uninflated except for dorsal side, on which they are gently inflated. Sutures distinct, strongly curved, limbate and merging with keel, on dorsal side very gently raised and on ventral side very gently depressed. Wall quite finely perforate on both sides, though less so dorsally, smooth. Aperture interiomarginal and equatorial, a very low arch running along ventral spiral suture for a few chambers, with very fine lip.

Remarks: This smooth form, with its low number of chambers and curved limbate sutures on both sides, flush to raised dorsally and depressed ventrally, is distinctive. The final few chambers do not increase so dramatically in size as they do in the type, although one specimen is broken and the other is not apparently adult.

Planulina gigas Keijzer

Planulina marialana Hadley var. gigas KEIJZER, 1945, p. 206, pl. 5, fig. 77.

Planulina marialana gigas Keijzer. BOLTOVSKOY, 1978, p. 163, pl. 5, figs. 35-38.

Test very low trochospiral, nearly planispiral, subequally biconvex, periphery barely lobulate in latest stages, sharply keeled except for final chamber which has flattened border and apertural face. Chambers more than 8 per whorl, not inflated, both sides of test with inner whorls visible but very obscure due to calcite deposits. Sutures strongly curved, limbate, raised, especially on ventral side where they produce a crest running parallel to periphery but close to inner edge of whorl. This produces an asymmetry to the test in axial view, with an angled appearance to the ventral side, which has a depressed but not umbilicate central region. Aperture

interiomarginal, at the periphery, without apparent extension along dorsal side spiral suture.

Remarks: The blunt periphery and flattened test of P. ariminensis readily distinguish it from the present species. Planulina renzi Cushman and Stainforth has far too many chambers per whorl, while P. marialana Hadley is essentially involute ventrally, nearly so dorsally, and thinner, without a crest on the ventral side.

Planulina italica Giannini

Planulina italica GIANNINI, 1948, p. 216, p. 186, t.f. 12.

Test virtually planispiral, bievolute, very thin, both faces flattened, periphery entire, acute and carinate, keel rather narrow and thin. Chambers 11 or so in outer whorl, increasing slowly in size as added, uninflated. Sutures distinct, limbate, strongly curved and very slightly depressed. Wall quite coarsely perforate, inner whorls with some rough secondary deposits. Aperture interiomarginal and equatorial, running along ventral spiral suture for a few chambers as a barely perceptible scratch or slit.

Remarks: This very thin test with limbate, nearly flush sutures is distinctive.

Planulina subdepressa Asano

Planulina subdepressa ASANO, 1951, pt. 13, p. 15, figs. 16-18.

Test nearly planispiral, bievolute, ventral side flat, dorsal side slightly convex but with gently excavated inner whorls, periphery very gently lobulate with narrow but rather thick imperforate keel. Chambers at least 8 in outer whorl, barely inflated, but surfaces flat. Sutures somewhat obscure, strongly curved, very gently depressed, limbate particularly on ventral side. Wall very coarsely pitted and perforate, which obscures detail. Aperture interiomarginal and equatorial, low, running along ventral spiral suture for a few chambers.

Remarks: The outer whorl is broken off all present specimens, except for a thin rim or flange at the attachment. For this reason, some of the details are taken from Asano's type figures and description, although in all observable aspects the

forms are the same. The coarsely pitted test, without raised sutures and with definite axial asymmetry to the periphery, is distinctive.

Family CIBICIDIDAE Cushman, 1927

Subfamily CIBICIDINAE Cushman, 1927

Genus Cibicides de Montfort, 1808

Cibicides cicatricosus (Schwager)

Anomalina cicatricosa SCHWAGER, 1866, p. 260, pl. 7, figs. 4, 108.

Cibicides cicatricosus (Schwager). BARKER, 1960, p. 194, pl. 94, fig. 8.---TODD, 1965, p. 52, pl. 22, fig. 3.

Cibicidoides cicatricosus (Schwager). MEAD, 1985, p. 240, pl. 6, figs. 3-5.---BELANGER AND BERGGREN, 1986, p. 344, pl. 6, fig. 6.

Test low trochospiral, almost flattened, dorsal side more strongly so, periphery asymmetrically rounded and becoming lobulate. Chambers usually 10 or 11 in final whorl, rarely as few as 8 (possibly representing megalospheric form), later inflated. Sutures distinct, radial, gently curved and becoming depressed on ventral side; on dorsal side radial but quite strongly curved, initially flush or gently raised to merge with boss covering inner whorls, later depressed. Ventral side with small depressed umbilicus, in some cases slightly evolute and in rare instances with clear umbo. Aperture interiomarginal, peripheral, running back along spiral suture for 1 or 2 chambers.

Remarks: Rotalina akneriana d'Orbigny is closely similar, but has a maximum of 8 chambers per whorl, and a fairly large, open umbilicus. Barker's figured specimen has many chambers but a rather open umbilicus, and Mead could have been correct in suggesting that the two forms may be conspecific.

Cibicides kullenbergi Parker
(Plate 6, Figures 4-6)

Cibicides kullenbergi PARKER, in PHLEGER et al, 1953, p. 49, pl. 11, figs. 7, 8.---?PFLUM AND FRERICH, 1976, pl. 2, figs. 6-8.---THOMAS, 1985, p. 675, pl. 8, figs. 1, 2.

Cibicides robertsonianus (Brady). TODD, 1965, p. 54, pl. 22, fig. 4.

Cibicidoides kullenbergi (Parker). CORLISS, 1979, p. 10, pl. 3, figs. 4-6.

Cibicidoides cf. kullenbergi (Parker). ?MEAD, 1985, p. 242, pl. 6, figs. 6,7.

Cibicidoides kullenbergi (Parker)-C. floridanus (Cushman) species group.

BELANGER AND BERGGREN, 1986, p. 344 (pars), pl. 6, fig. 7; pl. 7, figs. 1,2, not 3.

Test low trochospiral, inequally and variably biconvex, periphery essentially entire and narrowly rounded to acute, with blunt imperforate keel. Chambers 11 or more in final whorl, increasing little in size as added. Sutures limbate and essentially flush, on ventral side radial and curved, radiating from clear umbo of variable size; on dorsal side straight to curved, more strongly angled. Ventral side very finely if at all perforate, dorsal side with coarse, scattered perforations lacking an apparent pattern. Aperture interiomarginal, peripheral, bordered by lip and extending along spiral suture as little more than a scratch.

Remarks: The biconvex test and very weakly developed spiral extension of the aperture distinguish this species from Cibicides lucidus. The specimen illustrated by Belanger and Berggren as pl. 7, fig. 3 should be referred to that species. Cibicides robertsonianus has more chambers per whorl, a partially evolute ventral side with a clear umbo over the depressed umbilicus, and nearly straight radial sutures. For these reasons Todd's specimens have been herein referred to the present species. Although Thomas (1985) caught the essence of this species quite well, her SEM illustrations and the present material do not support her observation that the curved ventral sutures meet the keel tangentially. The uncertain assignment of the forms figured by Pflum and Frerichs (1976) and Mead (1985) is due to their quite rounded periphery, as compared to the more typically subacute to bluntly acute style of the present species. Truncatulina floridana Cushman has raised limbate sutures on both sides of the test, and is thereby distinguished.

Cibicides? margaritiferus (Brady)

Truncatulina margaritifera BRADY, 1881, p. 66.---BRADY, 1884, pl. 96, fig. 2.---CUSHMAN, 1921, p. 319, pl. 65, fig. 1; pl. 74, fig. 1.

Cibicides margaritiferus (Brady). BARKER, 1960, p. 198, pl. 96, fig. 2.

Test low trochospiral, inequally biconvex to nearly planoconvex; periphery acute and carinate, keel may initially be entire but more commonly is lobulate, becoming distinctly notched at the sutures and even imbricated. Chambers 11 to 14 in outer whorl, becoming slightly inflated on ventral side. Sutures on ventral side curved to rarely sigmoid, limbate, and may be anything from raised with fused beading to raised with scattered beads to depressed, sometimes with beads, this progression generally occurring along individual sutures from umbilicus to periphery, as well as from older to more recently formed; on dorsal side sutures limbate, raised and beaded, spiral suture marked with heavy beads, and chamber surfaces may have scattered beads as well. Aperture interiomarginal, a long ventral slit running almost from umbilicus to periphery, with fine bordering lip, and in rare cases extends along spiral suture for one chamber.

Remarks: This completely distinctive form may not be a true Cibicides, the major problem being the form of the aperture, which is predominately ventral rather than dorsal.

Cibicides? mckannai Galloway and Wissler

Cibicides mckannai GALLOWAY AND WISSLER, 1927, p. 65, pl. 10, figs. 5,6.---
INGLE et al., 1980, p. 132, pl. 7, fig. 2.

Test low trochospiral, lenticular with dorsal side evolute, inner whorls covered by heavy deposits, ventral side involute, slightly more strongly convex, with very small depressed to flush umbo, periphery non-lobulate, with thick, bluntly acute imperforate keel. Chambers 14 or so in outer whorl, increasing very slowly in size as added, on dorsal side quadrate, on ventral side triangular, last few very slightly inflated. Sutures rather obscure, on dorsal side heavily thickened and raised, slightly oblique and curved, merging with central boss and peripheral keel, such that chamber faces are sunken between raised areas; on ventral side sutures radial, gently curved, flush, limbate, later very slightly depressed. Wall finely perforate on ventral side, but on dorsal side with few coarse pores in sunken faces of outer

whorl. Aperture unknown due to broken final few chambers, presumed interiomarginal, from ventral side, across periphery and along spiral suture.

Remarks: The lenticular form, flush ventral side, and raised calcified boss, sutures and periphery on the dorsal side, as well as the high number of chambers all serve to distinguish this species. The dorsal wall structure is reminiscent of Cibicidoides, but in the absence of a preserved aperture, the species is tentatively left in Cibicides.

Cibicides mollis Phleger and Parker

Cibicides mollis PHLEGER AND PARKER, 1951, p. 30, pl. 16, figs. 7-9.

Cibicidoides mollis (Phleger and Parker). POAG, 1981, p. 54, pl. 29, fig. 4; pl. 30, fig. 4.

Test low trochospiral, almost planoconvex, ventral side convex but not strongly so, periphery mildly lobulate and acute, with very narrow imperforate carina. Chambers 7 in outer whorl, last few very slightly inflated on dorsal side, on ventral side more strongly inflated throughout. Sutures distinct, on dorsal side very thinly limbate, especially in early stages, strongly curved radial and latterly depressed, on ventral side radial, depressed, sigmoid to curved. Wall on ventral side finely perforate, on dorsal side with coarse pores, most of which are covered by secondary deposits on the inner whorls and the beginning of the outer whorl. Aperture interiomarginal, running from ventral side across periphery with a fine wide bordering lip, thereafter as fine slits or gashes along the spiral suture of the last few chambers.

Remarks: The low test, low number of chambers, and the inflated ventral side serve to distinguish this species from most. It is distinguished from lobulate specimens of C. refulgens, which is uniformly perforate on both sides, and particularly uniform and fine on the dorsal side when compared to the present species.

Cibicides planus (Belford)

Cibicides floridanus (Cushman). TODD, 1965, p. 52, pl. 22, fig. 6.

Planulina plana BELFORD, 1966, p. 122, pl. 10, figs. 14-19.

Test low trochospiral, plano- to concavo-convex, dorsal side wholly evolute and flat to gently concave, ventral side substantially evolute, convex, with depressed umbilical region exposing inner whorls, periphery gently lobulate, acute to narrowly rounded, with narrow imperforate keel. Chambers 8 or 9 in outer whorl, becoming inflated, sooner and more strongly so on ventral side. Sutures limbate, radial and quite strongly curved on both sides, becoming very gently depressed. Wall coarsely perforate on dorsal side, finely so with occasional coarse perforations in pits on ventral side. Aperture interiomarginal, barely on ventral side, crossing periphery and extending for as many as 4 chambers along dorsal spiral suture, with distinct thickened rim on inner margins of chambers.

Remarks: Truncatulina floridana Cushman is almost lenticular, and is biumbonate with heavy raised limbate sutures on both sides. The labelling of dorsal and ventral views is also incorrect in Todd's paper. Rosalina bertheloti d'Orbigny has but 6 chambers per whorl, and is ventrally concave.

Cibicides refulgens de Montfort
(Plate I, Figures 9-11)

Cibicides refulgens MONTFORT, 1808, p. 123; p. 122, t.f. [1].---BARKER, 1960, p. 190, pl. 92, figs. 7-9.

Truncatulina refulgens (Montfort). CUSHMAN, 1915, p. 30, t.f. 33, pl. 12, fig. 2.---CUSHMAN, 1921, p. 312, pl. 63, fig. 1.

Cibicides cf. refulgens Montfort. PHLEGER *et al.*, 1953, p. 49, pl. 11, figs. 10,11.

Test low trochospiral, planoconvex or with dorsal side very slightly convex, periphery acute with narrow imperforate keel, becoming very slightly lobulate. Chambers approximately 7 in outer whorl, increasing steadily in size as added but not much in height, becoming slightly inflated on ventral side and barely so on dorsal side, but enough to produce slight and distinct crenulation of surface. Sutures on ventral side distinct, radial, slightly curved to straight or rarely slightly sigmoid, gently depressed in later stages and meeting at closed umbilicus; on dorsal side

limbate, raised even where chambers slightly inflated, and curved, spiral suture also limbate and raised. Wall finely and evenly perforate on both sides. Aperture interiomarginal, confined mostly to periphery, bordered above by fairly thick lip until running under chamber margins along dorsal side spiral suture, usually for one chamber at most.

Remarks: The low number of chambers, acute carinate periphery and raised dorsal sutures throughout distinguish the present species from Fontbotia lucida.

Cibicides robertsonianus (Brady)

Truncatulina robertsoniana BRADY, 1881, p. 65.---BRADY, 1884, pl. 95, fig. 4.

Cibicides robertsonianus (Brady). BARKER, 1960, p. 196, pl. 95, fig. 4.---TODD, 1965, p. 54, pl. 22, fig. 4.

Cibicidoides robertsonianus (Brady). BELANGER AND BERGGREN, 1986, p. 344, pl. 6, fig. 5.

Test low trochospiral, inequally biconvex, ventral side more strongly so, dorsal side evolute, inner whorls under smooth imperforate hyaline boss, ventral side not wholly involute, inner whorls partially visible through hyaline cover in depressed umbilical region; periphery initially entire and sharply angled with narrow thick keel, becoming slightly lobulate and roundly angled. Chambers 13 in outer whorl, becoming inflated, increasing slowly in size as added. Sutures distinct, on dorsal side radial and curved, limbate and nearly flush becoming simple and depressed, on ventral side radial but fairly strongly curved, initially strongly limbate and nearly flush, becoming simple and fairly strongly depressed. Wall on dorsal side with scattered coarse pores in outer whorl, ventrally with rather indistinct fine pores. Aperture interiomarginal, an equatorial slit with border, passing as a very obscure slit along spiral suture for first few chambers on dorsal side.

Remarks: This species is distinguished from Cibicides umbonatus by its much greater number of chambers per whorl, lack of raised sutures with heavy dorsal calcification, and the fact the ventral sutures of the present species exhibit no tendency to run anteriorward with a posterior peripheral reflexion.

Cibicides umbonatus Phleger and Parker

Cibicides umbonatus PHLEGER AND PARKER, 1951, p. 31, pl. 17, figs. 7-9.

Cibicides sp. cf. **C. umbonatus** (Phleger and Parker). POAG, 1981, p. 55, pl. 31, fig. 4; pl. 32, fig. 4.

Test low trochospiral, almost planoconvex to inequally biconvex, ventral side more strongly convex; periphery becoming slightly lobulate for final chambers, narrowly rounded, with thick narrow keel for all but last few chambers. Chambers 10 in final whorl, only in later stages slightly inflated. Sutures on ventral side strongly limbate, nearly straight and angled slightly forward, then quite strongly hooked near periphery, latest sutures gently depressed and not so limbate, all sutures radiate from clear central umbo; on dorsal side sutures limbate, curved, initially raised but later flush and finally depressed. Wall coarsely perforate on dorsal side, pores as sunken pits in heavily calcified wall. Aperture interiomarginal and mostly confined to periphery, with small bordering lip, extending as a very fine slit along spiral suture for one or more chambers

Remarks: This species is readily distinguished from the more strongly biconvex **Cibicidoides mundulus** by the present species's depressed sutures in later stages, its more widespread and deeply sunken dorsal pores, and the less strongly acute periphery.

Cibicides? sp. A

Test low trochospiral, planoconvex, dorsal side evolute. flat, with inner whorls and first few chambers of outer whorl covered in irregular sparsely perforate boss, ventral side involute, low conical, with distinct umbo; periphery acute with fairly broad keel having distinct notches at the sutures, rather than being truly lobulate. Chambers 8 or 9 in outer whorl, increasing steadily in size but rather more rapidly in breadth as added to produce long apertural face, uninflated except for mildest inflation of final few chambers on dorsal side. Sutures distinct, limbate and thinning toward periphery, on dorsal side curved and slightly oblique, latterly

barely depressed, on ventral side flush and very gently curved. Wall on dorsal side coarsely and quite evenly perforate except at boss, ventral side distinctly but finely perforate. Aperture a low slit starting on ventral side and crossing periphery, presumably extending just past first chamber along spiral suture, bordered on ventral side by sharp lip.

Remarks: The planoconvex test, with flush ventral sutures and umbo, and wide, notched keel, is distinctive. The final chamber is broken off, which accounts for the uncertainty concerning the aperture and generic assignment.

Genus Fontbotia González-Donoso and Linares, 1970

Fontbotia lucida (Reuss)

Truncatulina lucida REUSS, 1866, p. 160, pl. 4, fig. 15.

?Cibicides lucidus (Reuss). BOLTOVSKOY, 1976, p. 157, pl. 3, figs. 13-15.

Cibicides sp. ?POAG, 1981, p. 52, pl. 3, fig. 2; pl. 4, fig. 2.

Cibicidoides kullenbergi (Parker)-C. floridanus (Cushman) species group.
BELANGER AND BERGGREN, 1986, p. 344 (pars), pl. 7, fig. 3 only.

Test low trochospiral, planoconvex, no ventral umbilicus but may have small umbo which may be raised; periphery somewhat acute, imperforate, with narrow blunt keel in earlier stages, and becoming lobulate later on. Chambers typically 9 or 10 in outer whorl, may be more, last 4 or 5 gently inflated on both sides of test. Sutures on both sides distinct, curved, initially somewhat limbate and flush, later depressed. Wall finely perforate on ventral side, coarsely so on dorsal side. Aperture interiomarginal, almost confined to periphery, with bordering lip, and running along spiral suture for a few chambers.

Remarks: Murray's (1971) Cibicides pseudoungerianus (Cushman) is similar, but coarsely perforate on both sides (although that species, defined under Truncatulina, should be equally biconvex, with flush sutures). Poag's (1981) Cibicides sp. has a noticeably flattened apertural face, and is possibly more strongly umbonate than the present forms. Among other planoconvex species, E.

wuellerstorfi has reflexed rather than curved sutures, and C. refulgens has a lesser number of chambers per whorl.

Fontbotia wuellerstorfi (Schwager)
(Plate 5, Figures 1-3)

Anomalina wuellerstorfi SCHWAGER, 1866, p. 258, pl. 7, figs. 105, 107.

Truncatulina wuellerstorfi (Schwager). CUSHMAN, 1915, p. 34, t.f. 36, pl. 12, fig. 3.
--CUSHMAN, 1921, p. 314, pl. 64, fig. 1.

Planulina wuellerstorfi (Schwager). BARKER, 1960, p. 192, pl. 93, fig. 9.---TODD, 1965, p. 51, pl. 23, figs. 3-5.---LAGOE, 1977, p. 127, pl. 5, figs. 1, 2.---CORLISS, 1979, p. 7, pl. 2, figs. 13-16.---COLE, 1981, p. 103, pl. 12, fig. 9.---HERMELIN AND SCOTT, 1985, p. 216, pl. 4, figs. 12, 13.---BELANGER AND BERGGREN, 1986, p. 338, pl. 3, figs. 9-11.

Planulina bradii Tolmachoff. BARKER, 1960, p. 192, pl. 93, fig. 8.

Cibicides wuellerstorfi (Schwager). PFLUM AND FRERICHS, 1976, pl. 4, figs. 2-4.---
?BOLTOVSKOY, 1978, p. 157, pl. 3, figs. 19-21.---SEJRUP *et al.* 1981, p. 290,
pl. 1, fig. 9.---POAG, 1981, p. 52, pl. 3, fig. 1; pl. 4, fig. 1.

Cibicidoides wuellerstorfi (Schwager). MEAD, 1985, p. 240, pl. 6, figs. 1, 2.

Test low trochospiral, planoconvex, ventral side markedly convex to somewhat flattened, profile in axial view has convex umbilical region and concave surfaces toward periphery on ventral side; periphery carinate with thick, rounded keel, not truncate. Chambers approximately 10 in outer whorl, strongly curved or reflexed, final 3 or so may be inflated. Sutures distinct, strongly curved or reflexed, limbate and thick, flush to gently raised at beginning of final whorl, later becoming gently depressed. Wall finely perforate on ventral side, and may have scattered to dense papillae or even digitate umbilical development of final chamber; on dorsal side coarsely perforate. Aperture interiomarginal, a low arch originating barely on ventral side and crossing periphery, bordered by thin lip, with well developed extension along spiral suture for 2 or more chambers.

Remarks: The bluntly acute rather than truncate periphery, non-evolute ventral side, and strong dorsal component to the aperture clearly place this species in the present genus, and not in Planulina. Planulina bradii, although poorly illustrated, apparently has a flattened umbilical region and indistinct sutures on the

dorsal side, in contrast to the specimen referred by Barker to that species. Mead provided an excellent analysis of the distinction between the genera Cibicides, Cibicidoides, and Planulina based on readily observable morphological criteria, but then referred the present form, with its strong dorsal apertural component, to Cibicidoides, which supposedly has an equatorial aperture. Planulina renzi Cushman and Stainforth has too many chambers, up to 18 per whorl.

Genus Lobatula Fleming, 1828

Lobatula lobatula (Walker and Jacob)

Nautilus lobatulus WALKER AND JACOB, 1798, p. 642, pl. 14, fig. 36.

Truncatulina lobatula (Walker and Jacob). CUSHMAN, 1921, p. 313, pl. 63, fig. 2.

Cibicides lobatulus (Walker and Jacob). BARKER, 1960, p. 190, pl. 92, fig. 10; p. 192, pl. 93, figs. 1,4, ?not 5; p. 238, pl. 115, figs. 4,5.---TODD, 1965, p. 52, not pl. 22, fig. 1.---MURRAY, 1971, p. 175, pl. 73, figs. 1-7.---SEJRUP *et al.*, 1981, p. 290, pl. 1, fig. 4.

Cibicidoides lobatulus (Walker and Jacob). CORLISS, 1979, p. 10, pl. 3, figs. 7-9.

Test planoconvex to concavo-convex, ventral side convex; periphery lobulate, initially acute and carinate, later may be subacute to narrowly rounded, without evident imperforate keel. Chambers typically 6 to 8 in outer whorl, inflated on ventral side, may be so later on dorsal side. Ventral side with depressed, open umbilicus which in its maximum development may reveal chambers of previous whorl. Sutures essentially straight, radial and depressed on ventral side, limbate, flush, radial and quite strongly curved on dorsal side, later may become depressed and non-limbate. Wall coarsely perforate on the dorsal side and usually on the ventral side. Aperture interiomarginal, an arched opening starting on ventral side, crossing periphery, thence running along spiral suture, especially pronounced in specimens where latest chambers are translated dorsalward; bordered above, until periphery crossed, by prominent lip.

Remarks: The low number of chambers, lobate periphery which is initially acute but becomes rounded, and the very irregular dorsal surface distinguish this

species. The specimen illustrated by Cushman (1921) has rather strongly curved ventral sutures, but has been left in synonymy. Barker's pl. 93, fig. 5 shows a specimen with very pronounced ventral ornament which appears to be pustular, a condition not observed in the present study. Todd's figured specimen has a far too rounded and non-lobate periphery to be referred to this species. Corliss assigned this species to the genus Cibicidoides supposedly because it is biconvex, but this is not convincingly illustrated in his figures, nor is it common in the current specimens. In addition, the strong extension of the aperture along the spiral suture clearly places this species in Lobatula.

Family PLANORBULINIDAE Schwager, 1877

Subfamily PLANORBULININAE Schwager, 1877

Genus Planorbulina d'Orbigny, 1826

Planorbulina mediterraneensis d'Orbigny

Planorbulina mediterraneensis d'ORBIGNY, 1826, p. 280, pl. 14, figs. 4-6.---BARKER, 1960, p. 190, pl. 92, figs. 1-3.---MURRAY, 1971, p. 179, pl. 75, figs. 1-6.

Test discoidal, initially low trochospiral with a resultant planoconvex Cibicides-like core, having ventral umbo and acute periphery, after which numerous subglobular to quadrate chambers added in very irregular fashion, all more or less in same plane, periphery lobulate and asymmetrically and narrowly rounded to subacute, dorsal side more strongly flattened. Sutures of terminal stage distinct, depressed, straight. Wall coarsely perforate on both sides of test in planate stage. Apertures consist of small interiomarginal arches on posterior and anterior inner margins of chamber, confined to periphery and bordered by lip; successive apertures remain open because chambers are added in irregular, rather than spiral, fashion.

Remarks: The specimens illustrated by Barker (pl. 92, fig. 3) and Murray (all specimens) are much more regular and quadrate in outline than the present ones. The Cibicides-like early stage is clearly evident in Barker, pl. 92, fig. 2. The type description of d'Orbigny is very vague with respect to the apertures and the nature

of the "core" of the test.

Family CYMBALOPORIDAE Cushman, 1927

Subfamily CYMBALOPORINAE Cushman, 1927

Genus Cymbaloporetta Cushman, 1928

Cymbaloporetta bradyi (Cushman)

Cymbalopora poeyi (d'Orbigny) var. bradyi CUSHMAN, 1915, p. 25, pl. 10, fig. 2; pl. 14, fig. 2.

Cymbaloporetta bradyi (Cushman). BARKER, 1960, p. 210, pl. 102, fig. 14.---TODD, 1965, p. 37, pl. 19, figs. 1-4; pl. 20, fig. 4.

Test concavo-convex, dorsal side rounded, periphery lobulate and rounded. Chambers initially added in low trochospiral stage of 1 or 2 whorls in the manner of Rosalina, later added in an irregular annular series in the manner of Planorbulina. Chambers 5 or more comprising periphery, on dorsal side petaloid to crescentic and somewhat inflated in later stages, on ventral side inflated and triangular-petaloid. Sutures on dorsal side depressed and straight, on ventral side successive chambers may be separated by a gap, and thus each has a suture marking the contact between it and the chamber of the preceding whorl that floors the gap. Apertures on ventral side, one or more arches on each side of chamber, in addition to opening into umbilicus, which is deep.

Remarks: This species is generally flatter, more irregular, and the periphery is more lobulate and rounded than on C. squamosa.

Cymbaloporetta squamosa (d'Orbigny)
(Plate 2, Figures 1-3;
Plate 3, Figures 6-8)

Rosalina squamosa d'ORBIGNY, 1839a, p. 91, pl. 3, figs. 12-14.

Cymbalopora poeyi (d'Orbigny). CUSHMAN, 1921, p. 308, pl. 59, fig. 2.

Cymbaloporetta squamosa (d'Orbigny). BARKER, 1960, p. 210, pl. 102, fig. 13.---LOEBLICH AND TAPPAN, 1964, p. 701, fig. 570:3.---TODD, 1965, p. 38, pl. 20, fig. 3.

Test planoconvex to concavo-convex, dorsal side conical, periphery lobulate, angled and narrowly rounded to subacute. One well developed trochospiral whorl

usually present, in the form of Rosalina, thence chambers added in alternating annular series, typically 5 or so prominent in final series on ventral side; chambers inflated and triangular-petaloid on ventral side, weakly inflated on dorsal side. Sutures oblique and nearly flush on dorsal side, on ventral side chambers separated by depressed regions which are floored by chambers of preceeding whorl, creating channels running from periphery to umbilicus, which is deep. Apertures on ventral side, consisting of one arch on each side of chamber bordering channel, plus a third opening at umbilical margin of chamber; complex porous umbilical plate not preserved.

Remarks: According to Barker, Cushman (paper not cited herein) placed Rosalina poeyi d'Orbigny, which is less strongly conical, in synonymy with the present species. The present species is more conical, is much more regular, has a more nearly acute periphery, and has much less separation between the chambers than C. bradyi.

Superfamily ASTERIGERINACEA d'Orbigny, 1839

Family EPISTOMARIIDAE Hofker, 1954

Subfamily EPISTOMARIINAE Hofker, 1954

Genus Asanonella Huang, 1965

Asanonella tubulifera (Heron-Allen and Earland)

Truncatulina tubulifera HERON-ALLEN AND EARLAND, 1915, p. 710, pl. 52, figs. 37-40.

Epistominella tubulifera (Heron-Allen and Earland). TODD, 1965, p. 31, pl. 10, fig. 2.

Alabamina tubulifera (Heron-Allen and Earland). BELFORD, 1966, p. 160, p. 175, t.f. 22:6, pl. 27, figs. 1-6.

Asanonella tubulifera (Heron-Allen and Earland). LOEBLICH AND TAPPAN, 1987, p. 600, pl. 666, figs. 1-7.

Test low trochospiral, inequally biconvex, more strongly so on ventral side. Chambers 7 or 8 in outer whorl, increasing slowly in size as added, on dorsal side very obscure, uninflated, petaloid to crescentic, on ventral side triangular, becoming

very slightly inflated. Sutures very obscure, on dorsal side oblique, curved and flush, on ventral side very gently depressed and radial sigmoid. Wall essentially imperforate or very finely so on ventral side, on dorsal side coarse perforations are concentrated in crescentic patches along sutures, and for all but the final chamber these patches are surrounded by raised crenulate ridges which become increasingly produced as subsequent chambers and laminations are added, all other detail and inner whorls obscured by heavy calcification. As chambers increase in size, the raised elongate rims, which parallel the oblique curved trend of the sutures, become longer in outline and less tubular in appearance, and project less beyond the otherwise narrowly rounded periphery. Aperture interiomarginal, ventral, a long fairly open arch with raised ridge projecting in front of it originating at beginning of outer whorl.

Remarks: This form is completely distinctive.

Subfamily NUTTALLIDINAE Saidova, 1981

Genus Nuttallides Finlay, 1939

Nuttallides bradyana (Cushman)
(Plate 6, Figures 1-3)

Pulvinulinella bradyana CUSHMAN, 1927a, p. 165, pl. 5, figs. 11-13.

Test low trochospiral, biconvex, periphery subacute to angular and distinctively lobulate. Chambers 7 to 8 in outer whorl, inflated, with posterior peripheral angle somewhat produced retrally and in some cases ventrally produced, creating distinctive outline. Sutures distinct, on ventral side nearly radial, somewhat sigmoid and depressed, meeting in closed. non-umbonate umbilicus, on dorsal side limbate but not too strongly so, and oblique. Wall smooth, finely perforate, inner whorls on dorsal side obscured by calcite deposits. Apertural face infolded, aperture a high interiomarginal arch, bordered above by strongly projecting lip that is wider near umbilicus, aperture neither parallel to periphery nor oblique to inner margin.

Remarks: The type description of Cushman is at variance with his type

illustrations on several points. He described the periphery as acute, the chambers as not inflated, and the sutures on the ventral side as radial and not curved, but his type specimen was in these aspects and all others the same as the present form. Both Pseudoparrella(?) decorata Phleger and Parker and N. rugosus are rugose to some extent, while P.(?) decorata and Pulvinulinella pulchra Cushman have too few chambers per whorl. The smooth test and lack of a ventral umbo serve to distinguish this species from others of the same genus in the present study.

Nuttallides rugosus (Phleger and Parker)

Pseudoparrella? rugosa PHLEGER AND PARKER, 1951, p. 28, pl. 15, figs. 8,9.

Nuttallides? rugosus (Phleger and Parker). TODD, 1965, p. 30, pl. 11, fig. 2.

Test low trochospiral, biconvex, periphery acute, becoming distinctly lobulate after non-lobulate initial phase, with thick, narrow, perforate keel. Chambers 9 or more in final whorl, slightly inflated on ventral side in later stages. Sutures on ventral side limbate, radial and very slightly curved, on dorsal side initially oblique and later strongly curved, limbate and flush becoming gently depressed. Wall roughly finished, including umbilical plug. Aperture interiomarginal, running part of way into apertural face which is reflexed or indented nearly parallel to periphery, bordered above by projecting flap that is nearly as wide as long.

Remarks: Pseudoparrella? decorata Phleger and Parker has fewer chambers per whorl and no umbo or plug, while N. bradyanus lacks an umbilical plug and is smoother, as is N. umboniferus.

Nuttallides umboniferus (Cushman)

(Plate 8, Figures 7-9;

Plate 9, Figures 1-3;

Plate 10, Figures 1-3)

Pulvinulinella umbonifera CUSHMAN, 1933a, p. 90, pl. 9, fig. 9.

Eponides bradyi Earland. BARKER, 1960, p. 196, pl. 95, figs. 9,10.---BOLTOVSKOY, 1978, p. 158, pl. 4, figs. 1-3.---?COLE, 1981, p. 102, pl. 11, fig. 5.

Nuttallides umboniferus (Cushman). TODD, 1965, p. 29, pl. 11, fig. 1.

Epistominella umbonifera (Cushman). CORLISS, 1979, p. 7, pl. 2, figs. 10-12.

Nuttallides umbonifera (Cushman). BURKE, 1981, pl. 2, figs. 5,6.---MEAD, 1985, p. 230, pl. 2, figs. 6,7.

NOT Nuttallides umbonifera (Cushman). HERMELIN AND SCOTT, 1985, p. 214, pl. 5, figs. 11-13.

Test low trochospiral, unequally to equally biconvex, periphery lobulate and narrowly rounded to subacute, with distinctly perforate carinal band. Chambers 7, 8, or occasionally 9 in outer whorl, slightly inflated, especially in later stages; earliest whorls obscured by calcite deposits on dorsal side. Sutures on ventral side limbate, tapering from central umbonal boss, somewhat oblique, and depressed, on dorsal side strongly oblique, limbate and depressed, especially late in final whorl. Aperture interiomarginal, a fairly high arch running almost from umbonal boss toward periphery, apertural face strongly infolded and aperture bordered above by strongly projecting, angled lip.

Remarks: This species and other related ones may superficially resemble Epistominella, but in that genus the aperture runs across the apertural face, parallel to the periphery. Other similar species are ventrally umbilicate, not umbonate, while Eponides bradyi has oblique, flush, indistinct sutures and an entire, acute periphery that may be keeled. For this reason Barker's specimen is referred herein to the present species, while the case is less certain for Boltovskoy's specimens, wherein the presence of an umbo is uncertain due to the use of the SEM. Hermelin and Scott illustrated forms with an acute, keeled periphery which thus do not belong in the present species. While Loeblich and Tappan (1964, 1987) asserted that the keel for this genus is poreless, this is not part of Finlay's (1939) type description of the genus. This species, with its perforate carina, is placed with confidence in the present genus.

Nuttallides sp. A

Test low trochospiral, nearly planoconvex, dorsal side very low convex, evolute, the whole surface smooth and highly polished, with inner whorls covered by clear boss, ventral side quite strongly convex, evolute, with large clear

protruding umbilical boss; periphery very slightly lobulate, acute, with very narrow nyaline keel. Chambers 7 or more typically 8 in outer whorl, increasing very slowly in size as added, subrhomboid but gently so, on dorsal side uninflated except for later stages, on ventral side more strongly but still only slightly inflated. Sutures distinct, nearly straight and gently oblique, thinly limbate, on dorsal side all but flush, on ventral side depressed, as is the suture between umbilical boss and outer whorl. Wall very finely perforate. Aperture a very fine interiomarginal slit, excursing slightly into apertural face toward periphery.

Remarks: This species is distinguished by the acute, carinate lobulate periphery, and the bi-evolute nature of the test, with large clear bosses on both sides.

Family ASTERIGERINATIDAE Reiss, 1963

Genus Eoeponidella Wickenden, 1949

Eoeponidella sp. A

Asterigerinata mamilla (Williamson). ?MURRAY, 1971, p. 141, pl. 59, figs. 1-6.

Test planoconvex, low trochospiral, dorsal side convex, ventral side flat with gently excavated umbilical region, periphery angled but rounded, barely lobulate. Chambers 5 in outer whorl, on dorsal side petaloid to crescentic, uninflated, on ventral side gently inflated, with umbilical ring of 4 slightly inflated chamberlets which are equant. Sutures distinct, on dorsal side limbate, narrow, strongly curved and flush, on ventral side straight, radial and gently depressed. Wall finely perforate, except on dorsal side where there is a single row of coarse perforations just below suture. Aperture a large umbilical to extraumbilical arch, skewed slightly anteriorward, with bordering lip, chamberlets formed by flaps which cover preceeding apertures.

Remarks: Rotalina mamilla Williamson has curved oblique, not radial, ventral sutures, and chamberlets are neither mentioned nor illustrated. Murray's specimens agree with the present material well, especially with respect to the coarse

perforations and form of the aperture, but his do have perhaps a more acute periphery, and less distinct, possibly more elongate, chamberlets.

Family ASTERIGERINIDAE d'Orbigny, 1839

Genus Asterigerina d'Orbigny, 1839

Asterigerina miocenica Cushman and Ponton

Asterigerina miocenica CUSHMAN AND PONTON, 1932, p. 95, pl. 14, fig. 4.

Test lenticular, low trochospiral, almost equally biconvex, dorsal side evolute with inner whorls typically covered by boss obscuring all detail, ventral side involute, periphery acute and slightly lobulate, with thin narrow hyaline keel. Chambers usually 7 or 8, rarely 8 1/2, in outer whorl, on dorsal side petaloid to slightly curved, almost uninflated, on ventral side umbilical region with blunt radial chamberlets, and outer part of whorl with mildly inflated, strongly curved chambers. Sutures distinct, on dorsal side oblique and gently curved, barely depressed, on ventral side strongly curved and oblique, gently depressed between chambers proper. Wall rather coarsely perforate for the size of the specimens, evenly distributed. Aperture a low interiomarginal slit reaching neither umbilicus nor periphery, with slight forward reflexion near periphery.

Remarks: The low equally biconvex test with strongly oblique, curved ventral sutures is distinctive.

Family AMPHISTEGINIDAE Cushman, 1927

Genus Amphistegina d'Orbigny, 1826

Amphistegina gibbosa d'Orbigny

Amphistegina gibbosa d'ORBIGNY, 1839a, p. 120, pl. 8, figs. 1-3.---BARKER, 1960, p. 228, pl. 111, figs. 2, 24, 211.

Amphistegina radiata (Fichtel and Moll). TODD, 1965, p. 34 (pars), pl. 14, figs. 1, 2, 23.

Test thin and lenticular, very low trochospiral, periphery carinate and entire. Chambers on the order of 6 to 7 in outer whorl, both sides of test with large, clear umbo. Sutures limbate and virtually flush to barely depressed, strongly recurved and

oblique on outer portion of test, toward umbo very obscure, producing appearance of vortex of chambers or iris diaphragm, but chambers have distinct, rounded inner terminations. Aperture a barely discernible interiomarginal slit.

Remarks: Amphistegina quoyii d'Orbigny is very similar, but has much thinner and more numerous chambers. The present forms are represented by some of Todd's specimens, none of which would appear to belong to Nautilus radiatus Fichtel and Moll, which apparently has radiate and sinuous but not reflexed sutures. The test is thinner, more nearly lenticular, and does not have the prominent inner chamberlets that characterize A. madagascariensis.

Amphistegina madagascariensis Fornasini
(Plate 3, Figures 1-3)

Amphistegina madagascariensis FORNASINI, 1903, p. 143, pl. 2, fig. 5.

Amphistegina lessonii d'Orbigny. BARKER, 1960, p. 230, pl. 111, figs. 5, 26.

Amphistegina madagascariensis d'Orbigny. TODD, 1965, p. 34, pl. 12, figs. 1, 2; not pl. 11, fig. 3.

Test very low trochospiral, inequally biconvex, ventral side more strongly so, periphery carinate and entire. Chambers relatively few, on the order of 7 or 8 in final whorl. Both sides of test with clear umbos, surface granulose on ventral side near aperture, on first few chambers of final whorl. Sutures limbate and virtually flush to barely depressed, on dorsal side sinuous and radiate for more than half of test diameter, then strongly reflexed and oblique to periphery; radiate portion with irregular limbate insertions. Sutures on ventral side are irregular and curved, nearly radial near umbo, then divergent and later reconverge with insertion of outer chambers between these chamberlets, thence converging rapidly and strongly reflexed; outer chambers separated by strongly oblique and curved sutures. Aperture an obscure interiomarginal slit.

Remarks: Barker regarded this form as a variant of A. lessonii, while Fornasini selected certain specimens of that species as the types to describe and illustrate the present species. While d'Orbigny originally gave this name, he did not

describe or illustrate it, so the authorship rightly belongs to Fornasini. This species is distinguished primarily by the low number of chambers per whorl and the unusual suture pattern created by the insertion of the chambers between the chamberlets on the ventral side.

Superfamily NONIONACEA Schultze, 1854

Family NONIONIDAE Schultze, 1854

Subfamily NONIONINAE Schultze, 1854

Genus Evolutononion N.W. Wang, 1964

Evolutononion? sp. A

Test planispiral, nearly involute, either small umbilici with earlier whorls barely discernible, or large proloculus fills the area, periphery lobulate and rounded. Chambers 6 or 7 in outer whorl, increasing fairly rapidly in size as added, inflated, not much broader than high. Sutures distinct, slightly limbate, depressed, virtually radial and straight. Aperture an equatorial interiomarginal slit, from umbilicus to umbilicus, with fine bordering lip.

Remarks: The rounded periphery, depressed sutures, and rapid chamber increase and characteristic shape are distinctive. This form bears a remarkable resemblance to Nonionella iridica Heron-Allen and Earland, but that species is trochospiral and involute/evolute, with a long narrow lobe from the final chamber over the ventral umbilicus. The generic assignment is tentative as no particular granular material is discernible.

Genus Nonion de Montfort, 1808

Nonion sp. cf. N. commune (d'Orbigny)

Nautilus scapha FICHTEL AND MOLL, 1798, p. 105, pl. 19, figs. d-f.

Nonionina commune d'ORBIGNY, 1846, p. 106, pl. 5, figs. 7,8.

Nonionina scapha (Fichtel and Moll). CUSHMAN, 1914, p. 28, pl. 15, fig. 1; pl. 16, figs. 3,4.

Nonion scaphum (Fichtel and Moll). ASANO, 1950, pt. 1, p. 4, figs. 17,18.---
BARKER, 1960, p. 224, pl. 109, figs. 14,15.

Nonion commune (d'Orbigny). RÖGL AND HANSEN, 1984, p. 66, pl. 24, figs. 1,2,4-6.---PAPP AND SCHMID, 1985, p. 45, pl. 34, figs. 1-5.

Test planispiral, auriculate in outline, both sides partially evolute with rather broad shallow umbilici, periphery rounded and essentially non-lobulate. Chambers 9 in outer whorl, increasing fairly rapidly in size and especially in breadth as added, very gently inflated near umbilici. Sutures distinct, limbate and curved, gently depressed toward umbilici. Wall hyaline and smooth, with no papillae evident using light microscope. Aperture a low interiomarginal slit, from umbilicus to umbilicus.

Remarks: Distinguished from other species by the rapid increase in chamber breadth, this specimen differs from the types in having a few less chambers per whorl, and no evident granular material in the umbilicus or along sutures. Many forms included in the synonymy have a rather rapid increase in chamber thickness as compared to the present specimen. Rögl and Hansen pointed out that Fichtel and Moll's type specimen is lost, and that the name had been used by an earlier author. They recommended placing Fichtel and Moll's material in d'Orbigny's synonymous species.

Nonion sp. A

Test planispiral, compressed, periphery rounded and nearly entire. Chambers 6 to rarely 6 1/2 in final whorl, increasing fairly rapidly in size as added, only slightly inflated latterly, with strongly projecting peripheral angle on final chamber. Sutures distinct, very slightly limbate, radial, gently curved and very slightly depressed. Wall fairly coarsely perforate. Aperture an interiomarginal slit, running from one umbilicus to the other, bordered above by fine lip.

Remarks: The umbilici are barely open, but their presence, coupled with the fairly coarse perforations and curved sutures, serves to distinguish this species from any belonging to Pullenia. It is distinguished from other species of Nonion primarily by the very low number of chambers per whorl.

Nonion sp. B

Test planispiral, slightly ovate in outline, strongly compressed with flattened faces, umbilici very small and shallow, periphery well rounded and nearly non-lobulate. Chambers 7 in outer whorl, increasing steadily in size as added, not much inflated near periphery, but more strongly so near umbilici. Sutures distinct, increasingly depressed toward umbilici, very strongly curved in two distinct stages, with smooth calcite deposits filling the depressed area. Aperture equatorial interiomarginal, bordered above by fairly prominent lip.

Remarks: This form has no well developed sutural and umbilical granules as is held by most authors to be characteristic of Nautilus depressulus Walker and Jacob. Rather, the present form has smooth stellate deposits, but not chamberlets as would characterize Astrononion. In addition, the type figures of N. depressulus show a 12-chambered form with very narrow chambers and less strongly curved sutures. Nonionina affine Reuss has 10 chambers per whorl, a non-lobulate periphery, and uninflated chambers with flush sutures that are radial and gently curved.

Nonion sp. C

Test planispiral, thick lenticular, bi-involute and biumbonate, umbos thick and imperforate, periphery non-lobulate, acute, with rather blunt keel. Chambers 10 in outer whorl, increasing steadily in size as added, essentially uninflated. Sutures distinct, limbate, curved and flush. Wall coarsely perforate. Aperture an interiomarginal slit, with very fine narrow lip, from umbilicus to umbilicus, at base of inflated apertural face.

Remarks: This species is distinguished by its remarkable resemblance, apart from the aperture, to Lenticulina.

Genus Nonionella Cushman, 1926

Nonionella amplilabrata Belford

Nonionella amplilabrata BELFORD, 1966, p. 159, pl. 31, figs. 16-20.

Nonionella turgida (Williamson). COLE, 1981, p. 109, pl. 13, fig. 3.

Test very low trochospiral, auriculate in outline, rather thick, ventral side

involute and a bit more convex than evolute dorsal side, periphery virtually entire, rounded and very slightly angled. Chambers likely 9 or so in outer whorl, barely inflated, increasing fairly rapidly in size as added, about twice as broad as high. Sutures distinct, curved, nearly flush. Final chamber on ventral side with thick rounded lobe hooked posteriorly from peripheral extension of chamber, forming a sharp angle where it joins chamber, and extending back across some 3 chambers, lobe with denticulate umbilical or lower margin, covering aperture.

Remarks: The single specimen consists of the final 3 chambers, and nothing else. Rotalina turgida Williamson has a final chamber running along the periphery for almost the entire length of the test, and it is somewhat straighter as well, while Nonionella basiloba Cushman and McCulloch has a much higher final chamber and the umbilical flap is continuous with it, without forming an angle on the posterior side. The illustrated specimen assigned by Poag (1981, pl. 43, fig. 4; pl. 44, fig. 4)) to this latter species seems to be intermediate in character, with a high final chamber but a distinct posterior angle to the chamber extension as well. It may be that this is all one species with some considerable degree of variability, in which case N. basiloba would have priority. Poag included N. opima Cushman in synonymy with that species.

Nonionella? sp. A

Test very low trochospiral, both faces somewhat flattened, dorsal side evolute with inner whorls hidden by flat, flush boss, ventral side involute without open umbilicus, final chamber with extremity passing beyond umbilicus, and face anteriorly tangent; periphery broadly rounded, not truly lobulate, but slightly angled. Chambers just over 6 in outer whorl, increasing quite rapidly in size as added, only latter few very mildly inflated, on ventral side broad triangular. Sutures distinct, initially flush and mildly limbate, later barely depressed, on dorsal side slightly oblique and on ventral side nearly radial. Wall on dorsal side with a few perforations exceptionally large. Aperture interiomarginal, a low slit running

from umbilical extremity of chamber on ventral side, across periphery and almost to extreme umbilicalward extremity of final chamber on dorsal side, with faint lip on ventral side.

Remarks: This species is unusual for the genus in having rapidly enlarging, broad triangular chambers, hence the uncertain assignment. The trochospiral coiling distinguishes it from Nonion and Pullenia.

Nonionella sp. B

Test low trochospiral, auriculate in outline, dorsal side flattened, evolute, ventral side slightly convex and very slightly evolute, with small, fairly deep umbilicus, periphery well rounded and almost non-lobulate. Chambers 8 in outer whorl, increasing quite rapidly in size as added, especially in breadth, not much in thickness, only last 1 or 2 slightly inflated. Sutures distinct, limbate, flush and later barely depressed, gently curved and somewhat oblique. Aperture interiomarginal, a low slit from dorsal extremity of periphery across to umbilicus, bordered above by weakly developed umbilical flap.

Remarks: This species is distinguished by its elongate auriculate test, and barely developed flap which fails to completely cover the umbilicus. The rounded periphery and flush sutures are also characteristic.

Genus Nonionellina Voloshinova, 1958

Nonionellina sp. A

Test very low trochospiral, becoming planispiral, auriculate in outline, ventral side with narrow, deep umbilicus, periphery barely lobulate, slightly angled but very well rounded. Chambers 8 in outer whorl, slightly more inflated ventrally and a bit tumid, increasing quite rapidly in height and breadth as added, apertural face between $1/2$ and $2/3$ of test length, well rounded and convex. Sutures distinct, curved, and slightly more depressed on ventral side. Aperture interiomarginal, a full broad equatorial slit, bordered by lip, with some granular material at umbilical borders of chambers.

Remarks: This species is thicker and has a lower apertural face than Nonionina elongata d'Orbigny, and is distinguished from Nonionellina sp. B in being more rounded, with a much lower apertural face.

Nonionellina sp. B

Test very low trochospiral and very elongate, about as thick as broad, dorsal side evolute but whorls tightly appressed, ventral side with deep open umbilicus, periphery entire, angled but rounded. Chambers 10 in outer whorl, uninflated, increasing very rapidly in breadth as added, apertural face over 2/3 of test length, inflated, almost elongate heart-shaped. Sutures distinct, flush, almost straight. Aperture a low interiomarginal equatorial slit under wide lower face of final chamber.

Remarks: The asymmetry, combined with a very broad and high apertural face, is distinctive.

Genus Nonionoides Saidova, 1975

Nonionoides sp. cf. N. grateloupi (d'Orbigny)

Nonionina grateloupi d'ORBIGNY, 1839a, p. 46, pl. 6, figs. 6,7.

NOT Nonion grateloupi (d'Orbigny) (?). CUSHMAN, 1933d, p. 43, pl. 10, fig. 8.

Pseudononion japonicum Asano. ?BOLTOVSKOY, 1978, p. 166, pl. 6, figs. 10,11.

Nonionoides grateloupi (d'Orbigny). LOEBLICH AND TAPPAN, 1987, p. 618, pl. 692, figs. 7-9,11-14, ?10.

Test very low trochospiral, strongly compressed, elongate auriculate, dorsal side evolute and flat, ventral side involute with narrow, deep umbilicus, more strongly convex due to inflation of final chamber, periphery nearly entire and well rounded. Chambers 12 in outer whorl, increasing very slowly in height but rapidly in breadth as added, inflated somewhat toward inner ends on both sides of test, and fairly strongly on final chamber on ventral side, which produces rounded umbilical shoulder; apertural face very long and straight in outline. Sutures distinct, very gently depressed except toward periphery, where flush, radial and very slightly

curved. Wall smooth, except for fine granules around umbilical region. Aperture a low interiomarginal equatorial slit or arch.

Remarks: The compressed test, with rounded outline and high, straight apertural face, is distinctive, and matches all but figure 10 of Loeblich and Tappan (1987) remarkably well. That figure is of a specimen more ovate in outline with a curved apertural face of lesser height, which is in fact more like d'Orbigny's type, although that was still somewhat auriculate, and without apparent asymmetry. It is on the basis of the rounded periphery and chamber shape that the present form is referred to this species. The specimen illustrated by Boltovskoy (1978) looks very similar, but there is no axial view to confirm the asymmetry. This species differs from Pseudononion japonicum, which is a bit more ovate, has a curved apertural face, a distinctly though gently lobulate outline, and the periphery is strongly angled to acute, particularly in the early stages. In no way does this appear to correspond to the SEM illustrations of that species found in Loeblich and Tappan (1987, pl. 692, figs. 1-6), which show much umbilical granulation and a heavy raised stellate appearance to that area, as well as a non-lobulate periphery. It may be that there is a problem with japonicum as type species for a genus characterized by so many species with angled periphery and umbilical granulation. The resolution of this problem lies beyond the scope of the present study.

Genus Zeaflorilus Vella, 1962

Zeaflorilus sp. A

Test very low trochospiral, somewhat auriculate, barely asymmetrical, ventral side involute and more strongly convex, dorsal side with inner whorls visible, periphery gently lobulate, strongly angled but neither acute nor carinate. Chambers 10 in outer whorl, very gently inflated except for umbilical lobes on ventral side which are more strongly so, increasing more rapidly in breadth than height as added, apertural face more than 1/2 of test length, triangular. Sutures distinct, gently depressed and curved. Umbilicus completely obscured by granulose material,

some extending along sutures, and some around aperture. Aperture interiomarginal, equatorial, obscured by pustules.

Remarks: The asymmetry distinguishes this from true Nonion, and the low number of chambers from known species of Zeaflorilus.

Subfamily **ASTRONONIONINAE** Saidova, 1981

Genus **Astrononion** Cushman and Edwards, 1937

Astrononion echolsi Kennett
(Plate 5, Figures 9,10;
Plate 6, Figures 11,12)

Astrononion echolsi KENNETT, 1967, p. 134, pl. 11, figs. 7,8.---CORLISS, 1979, p. 8, pl. 3, figs. 16,17.---MEAD, 1985, p. 235, pl. 4, figs. 3,4.---BELANGER AND BERGGREN, 1986, p. 340, pl. 4, figs. 7,8.

Test planispiral, more or less involute, periphery rounded and becoming gently lobulate. Chambers 7 or more in final whorl, increasing gradually in size as added, not noticeably inflated. Sutures distinct, limbate, radial and gently curved, essentially flush. Stellate inner or secondary chamberlets flush with surface, which in SEM would be smooth and featureless except for secondary apertures, which appear as obscure round holes not on primary sutures. Primary aperture an interiomarginal slit, bordered by fine lip, running from one umbilicus to the other.

Remarks: The low number of chambers distinguishes this species from Nonionina stelligera d'Orbigny, and the even, smooth surface with flush sutures distinguishes this species from A. gallowayi and Laminononion tumidum.

Astrononion gallowayi Loeblich and Tappan

Nonionina asterizans (Fichtel and Moll). CUSHMAN, 1914, p. 26 (pars), pl. 14, fig. 5.

Astrononion gallowayi LOEBLICH AND TAPPAN, 1953, p. 90, pl. 17, figs. 4-7.---HERMELIN AND SCOTT, 1985, p. 203, pl. 5, fig. 1.

Astrononion stelligerum (d'Orbigny). ?BARKER, 1960, p. 224, pl. 109, fig. 4 only.---BOLTOVSKOY, 1978, p. 152, pl. 1, fig. 13.

Astrononion antarcticum Parr. MEAD, 1985, p. 234, pl. 4, figs. 1,2.

Test planispiral, involute, periphery rounded and mildly lobulate. Chambers 8 or so in final whorl, somewhat inflated, increasing steadily in size as added. Sutures

distinct, depressed, and curved. Supplementary chambers form a stellate pattern centered on the umbilicus, extending at least halfway to periphery, broad and triangular in outline and covering a broad umbilical region. Primary aperture an interiomarginal slit, with supplementary apertures on outer posterior margin of supplementary chambers.

Remarks: Nonionina stelligera d'Orbigny is more strongly compressed, has more chambers per whorl, and its supplementary chambers are very elongate, narrow, and angled to stellate. For these reasons the specimens of Boltovskoy (1978) and possibly Barker (1960) are referred herein to the present species. Astrononion antarcticus Parr has too few chambers and very restricted supplementary chambers, which differ from those figured by Mead. Nautilus asterizans Fichtel and Moll has 12 or more narrow chambers, an angled to acute periphery, and a very small and obscure stellate region, hence Cushman's description was not consistent, nor did his figures match that species.

Genus Laminononion Hornibrook, 1964

Laminononion tumidum (Cushman and Edwards)

Astrononion tumidum CUSHMAN AND EDWARDS, 1937, p. 33, pl. 3, fig. 17.---
BARKER, 1960, p. 224, pl. 109, fig. 5.

Test planispiral, involute, periphery rounded and lobulate. Chambers 5 to 7 in final whorl, strongly inflated, increasing fairly rapidly in size as added. Sutures distinct, depressed, curved. Umbilical region furnished with supplementary chambers which are rhomboid, with elongate extensions along the sutures with tapering ends at least half way to periphery. Primary aperture an interiomarginal slit, with obscure posterior openings on supplementary chambers.

Remarks: The strongly inflated chambers and their low number serve to distinguish this species from most others. Astrononion antarcticus Parr has very restricted supplementary chambers, not extending much beyond the umbilicus.

Subfamily PULLENIINAE Schwager, 1877

Genus Melonis de Montfort, 1808

Melonis barlecanum (Williamson)
(Plate 4, Figures 3,4)

Nonionina barlecana WILLIAMSON, 1858, p. 32, pl. 3, figs. 68,69.

Nonionina umbilicatula (Walker and Jacob). CUSHMAN, 1914, p. 24, pl. 17, fig. 1.---
?CUSHMAN, 1921, p. 365, pl. 74, fig. 3.

Gavclionion barlecanum (Williamson). BARKER, 1960, p. 224, pl. 109, figs. 8,9.

Melonis pompilioides (Fichtel and Moll). MURRAY, 1971, p. 199, pl. 84, figs. 1-7.

Melonis barlecanus (Williamson). PFLUM AND FRERICHS, 1976, pl. 7, figs. 5,6.---
WESTON, 1985, pl. 2, fig. 4.

Nonion affine (Reuss). BOLTOVSKOY, 1978, p. 162, pl. 5, figs. 1,2.

Melonis barlecanum (Williamson). CORLISS, 1979, p. 10, pl. 5, figs. 7,8.---INGLE *et al.*
1980, p. 142, pl. 7, figs. 14,15.---BELANGER AND BERGGREN, 1986, p.
346, pl. 7, figs. 7,8.

Melonis affinis (Reuss). INGLE *et al.* 1980, p. 142, pl. 5, figs. 1,2.

Test planispiral, biumbilicate, umbilicus deep, with strong shoulder formed by convex apertural face which terminates chambers at umbilicus; previous whorls visible at umbilicus. Test compressed, periphery nearly entire but becoming very slightly lobulate toward final chambers, narrowly rounded to subangular. Chambers typically 10 or more in outer whorl. Sutures slightly curved, tangential to umbilical shoulder, initially limbate and flush, tending to be slightly depressed in final stages. Aperture a quite high interiomarginal slit, spiralling along umbilical shoulder for entire outer whorl and more, bordered by fine lip beyond umbilical region.

Remarks: Nautilus umbilicatus Walker and Jacob is clearly evolute on at least one side, although its description is poor, while Nonionina umbilicatula (Walker and Jacob) var. pacifica Cushman has distinctly depressed, not at all limbate sutures. Nonionina affinis Reuss, with which this form is most frequently confused, has very small umbilici, radial (rather than tangential) sutures, and a short semilunar aperture. The specimen illustrated by Cushman (1921) as N. umbilicatula is perhaps insufficiently compressed for the present species. Murray

(1971) assigned this compressed form to M. pompilioides, which is quite thick and not at all compressed.

Melonis pompilioides (Fichtel and Moll)

Nautilus pompilioides FICHEL AND MOLL, 1798, p. 31, pl. 2, figs. a-c.

Nonionina pompilioides (Fichtel and Moll). CUSHMAN, 1914, p. 25, pl. 17, fig. 2.

Nonion pompilioides (Fichtel and Moll). CUSHMAN, 1933d, p. 41, pl. 10, figs. 1,2.---
BOLTOVSKOY, 1978, p. 162, pl. 5, figs. 3,4.

Melonis sphaeroides VOLOSHINOVA, 1958, p. 153, pl. 3, figs. 8,9.---MEAD, 1985, p. 242, pl. 7, fig. 3.---BELANGER AND BERGGREN, 1986, p. 346, pl. 7, figs. 9,10.

Nonion(?) pompilioides (Fichtel and Moll). BARKER, 1960, p. 224, pl. 109, figs. 10,11.

NOT Melonis pompilioides (Fichtel and Moll). MURRAY, 1971, p. 199, pl. 84, figs. 1-7.

Melonis pompilioides (Fichtel and Moll). FRERICHS, 1969b, p. 43, pl. 1, figs. 2,3.---
PFLUM AND FRERICHS, 1976, pl. 7, figs. 7,8.---CORLISS, 1979, p. 12, pl. 5, figs. 9,10.---INGLE *et al.*, 1980, p. 142, pl. 9, figs. 14,15.---RÖGL AND HANSEN, 1984, p. 30, pl. 2, figs. 1,2; pl. 3, fig. 1.---HERMELIN AND SCOTT, 1985, p. 212, pl. 6, fig. 5.

Melonis soldani [sic] (d'Orbigny). FRERICHS, 1969b, p. 43, pl. 1, figs. 1,4,5.

Test planispiral, subglobular, biumbilicate, periphery almost completely non-lobulate and very broadly rounded. Chambers 9 or more in final whorl, as few as 6 in immature specimens, increasing rapidly in thickness as added, such that test thickness nearly doubles in one whorl. Sutures limbate, flush to only slightly depressed for final few chambers, nearly radial but tangential to umbilical shoulder, essentially straight. Umbilicus small, very deep and steep-walled. Aperture an interiomarginal slit, crossing periphery from umbilicus to umbilicus, bordered above by very fine but distinct lip or rim.

Remarks: Nonionina soldanii d'Orbigny is closely similar, with 11 chambers in the final whorl, but the sutures are anterior to the umbilicus, rather than posterior and tangential, and its aperture is a short or confined crescentic opening on the periphery. Melonis sphaeroides was erected by Voloshinova with reference to

Brady's (1884) illustrations, which are also those of Barker (1960). The number of chambers per whorl seems to have been an issue, but this is evidently affected strongly by the maturity or size of the specimen. Cushman (1933d) described 8 to 10 chambers, but illustrated 12, while Fichtel and Moll illustrated a specimen with 10 to 11 chambers in the outer whorl. The choice of this paper is to refer these forms to Fichtel and Moll's species, a conclusion supported by Rögl and Hansen's (1984) re-examination and illustration, by SEM, of the type material. As noted in the discussion for M. barleeianum, Murray's specimens are too highly compressed to be referred to the present species.

Melonis sp. A

Test planispiral, biumbilicate, quite strongly compressed, periphery gently lobulate and rounded. Chambers 6 or 7 in outer whorl, expanding rapidly in all but thickness as added. Sutures slightly limbate, essentially radial and nearly straight, only slightly depressed if at all. Umbilici small but distinct, shouldered by extension of apertural face. Aperture an interiomarginal slit, from umbilicus to umbilicus, bordered by extremely fine lip.

Remarks: This species has fewer chambers per whorl, a more irregular outline, and much smaller umbilicus than M. barleeianum. The more pronounced umbilicus, along with distinctly limbate and less depressed sutures, serve to distinguish it from Pullenia salisburyi.

Genus Pullenia Parker and Jones, 1862

Pullenia bulloides (d'Orbigny)
(Plate 10, Figures 4,5)

Nonionina bulloides d'ORBIGNY, 1846, p. 107, pl. 5, figs. 9,10.

Pullenia sphaeroides (d'Orbigny). CUSHMAN, 1914, p. 20, pl. 11, fig. 2.

Pullenia bulloides (d'Orbigny). BARKER, 1960, p. 174, pl. 84, figs. 12,13.---TODD, 1965, p. 48, pl. 18, fig. 6.---BOLTOVSKOY, 1978, p. 166, pl. 6, fig. 12.---CORLISS, 1979, p. 8, pl. 4, figs. 1,2.---INGLE *et al.*, 1980, p. 142, pl. 5, fig. 7.---BURKE, 1981, pl. 3, figs. 5,6.---SEJRUP *et al.*, 1981, p. 293, pl. 2, fig. 8.---HERMELIN AND SCOTT, 1985, p. 216, pl. 5, figs. 3,4.---MEAD, 1985, p. 236, pl. 4, fig. 6.---BELANGER AND BERGGREN, 1986, p. 342, pl. 5, fig. 1.

Test planispiral, involute, subspherical, thickness nearly equal to diameter, periphery entire and very broadly rounded. Chambers 4 or rarely 5 in outer whorl, not inflated nor increasing much in size as added. Sutures distinct, radial, straight and flush, somewhat limbate in appearance. Aperture an interiomarginal slit from one umbilicus to the other, bordered above by a very fine lip or rim.

Remarks: This species is distinguished from P. osloensis, which is more compressed, lobulate in outline, and has oddly curved sutures and an asymmetrical apertural face.

Pullenia osloensis Feyling-Hanssen
(Plate 8, Figures 10,11)

Pullenia osloensis FEYLING-HANSEN, 1954, p. 194, pl. 1, figs. 33-35.---
BOLTOVSKOY, 1978, p. 166, pl. 6, figs. 15-18.---CORLISS, 1979, p. 9, pl. 4,
figs. 3,4.---BELANGER AND BERGGREN, 1986, p. 342, pl. 5, figs. 2,3.

Test small, subspherical, involute, compressed, periphery lobulate and rounded. Chambers usually 4 1/2 in final whorl, gently inflated. Sutures depressed, distinctly curved. Aperture a very low interiomarginal slit at base of distinctive apertural face; face curved and asymmetrically skewed, oblique to peripheral plane.

Remarks: The subglobular test, combined with compression, depressed curved sutures, and the skewed apertural face, serve to distinguish this species.

Pullenia salisburyi Stewart and Stewart

Pullenia salisburyi STEWART AND STEWART, 1930, p. 72, pl. 8, fig. 2.---
BOLTOVSKOY, 1978, p. 166, pl. 6, fig. 19.---MEAD, 1985, p. 236, pl. 4, figs. 7,8.

Test planispiral, involute, strongly compressed, periphery rounded, lobulate and somewhat hexagonal in outline. Chambers usually 6 in outer whorl, may be 5 or 7, inflated, increasing fairly rapidly in all but thickness as added. Sutures distinct, radial and gently curved, depressed, meeting in small umbilicus. Aperture a low interiomarginal slit or arch, from umbilicus to umbilicus, with very fine bordering lip.

Remarks: The compressed test, rounded periphery and number of chambers serve to distinguish this species from all others except perhaps P. simplex Rhumbler.

That species has a very sketchy description, and poor type figures based on poorly preserved specimens, but evidently the chambers increase much more rapidly in thickness than in P. salisburyi.

Pullenia subcarinata (d'Orbigny)
(Plate 9, Figures 7-10)

Nonionina subcarinata d'ORBIGNY, 1839c, p. 28, pl. 5, figs. 23,24.

Nonionina quinqueloba REUSS, 1851a, p. 71, pl. 5, fig. 31.

Pullenia compressiuscula Reuss var. quadriloba REUSS, 1867, p. 87, pl. 3, fig. 8.

Pullenia quinqueloba (Reuss). CUSHMAN, 1914, p. 21, pl. 13, fig. 2.---TODD, 1965, p. 48, pl. 18, fig. 7.---INGLE *et al.*, 1980, p. 142, pl. 5, fig. 8.---BELANGER AND BERGGREN, 1986, p. 342, pl. 5, figs. 4-6.

Pullenia subcarinata (d'Orbigny). BARKER, 1960, p. 174, pl. 84, figs. 14,15.---HERMELIN AND SCOTT, 1985, p. 216, pl. 5, figs. 5,9.---WARD AND WEBB, 1986, p. 198, pl. 7, figs. 5-7.

Pullenia subcarinata quinqueloba (Reuss). BOLTOVSKOY, 1978, p. 166, pl. 6, figs. 23,24.

Pullenia subcarinata subcarinata (d'Orbigny). BOLTOVSKOY, 1978, p. 167, pl. 6, figs. 21,22.

Pullenia quadriloba Reuss. BOLTOVSKOY, 1978, p. 166, pl. 6, fig. 20.

Pullenia simplex Rhumbler. CORLISS, 1979, p. 9, pl. 4, figs. 5,6.---BELANGER AND BERGGREN, 1986, p. 342, pl. 5, fig. 7.

Pullenia cf. subcarinata (d'Orbigny). MEAD, 1985, p. 236, pl. 4, figs. 9,10.

Test planispiral, involute, compressed; periphery ranging from somewhat lobulate and pentagonal in outline, and broadly rounded, to nearly entire and circular in outline, and rounded to rarely narrowly rounded and approaching angular. Chambers usually 5 to 5 1/2 in outer whorl, but occasionally as few as 4 or as many as 6; in more nearly circular forms whorls strongly embracing and apertural face low. Sutures distinct, straight, may be depressed to virtually flush. Aperture an interiomarginal slit, from one umbilicus to the other, bordered above by fine lip.

Remarks: This form embraces at least three species described in the literature, in that all three are represented, and there is a full range of intermediate forms that

prevents separating them on any consistent and reliable basis. The form with the more rounded periphery, and lobulate pentagonal outline, may be thought of as the classic P. quinqueloba. The other, less commonly developed form, with rounded tending to angled, and non-lobulate periphery, is the form usually referred to P. subcarinata. The third form has 4 chambers per whorl and represents P. quadriloba, while P. simplex may be represented by the 6-chambered form, although this latter species is difficult to evaluate properly because of the poor type description and figure. Barker (1960) and Ward and Webb (1986) placed Nonionina quinqueloba Reuss in synonymy with P. subcarinata, erected by d'Orbigny under Nonionina. As originally described, this latter species has 6 chambers, is thick, and has a well-angled periphery described as "pourtour...un peu carenée, quoiqu'arrondi" (d'Orbigny, 1839c, p. 28), also "par la tendance à la forme carenée de son pourtour" (ibid., p. 28). Boltovskoy (1978) recognized both forms as distinct, and made of them two subspecies belonging to P. subcarinata. Mead concluded, as does the present study, that the two forms are indistinguishable, and placed them both within d'Orbigny's species as having seniority. Mead did have reservations, however, believing there was a lack of any forms like d'Orbigny's since the type illustration. Reference to Barker (1960) and Ward and Webb (1986) shows that such angled forms are in fact found in the literature, and the present material also has a few such specimens. While Reuss's description and type figure seem to do a better job of embracing the range of variation observed, d'Orbigny's species still has priority, though it may be based on the exceptional morphotype.

Pullenia sp. A

Test planispiral, ovate lenticular, thick, involute and non-umbilicate, periphery initially angled, soon becoming acute and carinate, with extremely narrow keel, and apparently lobulate in outline, the lobulation accentuated by the profile of the chambers, which is distinctly angled rather than rounded as is typical of the genus. Chambers 7 in outer whorl, uninflated, increasing quite rapidly in size as

added. Sutures obscure, may be limbate, radial, straight and flush, except where mildly indented at periphery. Aperture a low interiomarginal arch or slit, from one umbilical extremity of final chamber to the other.

Remarks: The angulated outline, combined with the acute and mildly carinate periphery, is distinctive. Pullenia elegans Cushman and Todd is far too compressed, has a slightly angled but not acute periphery, and the chamber profile is strongly produced and rounded, not angled.

Superfamily CHILOSTOMELLACEA Brady, 1881

Family CHILOSTOMELLIDAE Brady, 1881

Subfamily CHILOSTOMELLINAE Brady, 1881

Genus Chilostomella Reuss, 1849

Chilostomella oolina Schwager

Chilostomella oolina SCHWAGER, 1878, p. 527, pl. 1, fig. 16.---BARKER, 1960, p. 112, pl. 55, figs. 14,17,18, not 12,13.---INGLE *et al.*, 1980, p. 132, pl. 6, figs. 9,10.---COLE, 1981, p. 108, pl. 19, fig. 65.

Chilostomella ovoidea Reuss. ?BARKER, 1960, p. 112, pl. 55, fig. 21 only.

Test elongate ovoid, planispiral, usually completely embracing with 2 chambers per whorl, rarely with inner whorls visible on aboral side, circular in section. Chambers elongate, each one occupies almost 2/3 of test as formed, much of penultimate chamber still visible. Suture often obscure, very gently depressed at inner margin, oblique. Aperture interiomarginal and equatorial, a fairly high skewed arch, with elevated rim rather than thickened lip.

Remarks: Both C. ovoidea Reuss and C. grandis Cushman are much more stout and strongly embracing, while C. elongata Lagoe has 2 subequal lobes, and no prominent elevated rim at the aperture.

Family QUADRIMORPHINIDAE Saidova, 1981

Genus Quadrimorphina Finlay, 1939

Quadrimorphina fragilis (Hofker)

Allomorphina pacifica HOFKER, 1951, p. 139, t.f. 86a-f.

Allomorphina fragilis Hofker. THALMANN, 1952, p. 14.

NOT Allomorphina pacifica Hofker. BARKER, 1960, p. 112, pl. 55, figs. 24-26.

Test somewhat elongate triangular in outline, 3 sides very slightly concave and angles and periphery very broadly rounded. Chambers 3 per whorl, inflated and strongly embracing, all chambers visible on dorsal side, only final 3 on ventral, final chamber occupies over half of test. Sutures distinct, nearly flush. Aperture a low interiomarginal opening under the ragged ventral chamber margin extended as a thin flap over the umbilicus.

Remarks: This species is extremely fragile, and no intact specimens are present, although some are complete, i.e. all fragments are present. Allomorphina trigona Reuss is much more elongate and even thicker in proportion to its breadth, the aperture being a neat low arch with thickened lip or rim. Allomorphina pacifica Cushman and Todd was based on Brady (1884) pl. 55, figs. 24-26, which he had incorrectly called A. trigona, and which Barker assigned to A. pacifica Hofker. However, the former species called pacifica has an acute projection of the final chamber at the umbilicus, which is a neat sutural triple junction, rather than the ragged flap of Hofker's species of the same name. This latter was renamed on account of the priority of Cushman and Todd's species. Loeblich and Tappan (1987) have restricted Allomorphina to forms which are involute on both sides.

Quadrimorphina ? sp. A

Test low trochospiral, biconvex, involute ventral side more strongly convex, periphery well rounded and almost completely non-lobulate. Chambers 6 in outer whorl, increasing steadily but not too rapidly in size as added, gently inflated on both sides, especially the ventral surface of the final chamber, and also the umbilical extremities. Sutures distinct, on dorsal side gently depressed, curved, radial, on ventral side radial, nearly straight, very gently depressed except for inner extremities, which are quite strongly so. Aperture interiomarginal, from small open umbilicus under convex lipped margin of final chamber to a point near periphery.

at which point there is a fine reentrant or notch in apertural face, and a slit which runs across the periphery and even a very short distance along the dorsal spiral suture.

Remarks: The extent of the aperture is most unusual for this genus. The number of chambers and form of the aperture with its reentrant distinguish this species from most, and its test is much thinner than that of Quadrिमorphina sp. B.

Quadrिमorphina sp. B

Test low trochospiral, biconvex and very thick, with strongly tumid ventral side, periphery essentially non-lobulate and well rounded. Chambers rarely 4 to usually 5 in outer whorl, increasing very rapidly in size as added, particularly in thickness on ventral side, gently inflated on both sides. Sutures distinct, on dorsal side curved and gently depressed, on ventral side gently depressed, radial and nearly straight. Aperture ventral, interiomarginal, a high slit or low arch running from obscured umbilicus, covered by fairly thick and broad lip on convex inner margin, to a point near periphery where lip terminated by distinct notch, whence aperture runs as simple unbordered slit to periphery and across to beginning of first chamber along spiral suture.

Remarks: This tumid form, with very few chambers per whorl and a peculiar aperture, is distinctive.

Family OSANGULARIIDAE Loeblich and Tappan, 1964

Genus Osangularia Brotzen, 1940

Osangularia bengalensis (Schwager)

Anomalina bengalensis SCHWAGER, 1866, p. 259, pl. 7, fig. 111.

Truncatulina culter (Parker and Jones). CUSHMAN, 1915, p. 41, t.f. 44, pl. 16, fig. 1.
--CUSHMAN, 1921, p. 320, pl. 62, fig. 4.

Osangularia bengalensis (Schwager). BARKER, 1960, p. 198, pl. 96, fig. 3.---BURKE, 1981, pl. 3, figs. 11,14.

Osangularia culter (Parker and Jones). ?TODD, 1965, p. 25, pl. 15, fig. 1.---
BOLTOVSKOY, 1978, p. 163, pl. 5, figs. 29-34.

Osangularia rugosa (Phleger and Parker). ?PFLUM AND FRERICHS, 1976, pl. 7,

figs. 2-4.

Test low trochospiral, inequally biconvex, ventral side more strongly so, biumbonate, periphery very mildly lobulate, with thin ragged keel. Chambers 11 or 12 in outer whorl, only slightly inflated on ventral side. Sutures on ventral side radial, curved, gently depressed, on dorsal side limbate, raised and oblique. Aperture an unusual slit, oblique to inner margin and running a short distance up apertural face, surrounded by lip and nearly closed at base, with short interiomarginal slit umbilical-ward of that being faint if developed at all.

Remarks: Osangularia culter had a very sketchy type description, no ventral view, and an axial view in which the aperture is strongly shadowed. There are evidently 11 to 12 chambers in the outer whorl of this biconvex form, there is a wide, thin, ragged keel, no evident dorsal umbo, and the dorsal sutures are oblique but apparently depressed. Pseudoparrella rugosa Phleger and Parker (referred to Nuttallides in the present study) has a lobulate periphery, acute with a narrow, thickened keel, only 7 to 8 chambers per whorl, and an aperture that runs from the umbilicus, arching up into the chamber just before and parallel to the periphery. The form of Pflum and Frerichs should be referred either to the present species or some more rugose one. It is not clear from Todd's illustrations that the sutures are raised on the dorsal side, and so the reassignment is tentative.

Osangularia sp. cf. O. culter (Parker and Jones)

Planorbulina farcta (Fichtel and Moll) var. ungeriana (d'Orbigny) subvar. culter
PARKER AND JONES, 1865, p. 421, pl. 19, fig. 1.

NOT Truncatulina culter (Parker and Jones). CUSHMAN, 1915, p. 41, t.f. 44, pl. 16, fig. 1.---CUSHMAN, 1921, p. 320, pl. 62, fig. 4.

NOT Osangularia culter (Parker and Jones). ?TODD, 1965, p. 25, pl. 15, fig. 1.---BOLTOVSKOY, 1978, p. 163, pl. 5, figs. 29-34.

Osangularia culter (Parker and Jones). BELFORD, 1966, p. 175, pl. 35, figs. 1-5.

Test low trochospiral, planoconvex, dorsal side evolute, flattened but undulose, with very rough surface and innermost whorls covered by semi-opaque boss, ventral

side convex, involute, with small umbo; periphery with rather broad, fairly thick and rough keel, not very much lobulate. Chambers 10 or so in outer whorl, increasing slowly in size as added, latterly barely inflated on both sides of test. Sutures distinct, on both sides rather limbate, gently depressed latterly, on dorsal side curved, on ventral side radial and barely curved near periphery. Wall very roughly finished. Aperture interiomarginal, a narrow oblique arch on ventral side between umbilicus and periphery.

Remarks: This specimen is rather more rugose, and the dorsal sutures less strongly depressed, than the type, hence the uncertainty in identification. The distinction from *O. bengalensis*, and the transfer of several examples in the literature to this other species, have already been discussed.

Family ORIDORSALIDAE Loeblich and Tappan, 1984

Genus *Oridorsalis* Andersen, 1961

Oridorsalis umbonatus (Reuss)
(Plate 8, Figures 1-6)

Rotalina umbonata REUSS, 1851a, p. 75, pl. 5, fig. 35.

Truncatulina tenera BRADY, 1884, p. 665, pl. 95, fig. 11.---CUSHMAN, 1921, p. 318, pl. 64, fig. 2.

Pulvinulina umbonata (Reuss). CUSHMAN, 1921, p. 339, pl. 71, fig. 1.

Eponides (?) *tenera* (Brady). BARKER, 1960, p. 196, pl. 95, fig. 11.

Eponides umbonatus (Reuss). BARKER, 1960, p. 216, pl. 105, fig. 2.---SEJRUP et al., 1980, p. 293, pl. 2, figs. 2,3.

Oridorsalis umbonatus (Reuss). TODD, 1965, p. 23, pl. 6, fig. 2.---BOLTOVSKOY, 1978, p. 162, pl. 5, figs. 5,6.---BURKE, 1981, pl. 3, figs. 9,10.---HERMELIN AND SCOTT, 1985, p. 214, pl. 5, fig. 10.---MEAD, 1985, p. 237, pl. 5, figs. 8-13.---BELANGER AND BERGGREN, 1986, p. 344, pl. 5, fig. 10.

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 tener (Brady). CORLISS, 1979, p. 9, pl. 4, figs. 10-15.---INGLE et al., 1980, p. 142, pl. 5, figs. 5,6.---BELANGER AND BERGGREN, 1986, p. 342, pl. 5, fig. 9.

Eponides tener (Brady). LAGOE, 1977, p. 127, pl. 5, figs. 3,7,14.

Test low trochospiral, biconvex, relatively thin and equally so, to thicker and inequally biconvex with ventral side more strongly so. Periphery mildly lobulate, acute and carinate to narrowly rounded with imperforate margin. Chambers 5 to 6 in outer whorl, mildly inflated on ventral side only. Sutures on dorsal side limbate, radial, flush and nearly straight, on ventral side limbate, nearly flush, slightly oblique, sigmoid, forming vortex around umbilicus which may be closed and even obscured by flush umbo. Primary aperture on ventral side, a low interiomarginal arch bordered by lip; secondary apertures very small, at best only last one or two apparent, on dorsal side where intercameral sutures meet spiral suture, usually obscured or covered by secondary calcite which forms smooth umbo over inner whorls.

Remarks: When describing *L. tenera*, Brady (1884) noted that it was isomorphous with *R. umbonata*, and that there was no single distinguishing feature. It is not clear why Brady erected his species, although it may have been due to the fact that Reuss's species was from the Eocene. Brady illustrated a form that was equally biconvex, with an acute and carinate periphery, while Reuss's type figure was of an inequally biconvex form with the same type of periphery. Both forms were retained as distinct by Belanger and Berggren (1986) as well as Pflum and Frerichs (1976), this latter paper using the two as subspecies of *Q. tener*. In all cases the thinner, equally biconvex form was held to have an acute periphery (*Q. tener*), while the thicker, inequally biconvex form was supposed to have a narrowly rounded periphery (*Q. umbonatus*). Corliss (1979) believed all forms belonged to the one species, and chose *Q. tener* because the thinner, more acute form was more common. The present study supports the conclusion of Mead (1985), who found that the periphery could be either acute or rounded regardless of whether the test was equally or inequally biconvex. Thus all four possible combinations of test shape and periphery are found, and a complete range of intermediate forms as well. The species name chosen is *Q. umbonatus* on account of the priority of Reuss's species.

Sejrup *et al* (1981) and Mead (1985) pointed out the completely coincident ranges and occurrence for both forms.

Family HETEROLEPIDAE Gonzáles-Donoso, 1969

Genus Anomalinoides Brotzen, 1942

Anomalinoides ammonoides (Reuss)

Rosalina ammonoides REUSS, 1844, p. 214.---REUSS, 1845, pl. 8, fig. 53; pl. 13, fig. 66.

Anomalina ammonoides (Reuss). CUSHMAN, 1915, p. 46, t.f. 51, pl. 19, fig. 2.---CUSHMAN, 1921, p. 323, pl. 61, fig. 1.

Test small, low trochospiral to nearly planispiral, dorsal side evolute, ventral side slightly so but with round-shouldered, well developed and fairly open umbilicus. Periphery very slightly lobulate and well rounded. Chambers 9 or so in final whorl, slightly inflated, quadrate but nearly globular, increasing slowly in size as added. Sutures distinct, very gently depressed, on ventral side nearly radial and straight, almost mildly oblique, on dorsal side radial and curved. Aperture interiomarginal and peripheral, not evidently extending dorsally.

Remarks: This species may be distinguished from the following similar ones.

Anomalinoides colligerus has limbate sutures and an imperforate margin, while Anomalina flintii Cushman has raised limbate dorsal sutures and as many as 15 chambers in the outer whorl. Rotalia punctulata d'Orbigny is biconvex with an acute periphery and closed umbilicus.

Anomalinoides cavus Belford

Anomalinoides cavus BELFORD, 1966, p. 180, pl. 33, figs. 1-8.

Test very low trochospiral, both sides neither involute nor wholly evolute, but dorsal side flattened, more nearly evolute, with very slightly depressed inner whorls, ventral side slightly more convex, with deeper, narrower umbilical region, with inner whorls discernible; periphery broadly rounded, gently lobulate. Chambers 9 in outer whorl, increasing steadily in size as added, very gently but increasingly inflated, and triangular in outline. Sutures distinct, increasingly but gently

depressed as formed, initially somewhat limbate, essentially radial, gently curved. Wall evenly and quite coarsely perforate. Aperture a low interiomarginal slit, running along ventral spiral umbilical shoulder under tiny ragged lip, across periphery and barely discernible along dorsal spiral suture.

Remarks: The bievolute nature distinguishes this species from *A. globulosus*, and the very coarse perforations from other species. Belford's description mentioned fine perforations, but they appear to be somewhat coarser in the present specimens.

Anomalinoides colligerus (Chapman and Parr)

Anomalina colligera CHAPMAN AND PARR, 1937, p. 117, pl. 9, fig. 26.---BARKER, 1960, p. 194, pl. 94, figs. 2,3.

Anomalinoides colligerus (Chapman and Parr). BELFORD, 1966, p. 178, pl. 32, figs. 8-15.

Test very low trochospiral, biconvex but weakly so, dorsal side with slightly flattened face, both sides with slightly excavated inner whorls, evolute but not completely so, periphery non-lobulate except for final few chambers, somewhat angled and rounded, with imperforate carinal band. Chambers 12 or more in outer whorl, increasing very slowly in size as added, much broader than high, curved, and latterly slightly inflated. Sutures strongly limbate on both sides, curved and flush becoming slightly depressed. Wall on dorsal side particularly coarsely perforate. Aperture interiomarginal, equatorial, running back as fine slit along dorsal spiral suture for several chambers.

Remarks: This species is distinguished from most by the fact it is evolute on both sides, and from *Anomalina flintii* Cushman which has up to 15 chambers per whorl, a more pronounced trochospiral asymmetry to the coiling, thin depressed ventral sutures and limbate raised dorsal sutures.

Anomalinoides glabratus (Cushman)

Anomalina glabrata CUSHMAN, 1924, p. 39, pl. 12, figs. 5-7.---BELFORD, 1966, p. 177, pl. 32, figs. 1-7.

NOT? *Anomalina glabrata* Cushman. ASANO, 1951, pt. 13, p. 14, figs. 10-12.

Test low trochospiral, biconvex, dorsal side evolute, inner whorls covered by clear convex boss, ventral side involute with very small umbilicus, periphery rounded and very gently lobulate. Chambers 8 or so in outer whorl, increasing steadily in size as added, mildly inflated virtually throughout, somewhat quadrate on dorsal side, on ventral side triangular. Sutures distinct, limbate except in latter stages, depressed, on dorsal side oblique, on ventral side radial. Wall with distinct fairly coarse pores on both sides, quite well scattered. Aperture interiomarginal, a low slit from near umbilicus to just across periphery.

Remarks: The wholly involute/wholly evolute test, scattered coarse pores, radial ventral sutures and inflated triangular chambers form a distinctive combination, as does the low number of chambers per whorl.

Anomalinoides globulosus (Chapman and Parr)

Anomalina grosserugosa (Gümbel). CUSHMAN, 1915, p. 45, t.f. 50, pl. 20, fig. 1.---CUSHMAN, 1921, p. 323, pl. 62, fig. 3.

Anomalina globulosa CHAPMAN AND PARR, 1937, p. 117, pl. 9, fig. 27.---ASANO, 1951, pt. 13, p. 15, figs. 13-15.---BARKER, 1960, p. 194, pl. 94, figs. 4,5.---BOLTOVSKOY, 1978, p. 152, pl. 1, figs. 5-8.

NOT Anomalina globulosa Chapman and Parr. HERMELIN AND SCOTT, 1985, p. 203, pl. 6, figs. 1,2.

Test very low trochospiral, dorsal side wholly evolute, flattened, ventral side more strongly but gently convex, involute, with depressed narrow umbilicus, periphery well rounded but asymmetrical, lobulate. Chambers 7 in outer whorl, inflated, increasing fairly rapidly in size as added, on dorsal side curved equant quadrangular, on ventral side quite broad triangular. Sutures distinct, depressed, on dorsal side slightly oblique and gently curved, on ventral side radial and nearly straight. Wall with very coarse perforations throughout. Aperture interiomarginal, from umbilicus, across periphery to dorsal side and back along spiral suture for final chamber, with distinct strong lip throughout.

Remarks: This species is distinguished from Anomalinoides cavu by its wholly involute/wholly evolute arrangement, and from others by its inflated chambers and

very coarse perforations. Truncatulina grosserugosa Gümbel is the type species for Korobkovella Hagn and Ohmert, clearly attached and with complicated vermiform ornament, though this is difficult to reconcile with the type figures. At the very least, Gümbel's species is not wholly evolute on the dorsal side. The specimen of Hermelin and Scott is referred herein to Linaresia semicibrata, in which the dorsal side alone is coarsely perforate, and only slightly evolute.

Anomalinoides spissiformis (Cushman and Stainforth)

Anomalina alazanensis Nuttall var. spissiformis CUSHMAN AND STAINFORTH, 1945, p. 71, pl. 14, fig. 5.

Anomalinoides spissiformis (Cushman and Stainforth). PATTERSON, 1986a, p. 165, pl. 36, figs. 8-10.

Test extremely low trochospiral and nearly equally biconvex; dorsal side more strongly evolute but not wholly so, inner whorls partially overlapped, and detail obscured by thick calcification, but only gently sunken below level of low rounded spiral shoulder; ventral side nearly involute, but with extremely deep umbilicus having steep, sharp shoulder, first part of inner whorls visible; periphery broadly rounded and only latterly very slightly lobulate. Chambers 9 to 9 1/2 in outer whorl, increasing steadily in size, barely inflated in latter stages. Sutures distinct, limbate, quite strongly curved, merging on ventral side with thickened limbate umbilical shoulder. Wall densely and rather coarsely perforate, except for imperforate apertural face. Aperture interiomarginal, commencing where dorsal spiral suture ends, and running across periphery and under ventral spiral umbilical shoulder, into umbilicus, remaining open for several chambers.

Remarks: The limbate flush sutures, coarse perforations, and ventral umbilicus with spiral shoulder, are distinctive within this genus. This species looks very like Melonis barleeianum, from which it differs in being trochospiral and not biumbilicate.

Anomalinoides ungerianus (d'Orbigny)

Rotalina ungeriana d'ORBIGNY, 1846, p. 157, pl. 8, figs. 16-18.

Truncatulina ungeriana (d'Orbigny). CUSHMAN, 1915, p. 36, pl. 17, fig. 2.---
CUSHMAN, 1921, p. 317, pl. 65, fig. 3.

Planulina ungeriana (d'Orbigny). BELFORD, 1966, p. 121, pl. 10, figs. 7-13.

Test low trochospiral, equally biconvex, dorsal side evolute, inner whorls covered by heavy punctate boss which projects somewhat, ventral side almost wholly involute, with slight asymmetrical sunken umbilicus with hint of spiral suture; periphery angled but not acute, initially with imperforate margin, lobulate. Chambers about 12 in outer whorl, increasing slowly in size as added, very gently inflated on both sides. Sutures distinct, on both sides initially nearly flush, limbate and gently curved, later depressed, non-limbate, and strongly curved, almost hooked at periphery on ventral side. Both sides perforate, dorsal side with coarser and much more sparse pores. Aperture interiomarginal, a low slit from equatorial periphery with fine bordering line running as fine slit or gash along dorsal spiral suture.

Remarks: The nearly equally biconvex test, with angled periphery and strongly curved to hooked sutures, serves to distinguish this species from most. The lack of an open umbilicus distinguishes it from A. colligerus, while Rotalina akneriana d'Orbigny has only 8 or so chambers per whorl, with higher chambers and less strongly curved sutures.

Anomalinoides sp. A

Test very low trochospiral, somewhat flattened on evolute dorsal side, with sunken inner whorls, ventral side convex, nearly involute, with narrow umbilicus, periphery lobulate and broadly rounded. Chambers 8 in outer whorl, inflated, increasing slowly in size as added. Sutures distinct, depressed, on dorsal side slightly limbate, nearly straight, and somewhat oblique, on ventral side radial and nearly straight. Wall fairly coarsely perforate. Aperture interiomarginal, from near umbilicus across periphery and along dorsal spiral suture for one or two chambers.

Remarks: The number of chambers distinguishes this form from A. ammonoides and A. colligerus, while Anomalina glabrata Cushman, which in most

respects is very similar, has distinctly and strongly curved sutures on the dorsal side.

Genus Heterolepa Franzenau, 1884

Heterolepa dutemplei (d'Orbigny)

Rotalina dutemplei d'ORBIGNY, 1846, p. 157, pl. 8, figs. 19-21.

Truncatulina dutemplei (d'Orbigny). CUSHMAN, 1915, p. 37, t.f. 40, pl. 15, fig. 2.

Heterolepa dutemplei (d'Orbigny). PATTERSON, 1986a, p. 169, pl. 36, figs. 5-7 (plate caption has Cibicidoides).---LOEBLICH AND TAPPAN, 1987, p. 632, pl. 709, figs. 1-8.

Test low trochospiral, biconvex, dorsal side evolute, with flat outer whorl and strongly projecting inner whorls covered by thick boss, ventral side convex, involute, neither umbonate nor umbilicate, periphery barely lobulate, asymmetrically acute with narrow and thin ragged keel. Chambers 9 in outer whorl, barely inflated on both sides, increasing slowly in size as extended, on dorsal side oblique quadrate, on ventral side narrow triangular. Sutures distinct, barely depressed, on dorsal side limbate and oblique, straight, on ventral side nearly radial but slightly curved near periphery. Wall roughly pitted on both sides. Aperture obscure in specimen due to broken final chamber, evidently interiomarginal, running across periphery a very short distance along spiral suture.

Remarks: The present specimen and d'Orbigny's type are notable for their acute and carinate periphery, in contrast to the narrowly rounded type in the figured specimens of Cushman (1915) and Loeblich and Tappan (1987). The dorsal surface with protruding inner whorls and oblique limbate sutures, and the rough pitted wall distinguish this species.

Family GAVELINELLIDAE Hofker, 1956

Subfamily GYROIDINOIDINAE Saidova, 1981

Genus Gyroidinoides Brotzen, 1942

Gyroidinoides acutus (Boomgaart)

Gyroidina neosoldatii var. acuta BOOMGAART, 1949, p. 125, pl. 14, fig. 1.

Gyroidina altiformis acuta Boomgaart. PFLUM AND FREKICHS, 1976, pl. 4, figs 8,9; pl. 5, fig. 1.

Gyroidina altiformis Stewart and Stewart. INGLE *et al.*, 1980, p. 138, pl. 7, figs. 5,6.

Test low trochospiral, essentially planoconvex, convex ventral side with deep umbilicus, periphery entire and acute, although final stages may be translated ventralward and periphery may be undulose in axial view. Chambers 7 or 8 in final whorl, uninflated, tending to be excavated along inner edge on dorsal side, inner whorls obscured by umbos or calcite deposits. Sutures distinct, on ventral side flush, straight, radial and slightly limbate, on dorsal side curved back sharply, limbate and raised. Aperture an interiomarginal slit running from just above the periphery to the umbilicus, bordered above by thin lip that may have very weakly developed flap.

Remarks: Gyroidina soldanii var. altiformis Stewart and Stewart has 10 to 11 chambers in the final whorl, a narrowly rounded periphery, imbricated chambers on the dorsal side, and a less rapid increase in test thickness with growth. It would appear that the specimens of Ingle *et al.* should be referred to the present species, although the number of chambers is uncertain. Gyroidina cushmani Boomgaart, which was placed as a subspecies of altiformis by Pflum and Frerichs, has prominent umbilical flaps and is therefore a true Gyroidina. The high planoconvex test distinguishes the present species from other species with acute periphery.

Gyroidinoides lamarckianus (d'Orbigny)

Rotalina lamarckiana d'ORBIGNY, 1839b, p. 131, pl. 2, figs. 13-15.

NOT Gyroidina lamarckiana (d'Orbigny). TODD, 1965, p. 19, pl. 6, fig. 3.---BURKE, 1981, pl. 3, figs. 7,8.

Gyroidina lamarckiana (d'Orbigny). BOLTOVSKOY, 1978, p. 160, pl. 4, figs. 14,15.

Test large, low trochospiral, quite strongly compressed, periphery only slightly lobulate in final few chambers, and well rounded. Chambers 9 or so in final whorl, slightly inflated on both sides for final few, more so on dorsal side. Sutures on ventral side somewhat limbate, radial and only slightly curved, on dorsal side more strongly curved and depressed. Test is somewhat excavated near spiral suture, and

dorsal side is lobulate in axial view. Aperture interiomarginal, running from periphery into deep, narrow umbilicus, bordered above by very fine lip.

Remarks: The lobulate and excavated dorsal side distinguish this species from Gyroidinoides subplanulatus and G. tainanensis. The specimens of both Todd and Burke appear to have projecting inner whorls on the dorsal side, and essentially flush sutures, and so should not be referred to this species.

Gyroidinoides neosoldanii (Brotzen)

Rotalia soldanii (d'Orbigny). CUSHMAN, 1915, p. 71, pl. 29, fig. 1; pl. 31, fig. 4.---CUSHMAN, 1921, p. 349, pl. 71, fig. 2.

Gyroidina neosoldanii BROTZEN, 1936, p. 158.---BARKER, 1960, p. 220, pl. 107, figs. 6,7.---MURRAY, 1971, p. 197, pl. 83, figs. 1-5.

Gyroidina soldanii d'Orbigny. TODD, 1965, p. 19, pl. 6, fig. 4.---BOLTOVSKOY, 1978, p. 160, pl. 4, figs. 18,19.---HERMELIN AND SCOTT, 1985, p. 210, pl. 5, figs. 6-8.---BELANGER AND BERGGREN, 1986, p. 344, pl. 6, fig. 3.

Gyroidina orbicularis d'Orbigny. PFLUM AND FRERICHS, 1976, pl. 5, figs. 5-7.

Gyroidinoides soldanii (d'Orbigny). CORLISS, 1979, p. 9, pl. 5, figs. 4-6.

Gyroidina neosoldani Brotzen. INGLE *et al*, 1980, p. 138, pl. 7, figs. 10,11.

Gyroidina soldani d'Orbigny. INGLE *et al*, 1980, p. 138, pl. 7, figs. 12,13.

Gyroidinoides polius (Phleger and Parker). MEAD, 1985, p. 238, pl. 5, figs. 4-7.

Gyroidinoides orbicularis (d'Orbigny). ?BELANGER AND BERGGREN, 1986, p. 344, pl. 6, figs. 1,2.

Test low trochospiral, nearly planoconvex, ventral side strongly convex, dorsal side with inner whorls covered by projecting umbo, periphery rounded, not lobulate. Chambers typically 7 or 8 in final whorl, only last few inflated on dorsal side. Sutures distinct, limbate, on ventral side radial and flush, on dorsal side oblique and flush, later slightly depressed. On dorsal side, chamber surfaces gently excavated adjacent to spiral suture for much of outer whorl. Aperture an interiomarginal slit, bordered above by fine lip, running from near periphery on ventral side all the way to small but distinct umbilicus.

Remarks: Gyroidina neosoldanii was defined by Brotzen on the basis of

Brady's (1884, and hence Barker, 1960) figures. Mead opted to place this species in synonymy with G. soldanii, but that species has a subangular, not rounded, periphery, radial dorsal sutures, depressed ventral sutures, and a short, arched aperture confined more or less to a near peripheral position. Gyroidinoides orbicularis has an acute periphery and is thereby distinguished, although the specimen illustrated by Belanger and Berggren for that species may be too strongly convex on the ventral side to be referred to the present species. Eponides polius Phleger and Parker is biconvex with an acute periphery, unlike Mead's figured specimens.

Gyroidinoides orbicularis (d'Orbigny)
(Plate 5, Figures 11-13)

Gyroidina orbicularis d'ORBIGNY, 1826, p. 273.-- BARKER, 1960, p. 238, pl. 115, fig. 6.---BOLTOVSKOY, 1978, p. 160, pl. 4, figs. 16,17.

Rotalia orbicularis (d'Orbigny). CUSHMAN, 1915, p. 68, t.f. 62, pl. 29, fig. 3.

NOT Gyroidina orbicularis d'Orbigny. PFLUM AND FRERICHS, 1976, pl. 5, figs. 5-7.

NOT Gyroidinoides orbicularis (d'Orbigny). CORLISS, 1979, p. 9, pl. 5, figs. 1-3.---BELANGER AND BERGGREN, 1986, p. 344, pl. 6, figs. 1,2.

Test low trochospiral, planoconvex to biconvex, ventral side strongly convex, dorsal side flattened to excavated around prominent convex central umbo covering inner whorls. Periphery non-lobulate, acute. Chambers typically 7 or 8 in final whorl, not inflated. Sutures distinct, limbate, on ventral side flush, radial and very gently sigmoid, on dorsal side raised and oblique. Aperture an interiomarginal slit, bordered above by fine lip, running from small umbilicus to a point near periphery where apertural face attached to beginning of outer whorl and reflexed.

Remarks: The acute periphery distinguishes this species from most others, while it is less convex ventrally and moreso dorsally than Gyroidina altiformis and related forms. The forms illustrated by Cushman and Barker (see synonymy) have as many as 12 chambers in the final whorl, and may be a different species. The forms referred to the present species by Pflum and Frerichs (1976), Corliss (1979), and

Belanger and Berggren (1986) have very well rounded peripheries, and should be referred to other species. While the first and last of these references have been referred herein to Gyroidinoides neosoldanii, the number of chambers per whorl cannot be determined from Corliss's SEM illustrations, and his form is not transferred.

Gyroidinoides sp. cf. G. subplanulatus (Echols)

Gyroidina subplanulata ECHOLS, 1971, p. 157, pl. 15, fig. 5.

Gyroidinoides sp. A group MEAD, 1985, p. 238, pl. 5, figs. 1-3.

Test low trochospiral, both sides gently convex, but dorsal side with inner whorls projecting slightly as broad, flat area, periphery rounded and nearly entire. Chambers 7 or 8 in final whorl, uninflated, increasing slowly in size as added. Sutures distinct, nearly radial, gently curved and becoming very slightly depressed on both sides. Aperture interiomarginal, running from near periphery to small umbilicus.

Remarks: The rounded periphery distinguishes this species from G. orbicularis, and it has fewer chambers per whorl than G. tainanensis. This form differs somewhat from Echols's species in not having an umbilical aperture, a feature described but not emphasized in any way by Echols. It may be that the present form is a variant of G. tainanensis, or possibly a megalospheric form.

Gyroidinoides tainanensis (Nakamura)

Gyroidina tainanensis NAKAMURA, 1942, p. 91, pl. 6, fig. 3.

Gyroidina lamarckiana (d'Orbigny). ?TODD, 1965, p. 19, pl. 6, fig. 3.---?BURKE, 1981, pl. 3, figs. 7,8.

Test low trochospiral, quite strongly compressed, nearly equally biconvex, dorsal side with inner whorls projecting slightly and covered by thin, flat, hyaline boss, periphery well rounded and only slightly lobulate in later stages. Chambers commonly 10 to 11, sometimes as low as 8, in final whorl, only last 4 or so slightly inflated. Sutures distinct, limbate, radial and gently curved, flush becoming slightly

depressed. Aperture an interiomarginal slit, confined to ventral side, bordered above by fine lip and running to very small umbilicus.

Remarks: This species has more chambers per whorl than G. subplanulatus, if these two forms are indeed separate species. Gyroidinoides lamarckianus has a fairly large, open umbilicus with rounded shoulder, and the outer whorls project well below the inner ones on the dorsal side in contrast to the present species. Forms previously referred to that species are only tentatively reassigned to the present one, because Burke (1981) did not provide an axial view, and Todd's illustrated specimen had an aperture extending just across the periphery onto the dorsal side.

Gyroidinoides umbonatus (Silvestri)

Rotalia soldanii d'Orbigny var. umbonata SILVESTRI, 1898. p. 329, pl. 6, fig. 14.

Gyroidina umbonata (Silvestri). BOLTOVSKOY, 1978, p. 160, pl. 4, fig. 21.

Test low trochospiral, biconvex, dorsal side convex because successive whorls translated ventralward, ventral side strongly convex; periphery broadly rounded and very gently lobulate. Chambers 6 or 7 in final whorl, thick, slightly inflated. Sutures radial and straight, on ventral side depressed, on dorsal side gently depressed. Aperture an interiomarginal slit, bordered by very fine lip, running from near periphery to small umbilicus.

Remarks: This species is distinguished by the low number of chambers, strongly biconvex test, and broadly rounded periphery. The type figure shows only 5 chambers in the outer whorl.

Subfamily GAVELINELLINAE Hofker, 1956

Genus Linaresia González-Donoso, 1968

Linaresia semicibrata (Beckmann)

Anomalina pompilioides Galloway and Heminway var. semicibrata BECKMANN, 1954, p. 400, t.f. 24,25, pl. 27, fig. 3.

Anomalina globulosa Chapman and Parr. HERMELIN AND SCOTT, 1985, p. 203, pl. 6, figs. 1,2.

Anomalinoides globulosus (Chapman and Parr). THOMAS, 1985, p. 675, pl. 12, figs.

6,7.

Test low trochospiral, almost symmetrical, both sides with depressed central areas; on dorsal side is seen an extra 1/2 to 1 whorl, on ventral side is anything from point umbilicus to 1 or 2 chambers of penultimate whorl. Periphery broadly rounded and lobulate. Chambers 5 to 6 in outer whorl, inflated, on ventral side broad, almost equilateral triangular. Sutures depressed, on dorsal side strongly curved, on ventral side less so and nearly radial. Wall very finely perforate on ventral side, but on dorsal side very coarsely perforate, with some pustules on inner whorl. Aperture interiomarginal, beginning at equatorial margin and running well onto dorsal or coarsely perforate side, with bordering lip.

Remarks: Anomalina pompilioides is coarsely perforate on both sides of the test, has no evident asymmetry to the aperture, and its sutures are radial and nearly straight. Truncatulina grosserugosa Gumbel has 8 chambers in the outer whorl, and these are curved rectangular on the ventral side. The most closely similar species is Anomalinoides globulosus, which has 7 to 8 chambers per whorl, and these are elongate triangular on the ventral side. As well, the test surface is deeply pitted on both sides, the crescentic aperture is confined to the periphery, and the flattened dorsal side reveals 2 to 2 1/2 whorls. On account of these discrepancies, the forms of Thomas (1985) and Hermelin and Scott (1985) have been referred to the present species.

Superfamily ROTALIACEA Ehrenberg, 1839

Family ROTALIIDAE Ehrenberg, 1839

Subfamily PARAROTALIINAE Reiss, 1963

Genus Pararotalia Y. Le Calvez, 1949

Pararotalia calcar (d'Orbigny)

Calcarina calcar d'ORBIGNY, 1826, p. 276.---d'ORBIGNY, 1839a, pl. 5, figs. 22-24.---
BARKER, 1960, p. 222, pl. 108, figs. 3, 74.

Rotalia calcar (d'Orbigny). CUSHMAN, 1921, p. 350, pl. 71, fig. 3.

Pararotalia ozawai (Asano). TODD, 1965, p. 29, pl. 9, fig. 2, not fig. 1.

Test low trochospiral, biconvex to planoconvex, ventral side the more strongly convex. Chambers 9 or so in final whorl, not much inflated on dorsal side, quite strongly inflated on ventral; chambers produced at periphery to form acute points, or may be furnished with parallel-sided spines, without evident carina. Sutures radial, straight, and depressed. Inner ends of chambers characterized by nodes or bumps, test also has umbilical plug. Aperture interiomarginal, extending back under umbilical margin of chambers.

Remarks: The complexity of the aperture as shown by Loeblich and Tappan (1964) for this genus is not evident in the present specimens, nor is there the bizarre chamber elongation seen in d'Orbigny, 1839a, pl. 5, figs. 22-24. Barker's form illustrated in pl. 108, fig. 4 may be a juvenile. It has a carinate periphery, and chambers which are lobulate but not produced, though furnished with small spines. It matches R. ozawai Asano quite well, this latter being either a distinct species or a juvenile form of the present one. The elongate, kite-shaped chambers of Todd's (1965) pl. 9, fig. 2 clearly place it in the present species, while the specimen of pl. 9, fig. 1 has a rounded, carinate periphery that is lobulate and lacks spines.

Subfamily AMMONIINAE Saidova, 1981

Genus Ammonia Brünnich, 1772

Ammonia pauciloculata (Phleger and Parker)

"Rotalia" pauciloculata PHLEGER AND PARKER, 1951, p. 23, pl. 12, figs. 8,9.

Ammonia pauciloculata (Phleger and Parker). POAG, 1981, p. 38, pl. 45, fig. 3; pl. 46, fig. 3.

Test low trochospiral, biconvex, periphery lobulate and rounded but narrowly so, with weakly developed carina. Chambers usually 6 in final whorl, on ventral side inflated and triangular, on dorsal side rectangular and narrow. Sutures on dorsal side limbate, essentially flush, radial and straight; on ventral side radial, straight and depressed, with heavy rugose or pustulose ornament filling inner half, also

covering chambers, but umbilicus remains open under short chamber extensions. Spiral suture may rarely be excavated or gapping for final chamber. Aperture completely obscure.

Remarks: The low number of chambers, rounded periphery, and ornament without umbilical plug, are distinctive of this species.

Ammonia tepida (Cushman)

Rotalia beccarii (Linnaeus) var. **tepida** CUSHMAN, 1926b, p. 79, pl. 1.

Rotalia cf. **beccarii** (Linnaeus). ASANO, 1951, pt. 14, p. 12, figs. 93-95.

Ammonia beccarii (Linn.). BELFORD, 1966, p. 108, pl. 19, figs. 2-8.

Ammonia parkinsoniana (d'Orbigny) forma **tepida** (Cushman). POAG, 1981, p. 37, pl. 45, fig. 2; pl. 46, fig. 2.

Test low trochospiral, low and almost equally biconvex, dorsal side wholly evolute, ventral side involute with large deep umbilicus, periphery lobulate and broadly rounded. Chambers 7 in outer whorl, slightly oblique subglobular on dorsal side to blunt triangular on ventral side, on dorsal side inner whorls with smooth hyaline cover, later chambers gently inflated, on ventral side inflated. Sutures distinct, limbate, on dorsal side slightly oblique, flush, becoming gently depressed, on ventral side radial depressed to incised near umbilicus, where chambers become well separated and sharply terminated. Wall hyaline and finely perforate, umbilical region and umbilical extremities of incised ventral sutures with tubercular or rugose material, or in rare instances whole may be filled with smooth material. Aperture somewhat obscure, appears to be a low interiomarginal slit that extends to umbilicus.

Remarks: The present material differs from Cushman's type only in the explicit presence of granular material. **A. pauciloculata** has a more strongly convex dorsal side, and dorsal chambers that are much higher than broad. It appears that **Nautilus beccarii** Linnaeus in the strictest sense has many more chambers per whorl, incised dorsal sutures, and much heavier ornamentation on the dorsal surface and

bordering the sutures. There is also usually an umbilical plug of some kind. For these reasons the specimens of Asano (1951) and Belford (1966) have been referred herein to the present form.

Ammonia sp. A

Test low trochospiral, strongly biconvex but ventral side more strongly so, dorsal side evolute, ventral involute, with very deep open umbilicus, periphery essentially non-lobulate, somewhat angled and narrowly rounded. Chambers 8 in outer whorl, increasing steadily in size as added, on dorsal side uninflated, rhomboid, and almost as broad as high, on ventral side triangular, latter few barely inflated, umbilical extremities imperforate, projecting into and over, but not closing, umbilicus. Sutures distinct, limbate, on dorsal side heavily so, flush and oblique, on ventral side radial and latterly slightly sinuate, increasingly depressed toward umbilicus, where they are deeply incised, separating the chambers. Aperture an interiomarginal slit running from umbilicus toward periphery, where it joins a fairly large circular opening with extremely fine lip on the posterior or umbilical-ward side.

Remarks: This is distinguished from most known species by the non-lobulate periphery and less convex dorsal side, from A. pauciloculata which has radial dorsal sutures and higher than broad chambers on that side, and from Ammonia sp. B which has oblique ventral sutures incised almost to the periphery, an umbilical plug, and more strongly inflated dorsal side.

Ammonia sp. B

Test low trochospiral, biconvex, dorsal side more strongly so and wholly evolute, ventral side involute with large, fairly open umbilicus revealing preceeding whorls to a minor extent, and with small, free-standing umbilical plug which incompletely occupies the area; periphery lobulate and rounded. Chambers 7 in outer whorl, distinctly inflated and increasingly so as added, on dorsal side broader than high, on ventral side broad triangular to subglobose in the final stages. Sutures

distinct, depressed, mildly limbate, on dorsal side well curved and nearly oblique, on ventral side distinctly oblique, incised or channelled beginning near periphery and broadening toward umbilicus, where they separate chambers significantly. Aperture interiomarginal, a low slit from the umbilicus, opening up into a fairly large orifice toward periphery, rarely with broad thin bordering flap.

Remarks: The distinction from Ammonia sp. A has already been discussed, while it is distinguished from other species of the genus by its oblique, incised ventral sutures, thinly limbate dorsal sutures, and fairly strong chamber inflation with chambers broader than high.

Genus Rotalinoides Saideva, 1975

Rotalinoides compressiusculus (Brady)

Rotalia papillosa H. B. Brady var. compressiuscula BRADY, 1884, p. 708, pl. 107, fig. 1; pl. 108, fig. 1.---CUSHMAN, 1921, p. 348, pl. 72, fig. 2.

Rotalia papillosa Brady. CUSHMAN, 1921, pl. 72, fig. 3 only.

Streblus gaimardi var. compressiuscula (Brady). BARKER, 1960, p. 220, pl. 107, fig. 1; p. 222, pl. 108, fig. 1.

Test unequally biconvex, nearly planoconvex with ventral side the more strongly convex. Periphery acute, carinate, and notched at the sutures. Chambers typically 7 to 8 in final whorl, not truly inflated, but separated by wide sutural gaps on both sides of test, on ventral side sutures somewhat oblique, producing imbricate appearance. Edges of chambers ornamented with raised beaded clear keels, which may fuse near inner extremities of sutures, producing depressed sutural areas bounded by paired keels. Periphery similarly ornamented with single keel. Umbilical region obscured by heavy clear tubercles and irregular deposits, with occasional slits in a radial pattern. Aperture most prominently a fairly high, somewhat oblique arched slit with thin, somewhat triangular bordering flap at about midpoint of apertural face, with additional lower slit-like opening running toward umbilicus.

Remarks: Rotalia papillosa Brady has an obtuse, rounded periphery and 12 to 14 chambers per whorl, hence Cushman's figure 3 was not referable to that species.

Turbinulina gaimardii d'Orbigny is more equally biconvex, and has 12 chambers per whorl.

Family ELPHIDIIDAE Galloway, 1933

Subfamily ELPHIDIINAE Galloway, 1933

Genus Criboelohidium Cushman and Brönnimann, 1948

Criboelohidium oceanicum (Cushman)

Elphidium oceanicum CUSHMAN, 1933d, p. 52, pl. 12, fig. 7.

Elphidiononion poevanum (d'Orbigny). BARKER, 1960, p. 226, pl. 109, fig. 22a.

Elphidium cf. kerquelenense Parr?. BARKER, 1960, p. 226, pl. 109, fig. 22b.

Test gently compressed, planispiral, slightly evolute, umbilici slightly open, with granulose material, periphery rounded and becoming very gently lobulate. Chambers 9 or so in outer whorl, gently inflated, not very much broader than high. Sutures distinct, gently depressed, nearly radial and straight. Wall smooth except for fine retral processes confined to sutural areas. Aperture interiomarginal, a series of multiple pores.

Remarks: Polystomella poevana d'Orbigny has 12 very low, broad chambers, and simple depressed umbilici, while E. kerquelenense Parr has a single or double row of sutural pores, rather than depressed sutures with retral processes. Therefore both of Barker's specimens are reassigned herein. Polystomella excavata Terquem differs in being more strongly lobulate.

Genus Elphidium de Montfort, 1808

Elphidium advenum (Cushman)

Polystomella advena CUSHMAN, 1922b, p. 56, pl. 9, figs. 11, 12.

Elphidium advenum (Cushman). CUSHMAN, 1933d, p. 50, pl. 12, figs. 1-3.

Elphidium advena (Cushman). BARKER, 1960, p. 226, pl. 110, fig. 1.

Test lenticular, planispiral and involute, periphery acute with narrow but distinct imperforate carina, initially non-lobulate but irregular, later lobulate. Chambers typically 12 in final whorl, final 5 or 6 inflated. Sutures distinct.

depressed, quite strongly curved, with short fossettes leaving bulk of chamber surface clear. Umbilical region with clear umbo; in juveniles protruding to general contour of test, but in adult stage with inflated chambers is below their surface, often with slight surrounding depression. Aperture interiomarginal, consisting of multiple rounded openings.

Remarks: This lenticular form with acute, carinate periphery is also distinguished by its depressed sutures and short fossettes which leave the chambers more or less clear.

Elohidium crispum (Linnaeus)

Nautilus crispus LINNAEUS, 1758, p. 709.

Polystomella crispa (Linnaeus). CUSHMAN, 1914, p. 32, pl. 18, fig. 1.

Elohidium crispum (Linnaeus). CUSHMAN, 1933d, p. 47, pl. 11, fig. 4.---BARKER, 1960, p. 226, pl. 110, figs. 6,7.---MURRAY, 1971, p. 155, pl. 64, figs. 1-6.

Test lenticular, planispiral, biumbonate, periphery bluntly acute, carinate, nearly entire, being somewhat undulose rather than lobulate. Chambers 11 or so in outer whorl, increasing slowly in size as added, uninflated. Sutures distinct, strongly curved, limbate and evidently raised, although this may in fact be the anterior margin of the chambers. Chamber surface between raised sutures covered by heavy transverse ribs or retral processes, and umbones with a few coarse punctae or perforations. Aperture interiomarginal, multiple.

Remarks: The lenticular test with carinate periphery, large umbones, and raised sutures with transverse ribs is distinctive. The resemblance to the two forms placed by Linnaeus in synonymy is minimal, and the concept of this species seems to have been stabilized by subsequent usage.

Elohidium sp. cf. *E. gerthi* Voorthuysen

Elohidium gerthi VOORTHUYSEN, 1957, p. 32, pl. 23, fig. 12.---MURRAY, 1971, p. 161, pl. 67, figs. 1-7.

Test compressed lenticular, planispiral, nearly involute, periphery angled but narrowly rounded, with imperforate carina, becoming slightly lobulate in later

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stages. Chambers 10 or so in outer whorl, slightly inflated, increasing steadily in size as added, and smooth. Sutures distinct, radial curved, depressed, traversed by up to 6 or so very short retral processes. Umbilici with fairly large but not elevated bosses. Aperture interiomarginal, multiple fine arches.

Remarks: Voorthuysen's type description is not translated and the type figure is a bit faint. It gives no indication of an imperforate, slightly angled periphery, nor late stage lobulation, and so the identification herein is tentative. Elohidium advenum has an acute carinate periphery by way of distinction.

Elohidium jenseni (Cushman)

Polystomella jenseni CUSHMAN, 1924, p. 49, pl. 16, figs. 4,6.

Elohidium jenseni (Cushman). CUSHMAN, 1933d, p. 48, pl. 11, figs. 6,7.

Test planispiral, strongly compressed, periphery entire, acute and carinate. Chambers very numerous, 13 or more visible in smaller individuals, and as many as 21 in larger individuals, which exhibit a slight tendency to uncoil. Sutural areas raised, connected across chambers by retral processes which are as high, producing a densely reticulate pattern. Test faces flattened, umbilical region somewhat open and slightly concave, with fine papillae. Aperture interiomarginal, multiple openings at base of very high apertural face.

Remarks: Nautilus macellus var. α Fichtel and Moll has 23 chambers visible, much finer and lower retral processes, and an umbilical region marked by the clear convergence of the raised suture lines. This is also seen in the compressed form of Elohidium macellum illustrated in Barker (1960) as pl. 110, fig. 8.

Elohidium simplex Cushman

Elohidium simplex CUSHMAN, 1923d, p. 52, pl. 12, figs. 8,9.

Test planispiral, compressed, umbilici fairly large, with flat irregular mass of shell material, periphery lobulate and rounded. Chambers 9 in outer whorl, inflated, increasing steadily in size as added. Sutures distinct, depressed, curved quite strongly, with traces of retral processes discernible in the umbilicalward extremities

of the more adult chambers. Aperture multiple, a few interiomarginal equatorial openings.

Remarks: This species is distinguished from most by its lobulate form, very subtle retral processes, and umbilical plug, and from Criboelphidium oceanicum by the present species's curved rather than radial sutures.

Elphidium sp. A

Test planispiral, compressed, somewhat evolute, umbilici gently sunken, periphery initially angled and non-lobulate, with blunt imperforate keel, later rounded and lobulate. Chambers 12 or so in outer whorl, becoming inflated. Sutures distinct, curved, initially limbate and flush to raised, later depressed. Whole of test with numerous quite heavy transverse ribs, all the way into umbilici, which obscures inner whorls of dry test, and obscures sutures. Aperture evidently a single interiomarginal slit.

Remarks: This species is distinguished by the universal presence of transverse bars, and the change of periphery and suture style with growth. Smaller specimens are often very rough, and almost look hispid. Nautilus striato-punctatus Fichtel and Moll is umbonate, the sutures are more closely spaced and raised throughout, and the transverse bars are not so fine as in the present form.

Elphidium sp. B

Test lenticular, planispiral, biumbonate with very small umbones, periphery acute, carinate, and non-lobulate. Chambers 9 in outer whorl, uninflated, increasing slowly in size as added. Sutures obscure, limbate, apparently flush, curved. Entire surface covered in very fine rough ornament that is apparently irregular reticulate, with no hint of transverse orientation. Aperture obscure, presumed interiomarginal multiple.

Remarks: The ornament is completely distinctive and characteristic. Polystomella verriculatus Brady has raised thin sutures and widely spaced transverse bars to produce an even reticulate ornament, and has flattened faces.

Elohidium sp. C

Test lenticular, planispiral, biumbonate with depressed umbones, periphery acute and carinate with thick blunt keel, non-lobulate. Chambers 10 in outer whorl, becoming inflated. Sutures distinct, curved, limbate and flush becoming depressed. Test smooth except for a few traces of transverse ribs on early portion and barely perceptible sutural processes. Aperture interiomarginal and multiple, with 4 large pores.

Remarks: This very smooth form with depressed umbones and angled carinate periphery is distinctive.

CHAPTER 4. BENTHIC FORAMINIFERAL ASSEMBLAGES.

4.1. INTRODUCTION.

Three main factors mitigated against a completely satisfactory cluster analysis of the data. The first is the number of counts per sample, which although typically 200 to 300, was nevertheless responsible for species abundance uncertainties that equalled or exceeded those abundances. As a result, the analysis was characterized by a large number of unresolved axes, as the data was overwhelmed by the statistical uncertainty.

The second factor is the very large number of species that were rare. The paper by Patterson and Fishbein (1989) had come to this author's attention prior to the analysis, and so those species whose abundances never exceeded 1 or 2 percent were removed from the data set, which otherwise would have been too cumbersome for the capacity of the computer. Even for the 88 species or taxonomic units whose abundances were retained for analysis, several were rare from a statistical viewpoint, even though there may have been several dozen or even hundreds of specimens within the study. Many of these species were included for the simple reason that without them, some samples with a very even distribution of specimens of component species would have barely been characterized in the matrix. Appendix III is a table compiling the fractional abundances for the species used in the cluster analysis. The abbreviations for the species may be easily deciphered with reference to the Specific Index, while the samples are represented by the Arabic numeral assigned to them in Appendix I. The total number of specimens is also given. Fractional abundances less than .005 (.5%) are given as .00, while the absence of a species in a given sample is indicated by the lack of an entry.

The third factor is the great range of depths and environments represented by the 62 samples. While this enabled this author to compile a very extensive taxonomic catalogue for the area, such a reconnaissance scale study does not lend itself to rigorous statistical analysis. There are simply too few samples per environment for

them to be adequately characterized by the benthic foraminiferal assemblages. From a statistical standpoint, this is the problem of undetermined axes discussed in section 2.3. This means that there is a great deal of uncertainty associated with the probability calculated at each clustering (not to be confused with the uncertainty for species abundances). Because the clusterings produced by the algorithm depend on the probability of those clusters, the confidence that can be placed in their ability to represent the environments or biofacies is limited.

4.2. RESULTS OF CLUSTER ANALYSIS.

The clusters produced by the EWML algorithm (Fishbein and Patterson, in prep.) are listed in Table 4.1, and are arranged to some extent in order of increasing water depth. The sixteen clusters are those for which Fishbein (pers. comm.) believed there was sufficient supporting probability. Figure 4.1, which is a plot of the natural log (probability)/clustering event versus the number of clusters produced at that event, shows that the probability has begun to decrease quite substantially at around sixteen clusters. Below sixteen clusters, the probability of a cluster representing the same environment as the one with which it is clustered is too low to support the clustering on rigorous statistical criteria. Nevertheless, the present author believes some of the clusters formed below this level are reasonable and likely. The clustering below sixteen clusters is depicted in Figure 4.2, which is not the typical dendrogram associated with other hierarchical methods, with the length of lines proportional to probability. Rather, the sixteen clusters that were recognized at a sufficient level of probability are listed across the bottom of the figure. Clusters are then joined to others, the number (from 1 to 15) at the cross bar or connection representing the number of clusters remaining after that clustering event. The cross bars are drawn at increasing distances from the listed clusters as the probability of clustering decreases, but there is no scale. Thus the next cluster formed after the algorithm produced sixteen clusters was by the joining of Cluster

<u>Cluster #</u>	<u>Samples</u>
Cluster 33	NOVA-H 5G, PROA 71D
Cluster 4	DODO 52G, ERDC 115G
Cluster 31	NOVA-H 1G, NOVA-HV 16QV
Cluster 8	NOVA-H 2G, ERDC 97G
Cluster 3	DODO 50G, LSDH 66PG
Cluster 9	ERDC 104G, LSDH 58G
Cluster 46	REC 11G, PROA 34P
Cluster 7	ERDC 87BX, ERDC 121G
Cluster 6	ERDC 20G, PROA 41G
Cluster 2	DODO 48D, PROA 28P, PROA 73PG-2, PROA 107PG-1, PROA 63PG-1, PROA 63PG-2, PROA 73PG-1, PROA 43P-2, LSDH 69G-2, LSDH 69G-1, PROA 107PG-2, PROA 43P-1, NOVA-H 12G, PROA 56G, REC 7G, DODO 43D, PROA 48G, ERDC 19G, PROA 54G, LSDH 77G, NOVA-A 48G, NOVA-A 40PG, NOVA-H 19QV, NOVA-A 64G, NOVA-HV 9G, LSDH 65G, NOVA-H 30V
Cluster 19	LSDH 74G, NOVA-H 53QV, NOVA-HV 15G, REC 31G, NOVA-HV 11G, PROA 83PG, LSDH 78V, PROA 52G, LSDH 76V, NOVA-A 31P
Cluster 23	LSDH 79P, NOVA-HV 18G
Cluster 14	NOVA-H 57G, LSDH 64G
Cluster 12	ERDC 132PG, NOVA-HV 8 QV
Cluster 25	PROA 82PG, NOVA-A 32G
Cluster 26	NOVA-A 35G-1, PROA 40G-1, NOVA-A 35G-2, PROA 40G-2

Table 4.1. Composition of clusters with acceptable level of probability, as determined by EWML algorithm.

Figure 4.1.1. Plot of natural logarithm of probability associated with each clustering event versus number of clusters remaining after that event.

Figure 4.2. Clustering below acceptable level of statistical significance. Composition of clusters listed across bottom is given in Table 4.1. Numbers at branching points indicate number of clusters remaining after each clustering event depicted.

19 with 2, after which there were fifteen clusters. The next event was the joining of Cluster 12 with 25, and so on. The final clustering event joined Cluster 31, which had already had Clusters 8 and 4 joined to it, with Cluster 2. This of course represents the unreasonable hypothesis that all samples in the study represented the same biofacies. It is encouraging to note that for all cores in which separate aliquots were processed and analyzed, the aliquots from the same core always clustered together.

It is almost certain that some of the clusters formed in the process of reducing the data matrix to sixteen clusters do not represent legitimate assemblages or portions thereof, and it is also likely that certain clusters formed below an acceptable level of statistically defined probability do in fact represent reasonable groupings or assemblages of samples. What follows is a discussion of the significance of and problems encountered with certain of the clusters. Species abundances are reported in the fractional form rather than as percentages (e.g. .10 instead of 10%).

As a general rule, Clusters 33, 4, 31, 8, 3, 9, 46, 7, and 6, or the first nine clusters listed in Table 4.1, are the ones representative of the shallow water assemblages. Sample NOVA-H 16QV in Cluster 31 contained only 27 specimens, and is not assigned to one of the eleven meaningful assemblages. In Cluster 46, sample PROA 34P was recovered from 8900 m water depth, but its 34 specimens are calcareous and none agglutinated. As it is well below calcite compensation depth (CCD, to be discussed more fully later), it is almost certainly a transported fauna. Samples NOVA-H 5G and PROA 71D clustered in 33, but their only apparent strong similarity is the high abundance of Globocassidulina rarilocula, .16 in the former and .33 in the latter. They differ significantly in many respects, however, and are placed in separate assemblages. Likewise, DODO 52G is unique, while NOVA-H 1G and NOVA-H 2G are very similar, as will be seen later, and are placed in the same assemblage. The rest of the samples in the nine clusters are placed in the same assemblage, except for PROA 41G, which clustered with ERDC 20G. This is

surprising in view of the fact that the former sample has less than .005 Nuttallides bradyanus but .10 N. umboniferus, an AABW indicator, while ERDC 20G has .04 abundance of the former but only .02 of the latter species. As the relative proportion of these two species seems to be a major factor in placing samples within clusters, something else must have caused these two samples to cluster. Evidently it is the combination of less than .005 Epistominella sp. A with abundant Globocassidulina sp. A (.06 in ERDC 20G and .04 in PROA 41G). Clusters 31 and 8 are joined, presumably because of the similarity between samples NOVA-H 1G and 2G, while the resultant cluster probably is joined to Cluster 4 because of samples ERDC 97G and ERDC 115G, both of which are in the same assemblage and from the top of the Ontong Java Plateau.

Cluster 2 is the largest, with 27 samples, and is certainly artificially large. The limitations inherent in the data set have allowed the algorithm to create an unwieldy cluster combining at least three distinct environments or assemblages. The faunas from the ten aliquots from five core locations, from PROA 73PG-2 to PROA 43P-1, are almost exclusively agglutinated and make sense as an assemblage. PROA 28P has only 7 specimens, two of which are of Hyperammina laevigata. It clusters with the agglutinated faunas of the next ten samples, and may well belong there, but has too few specimens to be considered reliable. Sample DODO 48D has a mixed deep-water calcareous and agglutinated fauna, and it is certainly the sample that causes those with agglutinated faunas to cluster with the remaining fifteen samples of the cluster, which represent shallower, calcareous faunas. Of those fifteen, NOVA-H 12G is exceptional. It was recovered from a depth of 735 m, while all the rest were from depths greater than 1800 m, and from a different water mass. The species Globocassidulina rarilocula apparently causes the clustering here, because it is present at .09 in NOVA-H 12G, and at comparably high or higher abundances in most of the other samples in the cluster with calcareous faunas.

Cluster 19 is a reasonable grouping except for the inclusion of LSDH 74G.

While the other samples in the cluster were near or below the lysocline, in AABW, LSDH 74G was recovered from 1738 m water depth, in the Deep Oxygen Minimum. It certainly does not represent the same environment or belong in the same assemblage, but there is no apparent reason for its clustering here. The abundances of *N. bradyanus* (.04) and *N. umboniferus* (<.005) clearly place it in one of the two large assemblages that lie shallower than the one based on Cluster 19.

Clusters 23, 14, 12, and 25 form a reasonable group, with Clusters 12 and 25 joining to leave fourteen clusters, and Clusters 23 and 14 joining to leave ten clusters. While the algorithm assigns these latter clusterings a low probability, other considerations make it likely that these are all members of a deep-water assemblage. Also placed in this assemblage are the two aliquots of NOVA-A 35G, which clustered in 26 with the aliquots of PROA 40G, which has a mixed deep-water calcareous and agglutinated fauna.

All apparent inconsistencies between the clusterings and what would appear to be reasonable assemblages representative of certain environments can be explained, with the exception of the presence of LSDH 74G in Cluster 19. The assemblages may be understood as those groups of samples which represent the same environment, and are characterized by similar faunas.

4.3. BENTHIC FORAMINIFERAL ASSEMBLAGES.

Eleven foraminiferal assemblages were recognized, while six of the samples are placed in a so-called Null Assemblage. These six cannot be placed in the other assemblages for reasons which will be explained, although the cluster analysis suggests reasonable possibilities for some of them. The first four assemblages are composed of a single sample each, and it would be inappropriate to be dogmatic about these. Nevertheless, they are all distinctly different from each other at a gross level, and surely represent different water masses or environments. The first nine assemblages are named for abundant species which characterize the sample or

samples in the assemblage, although those species may be equally abundant in other assemblages. The remaining assemblages are named for their gross aspect rather than for particular species which may characterize them. The distribution of the assemblages according to their constituent samples is depicted in Figure 4.3, a map in the pocket at the back of the thesis.

i. Bolivina dilatata - Siphouvigerina interrupta Assemblage.
(Plate 1)

Sample: NOVA-H 5G.

Depth: 110 m.

Discussion: This assemblage is the shallowest in the present study, its sample being the only one from a shelf and from the Subtropical Lower Water mass or Upper Salinity Maximum. The fauna is very diverse, with 112 species, of which 18 are porcelaneous, and 14 agglutinated. These agglutinated species are not the same ones which characterize the bathyal and abyssal faunas. Within the calcareous perforate forms, there are five particularly abundant species, namely B. dilatata (.19), S. interrupta (.12), Globocassidulina rasilocula (.16), Trifarina bradyi (.07), and Cibicides refulgens (.05).

ii. Cymbaloporella squamosa - Brizalina abbreviata Assemblage.
(Plate 2)

Sample: NOVA-H 12G.

Depth: 735 m.

Discussion: This sample from the continental slope came from within the Antarctic Intermediate Water mass, likely the Oxygen Maximum and just above the Salinity Minimum. This assemblage is also extremely diverse, with 144 species, of which only 3 are agglutinated, while 31 are porcelaneous. The decrease in agglutinated species likely reflects a decrease in the supply of clastic material, while the increase in porcelaneous species may be caused by the reduction in salinity which reaches a peak just below the depth of this sample. The distribution of specimens among the species is very even, but the more abundant species include C.

squamosa (.03), B. abbreviata (.04), Globocassidulina rarilocula (.09), and the porcelaneous specie. Triloculinella australis (.02) and Quinqueloculina sp. B (.02).

iii. Amphistegina madagascariensis - Globocassidulina rarilocula
Assemblage.
(Plate 3)

Sample: PROA 71D.

Depth: 1390/1550 m (dredge sample from margin of bank).

Discussion: While this dredge sample spanned a great range of water depths, it still represents the Deep Oxygen Minimum. Unlike other assemblages in this study that are related to the same water mass, this one lacks both Nuttallides bradyanus and N. umboniferus. It has an unusual fauna with A. madagascariensis (.14), G. rarilocula (.33), Cymbaloporeta squamosa (.08), Sigmavergulina tortuosa (.05), and Bolivina compacta (.05) as the dominant constituents.

iv. Brizalina bevrichi - Melonis barleeaanum Assemblage.
(Plate 4)

Sample: DODO 52G.

Depth: 2353 m.

Discussion: The most striking aspect of this assemblage is its extremely low diversity, wherein three species, B. bevrichi (.29), M. barleeaanum (.22), and Valvulineria minuta (.18), comprise 69% of the 182 specimens recovered. The sample itself was also distinctive, being composed overwhelmingly of clastic material of probable volcanic origin. Pyroxene and olivine clasts of high angularity and minimal sphericity were most noticeable, but given the small sample size and lack of any other comparable samples, the use of the term volcanoclastic is avoided. While this assemblage represents an environment near the base of the Deep Oxygen Minimum, it bears very little similarity to any other samples from this water mass. They are characterized by calcareous oozes, and it is probable that the great influx of clastic volcanic sediment and/or its effect on water properties (perhaps pH) has produced this distinctive assemblage. It is unlike any known to this author, and the

environment represented is probably highly stressed.

v. Cassidulina teretis - Fontbotia wuellerstorfi Assemblage.
(Plate 5)

Samples: NOVA-H 1G, NOVA-H 2G.

Depth range: 1143 to 1181 m.

Discussion: The two samples comprising this assemblage are the only ones which represent the Salinity Minimum of Antarctic Intermediate Water, and are both from the Lord Howe Rise. The most significant species are C. teretis (.06-.08) and F. wuellerstorfi (.06-.09), and other important species include Astrononion echolsi (.04-.08), Hoeglundina elegans (.02-.04), Gavelinopsis lobatulus (.02-.04), and Gyroidinoides orbicularis (.02-.03). Also present in significant numbers are Epistominella exigua (.03-.09) and Globocassidulina subglobosa (.05-.07), but these two species become generally much more abundant in the deeper assemblages. Corliss (1979) found that F. wuellerstorfi was an important constituent of one of the assemblages in the Indian Ocean related to AABW. However, both samples in the present assemblage lack specimens of both Nuttallides bradyanus and N. umboniferus, this latter species being an AABW indicator. The only other samples in the present study in which the abundance of F. wuellerstorfi exceeded .03 were NOVA-A 48G (.06) and NOVA-H 19QV (.08). This latter sample had but 12 specimens, and no significance can be attached to its abundances, while the former, at 2220 m water depth, had .06 N. bradyanus and only .01 N. umboniferus, and cannot be considered representative of AABW. The results of the present study do not support F. wuellerstorfi as an indicator of AABW, and it is possible, in light of the paper of Schröder *et al* (1987), that this species is over-represented in Corliss's assemblages because of its large size and the use of a 150 μ m lower size limit by Corliss.

vi. Nuttallides bradyanus Assemblage.
(Plate 6)

Samples: DODO 50G, ERDC 20G, ERDC 87BX, ERDC 97G, ERDC 104G,
ERDC 115G, ERDC 121G, LSDH 58G, LSDH 66PG, LSDH 74G, REC

11G.

Depth range: 1349 to 3477 m.

Discussion: This assemblage is strongly related to the next one, and also has many similarities to the two following. The resolution of these four assemblages would have been most unlikely without the aid of cluster analysis. The samples of this assemblage span both the Deep Oxygen Minimum and Deep Water, all above the lysocline, which is at 3500 m water depth in this area (Berger *et al.*, 1976). It has not been possible to resolve a separate component for the two water masses. The major characteristic of this assemblage is the high abundance of N. bradyanus (.04-.22), especially as compared to N. umboniferus (.00-.06) within samples. Three other species, whose abundances are often high though quite variable, will be used to help characterize this and the next three assemblages. In the present assemblage they are Epistominella exigua (.00-.13), Globocassidulina subglobosa (.02-.23), and Oridorsalis umbonatus (.02-.07).

In addition to these three, Epistominella sp. A, Globocassidulina sp. A, Cibicides kullenbergi, Pullenia osloensis, P. subcarinata, and Alabaminella weddellensis are also very common deep water benthic species whose abundances are often very high (even above .15), but also highly variable and without any apparent pattern that will allow finer subdivision of this and the next three assemblages. Given the frequently high abundances of these species, it is clear that they cannot all be simultaneously abundant or rare. However, there are no readily apparent inverse relationships between these species. This may be a manifestation of the distribution of deep-sea benthic foraminifera, which is demonstrably patchy on the scale of centimetres (Douglas and Woodruff, 1981, and other references cited therein). There are too few samples per environment and too few specimens counted per sample to allow this possibility to be investigated further in the present study.

The Nuttallides bradyanus Assemblage is restricted to samples which were not placed in Cluster 2 at a high probability, while the samples from cores within the

same water masses that comprise the calcareous component of Cluster 2 make up the next assemblage, with reduced N. bradyanus and low N. umboniferus. Apart from this slight distinction, there is no apparent significant difference between this assemblage and the next, which has slightly deeper upper and lower depth limits, but significant overlap in range.

Within the Nuttallides bradyanus Assemblage is a group of five samples, four from the Ontong Java Plateau (ERDC 87BX, ERDC 97G, ERDC 115G, and ERDC 121G), and one separated from the Plateau by a very narrow arm slightly deeper than 3000 m (LSDH 74G). Within these samples, the abundance of Siphouvigerina interrupta ranges from .06 to .10, while it is otherwise never more abundant than .02, except in the shelf sample NOVA-H 5G. Burke (1981) noted that the foraminiferal assemblages from the top of the Plateau were marked by abundant S. interrupta, among other species, and suggested that they represented the Deep Oxygen Minimum. However, many other samples within the present assemblage must lie within this water mass, according to the range given by Wyrski (1962), yet they have no significant S. interrupta component. There may well be some other environmental control on the distribution of this species, but it cannot be identified at present.

vii. Globocassidulina subglobosa - Epistominella exigua Assemblage.
(Plate 7)

Samples: DODO 43D, ERDC 19G, LSDH 65G, LSDH 77G, NOVA-A 40 PG, NOVA-A 48G, NOVA-A 64G, NOVA-H 19QV, NOVA-H 30V, NOVA-HV 9G, PROA 48G, PROA 54G, PROA 56G, REC 7G.

Depth range: 1832 to 3900 m.

Discussion: This assemblage consists exclusively of the samples which comprise the deep-water calcareous component of Cluster 2. As with the preceding assemblage, the water masses represented are the Deep Oxygen Minimum and Deep Water, mostly above the lysocline in this case. A few of the samples occur well within the range expected for AABW, but the abundance of Nuttallides umboniferus

never exceeds .03. The species G. subglobosa (.03-.17) and E. exigua (.02-.28) do not necessarily occur at higher abundances than in samples from the other deep-water calcareous assemblages, but are given prominence in the name of this one because the abundances of the other deep-water species are lower. They are N. bradvanus (.00-.09), N. umboniferus (.00-.03), and Oridorsalis umbonatus (.00-.07). Sample NOVA-H 19QV is left in this assemblage, though it has but 12 specimens. At a water depth of 2783 m it lies well within the range for this assemblage, and was in very close proximity to other samples from the same assemblage to the north and west of the Fiji Islands.

viii. Oridorsalis umbonatus - Nuttallides umboniferus Assemblage.
(Plate 8)

Samples: LSDH 76V, LSDH 78V, NOVA-A 31P, NOVA-HV 11G, NOVA-HV 15G, PROA 52G, PROA 83PG, REC 31G.

Depth range: 3055 to 4290 m.

Discussion: This assemblage is the first one to be strongly related to AABW, being restricted to depths greater than 3000 m. This means that the samples came from within basins filled with AABW or one of its derivatives, and most were from below the lysocline. This assemblage is composed solely of the samples of Cluster 19, less the two excluded for reasons discussed previously. The most significant species are O. umbonatus (.05-.09) and N. umboniferus (.01-.11), while other species abundances include N. bradvanus (.00-.03), Epistominella exigua (.08-.27), and Globocassidulina subglobosa (.03-.10). In general, this assemblage is contrasted with the previous two by its increased abundance of N. umboniferus and decreased N. bradvanus, while O. umbonatus is also consistently abundant rather than rarely or sporadically so. The inverse relationship between the two species of Nuttallides, with N. umboniferus being favoured with increasing depth, is one of the most striking features of the deep calcareous assemblages.

ix. Nuttallides umboniferus Assemblage.
(Plate 9)

Samples: ERDC 132PG, LSDH 64G, LSDH 79P, NOVA-A 32G, NOVA-A 35G,

NOVA-H 57G, NOVA-HV 8QV, NOVA-HV 18G, PROA 41G, PROA 82PG.

Depth range: 3566 to 4951 m.

Discussion: All samples within the assemblage were recovered at depths below the lysocline and within AABW. While the range of this environment thus overlaps strongly that of the preceding assemblage, it has deeper upper and lower depth limits. This assemblage is readily distinguished by the abundance of N. umboniferus (.09-.26), with the lowest value encountered being barely less than the highest observed in the Oridorsalis umbonatus - Nuttallides umboniferus Assemblage. In the absence of data for living versus dead specimens, it is impossible to say whether this increase is due to a higher number of living individuals, or a post-mortem effect. Certainly solution of specimens becomes a factor below the lysocline and particularly as the calcite compensation depth (CCD) is approached. Deep samples have increasing numbers of N. umboniferus in which the outer whorl has been dissolved, leaving a free-standing umbo or plug above the level of the inner whorls. This may be a more robust, solution-resistant species whose abundance is enhanced by the destruction of other thin-walled, more fragile species. The abundances of such other species include N. bradyanus (.00-.02), Epistominella exigua (.00-.20), Globocassidulina subglobosa (.01-.27), and Oridorsalis umbonatus (.03-.08). The extreme variability in abundance of deep-sea benthic species is seen to persist throughout these assemblages.

x. Mixed Calcareous/Agglutinated Abyssal Assemblage.
(Plate 10)

Samples: DODO 48D, PROA 40G.

Depth range: 4470 to 4783 m.

Discussion: The two samples represent AABW, but at depths very near the CCD. At the CCD, the production or supply of calcite to the environment is balanced by solution of calcite, while below this there is a net loss of calcite. According to Berger *et al* (1976), the CCD in this part of the Pacific Ocean may be

as shallow as 4200 m $\pm$ 200 m, in areas of low productivity, but is generally between 4500 and 5000 m. Equatorward, high productivity depresses the CCD to depths of 4900 m or more, with the maximum known to this author being 5250 m, reported from the vicinity of the Ontong Java Plateau (Burke, 1981). Due to the difficulty of calcite metabolism under these conditions, the abyssal agglutinated species become very prominent rather than rare components of the faunas, while the calcareous component is dominated by Nuttallides umboniferus (.05-.31). The most abundant agglutinated forms are Nodellum membranaceum (.09-.19), Ammobaculites sp. A (.05-.12), and Astrorhizaceans (.08-.21). The fragmentary nature of the latter forms may cause them to be over-represented in the census data.

xi. Abyssal Agglutinated Assemblage.
(Plate 11)

Samples: LSDH 69G, PROA 43P, PROA 63PG, PROA 73PG, PROA 107PG.

Depth range: 4850 to 8900 m.

Discussion: This assemblage represents AABW below the CCD. Calcareous species are either not developed in the faunas, or are dissolved post-mortem. All specimens are agglutinated with the occasional exception of a few corroded calcareous ones. The specimens are fairly evenly distributed among many species, although the counts are generally too low to enable dominant or significant species to be identified as such.

xii. Null Assemblage.

Discussion: This is not really an assemblage, comprising as it does the six samples that cannot be assigned to other assemblages. Samples MSN 18G (5000 m) and PROA 106PG (5426 m) are barren, while NOVA-H 53QV (4321 m, 4 specimens), NOVA-HV 16QV (2968 m, 27 specimens), and PROA 28P (7740 m, 7 specimens) have too few specimens for reliable analysis. Sample PROA 34P (8900 m, 34 specimens) clustered with REC 11G, which belongs to the Nuttallides bradyanus Assemblage. The fauna in PROA 34P is calcareous, but at a water depth of 8900 m, well below the CCD, must be a transported fauna.

CHAPTER 5. CONCLUSIONS.

This study is an important contribution to the study of modern deep-sea benthic foraminifera because it is both comprehensive and up-to-date, incorporating many species into the new taxonomic framework of Loeblich and Tappan (1987). Although 606 species of benthic foraminifera have been identified and described, 136 of these are not referable to species known to this author. Many of these are represented by poorly preserved or too few specimens to justify description as new species, but several do represent new species that will be described and illustrated in a paper that is in preparation.

While this study has identified eleven benthic foraminiferal assemblages in the tropical southwest Pacific Ocean, it is clear that there is room for a great deal of improvement. Three conditions need to be met in future quantitative studies in this and other areas.

The first is that all specimens greater than 63 μm should be examined, because too much information is lost by using a coarser lower size limit of 125 or 150 μm . Not only are smaller species missed, but the apparent significance of larger species becomes exaggerated when the smaller size fraction is ignored. The present study satisfied this condition, but due to statistical limitations, it was not possible to demonstrate any impact this may have on the resolution and characterization of benthic foraminiferal biofacies.

The second condition is that the number of specimens counted per sample should be very high, probably 600 at a minimum, for high diversity samples. Counting 800 or even 1000 specimens would be even more desirable, but one begins to approach limitations imposed by available sample size or the time and effort required. The larger number of specimens is needed to reduce the uncertainty associated with each species's abundance, thereby increasing the significance of the data. This would enable many more species to contribute meaningful information to the statistical analysis, and may ultimately enable much finer resolution of benthic

foraminiferal assemblages and their associated water masses and environments. The present study failed to meet this condition for all but a few samples. As a result, a lot of census data, acquired with much effort, was rendered virtually meaningless because of its statistical limitations.

The third condition is that very large numbers of samples are required to characterize a single environment. Fishbein (pers. comm.) believes that as many as a few hundred or more samples are necessary to provide an adequate statistical base to accurately represent a single environment. When a study depends for its samples on cores recovered during scientific cruises, it will of course not be practical to satisfy this condition fully, due to the time and expense involved. Nevertheless, the present study represents the opposite extreme, with four assemblages represented by single samples, and two more represented by just a pair of samples each. For this and other studies, sampling density needs to be increased.

There are two major points that emerge from this study. The first is that our knowledge of the modern deep-sea benthic foraminifera is by no means complete, which is evident in the large number of species that had not been previously described. Many of these are anything but obscure, being represented by several if not dozens of specimens, comprising in some instances six percent or more of the benthic foraminiferal fauna in a given sample. The second point is that there is a great need for improved and standardized sampling, processing, and statistical techniques in order to do sound quantitative micropaleontological analysis. It is not enough that all studies be consistent in the techniques used, but the best techniques, applied to the best information that can be extracted from the samples, must be used.

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APPENDIX I

**Location and Details
of
Samples Processed**

Sample No.	Latitude (South)	Longitude (East)	Depth (m)	Interval (cm)	Weight (g)	Lithology and Remarks
1. DODO 43D	04°25.0'	154°35.0'	2000	surf.	0.709	Tan-grey calcareous ooze with much fine dark clastic material.
2. DODO 48D	07°50.0'	153°00.0'	4783	surf.	11.490	Chocolate brown ooze. P to Ex.
3. DODO 50G	11°30.0'	150°30.0'	2681	2-4	0.751	Grey-brown ooze.
4. DODO 52G	10°30.0'	147°40.0'	2353	4-6	3.367	Green-grey ooze, lots of clastics possibly volcanic. P to Ex.
5. ERDC 19G	12°12.4'	177°11.0'	3487	0-2	1.462	Light brown ooze.
6. ERDC 20G	15°30.6'	172°45.1'	3447	3-5	3.841	Light brown ooze. P to Ex.
7. ERDC 87BX	00°00.8'	155°51.8'	1930	0-5	0.752	Greyish tan ooze.
8. ERDC 97G	02°18.0'	156°53.8'	1622	0-2	0.551	Light cream-tan ooze.
9. ERDC 104G	03°40.1'	161°17.7'	2255	0-2	0.929	Tan-grey calcareous ooze.
10. ERDC 115G	01°38.7'	159°11.9'	2157	0-2	0.756	Light tan ooze.
11. ERDC 121G	00°01.1'	158°42.8'	2245	1-3	0.750	Light cream-grey ooze.
12. ERDC 132 PG	00°02.6'	162°41.0'	4441	1-2	2.271	Light cream-tan ooze.
13. LSDH 58G	14°30.0'	148°42.0'	2122	8-9	1.472	Grey-tan ooze.
14. LSDH 64G	16°03.0'	155°00.0'	4070	5-7	1.603	Tan-brown ooze.

Appendix I. Location and details of samples processed.

Sample No.	Latitude (South)	Longitude (East)	Depth (m)	Interval (cm)	Weight (g)	Lithology and Remarks
15. LSDH 65G	14° 47.0'	155° 56.0'	2982	6-8	1.581	Light brown ooze.
16. LSDH 66PG	13° 17.0'	156° 51.0'	2031	4-6	1.542	Light grey-brown ooze.
17. LSDH 69G-1	09° 52.0'	159° 01.0'	4850	2-6	5.491	Olive-brown ooze. P to Ex.
18. LSDH 69G-2	<--As above.-->			3-7	3.022	As above. P to Ex.
19. LSDH 74G	07° 53.0'	160° 29.0'	1738	0-2	1.290	Light cream ooze. P to Ex.
20. LSDH 76V	06° 40.0'	163° 13.0'	3565	0-10	1.416	Cream coloured ooze.
21. LSDH 77G	05° 42.0'	165° 25.0'	2556	3-6	1.596	Light cream ooze.
22. LSDH 78V	04° 30.0'	167° 58.0'	3055	0-4	1.607	Bleached cream coloured ooze.
23. LSDH 79P	03° 23.0'	170° 02.0'	3600	2-4	1.455	Light cream ooze.
24. MSN 18G-1	08° 58.0'	171° 27.0'	5000	3-6	1.744	Rich brown ooze. P to Ex.
--- MSN 18G-2	<--As above.-->			0-3	3.784	As above. P to Ex.
25. NOVA-A 31P	12° 17.0'	145° 50.0'	3558	0-3	1.582	Grey-tan ooze.
26. NOVA-A 32G	14° 08.0'	152° 55.0'	4582	4-6	2.097	Mottled mid and dark brown mud.
27. NOVA-A 35G-1	21° 27.0'	164° 07.0'	3566	2-5	5.722	Light grey-tan ooze. P to Ex.
28. NOVA-A 35G-2	<--As above.-->			2-5	4.703	As above. P to Ex.
29. NOVA-A 40PG	23° 00.0'	164° 58.0'	3617	2-5	1.573	Light cream-tan ooze.

Appendix 1 (cont.). Location and details of samples processed.

Sample No.	Latitude (South)	Longitude (East)	Depth (m)	Interval (cm)	Weight (g)	Lithology and Remarks
30. NOVA-A 48G	28°12.0'	158°13.0'	2220	3-7	1.814	Light tan ooze.
31. NOVA-A 64G	27°37.0'	168°59.0'	3182	3-5	1.545	Light tan ooze.
32. NOVA-H 1G	29°45.0'	162°34.0'	1181	0-3	0.745	Light grey-tan sandy ooze.
33. NOVA-H 2G	24°40.0'	162°03.0'	1143	0-2	1.015	Light cream-tan sandy ooze.
34. NOVA-H 5G	08°17.0'	145°17.0'	110	0-3	1.023	Green-grey sandy silt.
35. NOVA-H 12G	11°21.0'	152°22.0'	735	0-3	1.043	Tan-grey calcareous sandy silt.
36. NOVA-H 19QV	14°26.0'	17°21.0'	2783	0-4	0.266	Brown ooze. P to Ex.
37. NOVA-H 30V	12°39.0'	173°44.0'	3148	0-10	0.431	Light brown ooze. P to Ex.
38. NOVA-H 53QV	23°24.0'	171°12.0'	4321	0-10	0.361	Brown ooze and clastics. P to Ex.
39. NOVA-H 57G	22°52.0'	174°21.0'	4275	0-4	5.434	Mid brown ooze. P to Ex.
40. NOVA-HV 8QV	27°07.0'	155°55.0'	4780	0-10	1.043	Grey to buff-grey clay. P to Ex.
41. NOVA-HV 9G	28°24.0'	159°15.0'	3403	1-5	4.329	White foram ooze. P to Ex.
42. NOVA-HV 11G	27°57.0'	166°04.0'	3549	0-3	1.540	Light brown-tan-cream ooze.
43. NOVA-HV 15G	28°10.0'	171°12.0'	3489	3-7	1.516	Light brown-tan ooze.
44. NOVA-HV 16QV	28°58.0'	173°29.0'	2968	0-10	0.476	Light tan ooze. P to Ex.

Appendix I (cont.). Location and details of samples processed.

Sample No.	Latitude (South)	Longitude (East)	Depth (m)	Interval (cm)	Weight (g)	Lithology and Remarks
45. NOVA-HV 18G	29° 39.0'	175° 02.0'	4260	0-3	4.984	Brown ooze. P to Ex.
46. PROA 28P-1	06° 16.0'	151° 33.0'	7740	0-5	3.931	Light brown ooze. P to Ex.
--- PROA 28P-2	<---As above---			2-5	15.567	As above. P to Ex. Barren.
47. PROA 34P	06° 19.0'	153° 46.0'	8900	wgt. std.	1.606	Grey-green ooze, no core recovery. P to Ex.
48. PROA 40G-1	11° 35.0'	164° 37.0'	4470	5-7	4.239	Light red-brown ooze. P to Ex.
49. PROA 40G-2	<---As above---			0-7	11.486	As above. P to Ex.
50. PROA 41G	12° 46.0'	163° 52.0'	4110	5-7	2.930	Mottled tan and brown ooze.
51. PROA 43P-1	12° 16.0'	165° 50.0'	8900	0-4	2.856	Grey brown, lots clasts. P to Ex.
52. PROA 43P-2	<---As above---			0-7	25.192	As above. P to Ex.
53. PROA 48G	20° 35.0'	167° 34.0'	3900	5-8	1.482	Dark tan ooze.
54. PROA 52G	20° 20.0'	170° 46.0'	3140	2-4	1.751	Light red-brown ooze. P to Ex.
55. PROA 54G	19° 21.0'	174° 26.0'	3075	3-5	1.002	Soft grey-tan ooze.
56. PROA 56G	18° 50.0'	177° 35.0'	2260	4-6	0.774	Tan-grey ooze.
57. PROA 63PG-1	07° 48.0'	174° 25.0'	5265	2-4	1.758	Rich brown ooze. P to Ex.
58. PROA 63PG-2	<---as above---			0-5	15.895	As above. P to Ex.
59. PROA 71D	11° 34.0'	175° 11.0'	1550 -1390	surf.	0.214	Creamy ooze, lots molluscs.

Appendix I (cont.). Location and details of samples processed.

Sample No.	Latitude (South)	Longitude (East)	Depth (m)	Interval (cm)	Weight (g)	Lithology and Remarks
60. PROA 73PG-1	09°01.0'	177°49.0'	5105	2-4	1.615	Mid to dark brown ooze. P to Ex.
61. PROA 73PG-2	<---As above---			0-6	7.421	As above. P to Ex.
62. PROA 82PG	03°05.0'	174°27.0'	4951	2-5	8.736	Rich brown mottled ooze. P to Ex.
63. PROA 83PG	02°04.0'	172°29.0'	4290	4-6	2.924	Light cream coloured ooze.
64. PROA 106PG	01°22.0'	178°24.0'	5426	4-6	1.264	Brown ooze. P to Ex.
65. PROA 107PG-1	02°27.0'	179°59.0'	5490	2-4	1.587	Mid brown mottled ooze. P to Ex.
66. PROA 107PG-2	<---As above---			0-9	19.170	As above. P to Ex.
67. REC 7G	23°59.8'	153°54.3'	1832	0-3	1.762	Light grey-tan ooze.
68. REC 11G	17°38.4'	147°36.3'	1349	0-2	1.116	Light grey-cream ooze.
69. REC 31G	11°41.0'	155°20.8'	3914	3-5	1.361	Light tan ooze.

Key To Suffixes and Abbreviations

BX - box core	QV - heat probe, sediment catcher
D - dredge sample	V - heat probe, sediment catcher
G - gravity core	-1 - first sample from core
P - piston core	-2 - second sample from core
PG - gravity core	P to Ex - processed to exhaustion

Appendix I (cont. and completed). Location and details of samples processed.

APPENDIX II

Census Data for all Species and Samples

**Appendix consists of a computer diskette
in pocket at back of thesis.
Data is in a Lotus 1-2-3 file named
BENTHRAW.WK1,
for use with MS-DOS/IBM compatible computers.**

APPENDIX III

Fractional Abundance Data for all Species Used in the Cluster Analysis

APPENDIX III

Sample No.	34	35	59	4	32	33	8
Depth (m)	110	735	1550	2353	1181	1143	1622
Total specimens	1183	375	1018	182	178	361	230
Trifar. bradyi	0.07	0.00					
Triloc. austr.	0.00	0.02					
Gavel'is sp. A	0.01	0.02					
Cornu. involv.		0.01					
Disc'des sp. C		0.01					
Disc'des sp. D		0.02					
Sagrin. lobata		0.01	0.01				
Cymbal. bradyi		0.02	0.01				
Cymbal. squam.		0.05	0.08				
Briz. abbrev.		0.04	0.03				
Sig. tortuosa		0.02	0.05				
Quinque. sp. B	0.00	0.02	0.00			0.00	
Amphi. madagas.		0.01	0.14	0.01			
Cib'ides umbon	0.04					0.01	0.01
Cib'ides cicat	0.03	0.01	0.00		0.03	0.01	
Cib'ides plan.	0.02	0.00	0.00			0.00	0.01
Cib'ides reful	0.05	0.01	0.00		0.01		
S'uvig. inter.	0.12		0.00		0.01	0.00	0.10
Gl'cass. rari.	0.16	0.09	0.33		0.01	0.04	0.07
Bol. dilatata	0.19	0.01	0.00	0.02			0.00
Cassid. carin	0.02	0.00	0.01	0.05	0.02		0.00
Valv. minuta				0.18			
Briz. beyrichi				0.29			
Melonis barlee	0.00	0.01		0.22		0.01	0.01
Pyrq'la globu.	0.00	0.00	0.00			0.07	
Cassid. teret	0.00	0.00		0.02	0.08	0.06	
Font. wueller.	0.00	0.00			0.06	0.09	0.03
Gavel'is lobat	0.00		0.00		0.04	0.02	
Hoeg. elegans	0.00	0.00			0.02	0.04	0.00
Angu. earlandi			0.00		0.02	0.00	
Aster. miocen.	0.00	0.00			0.01		
Bol. compacta		0.02	0.05				
Bol. robusta	0.00	0.02			0.01	0.00	
Briz. oceanica						0.00	
Briz. pusilla				0.01		0.00	0.02
Bul. transluc.			0.00				
Cassid. laevi							0.00
Cerat. contrar			0.00		0.02	0.01	
Euuvig. probos	0.00						0.05
Gl'cass. minut	0.00	0.00	0.01		0.02	0.00	
Gl'cass. oblon			0.00				
Gyroid. orbic.		0.00		0.01	0.03	0.02	0.01
Gyroid. subpl.	0.01	0.00	0.00		0.01	0.01	0.01
Ioan. tumidula		0.01					0.01

APPENDIX III (cont.)

Sample No.	34	35	59	4	32	33	8
Depth (m)	110	735	1550	2353	1181	1143	1622
Total specimens	1183	375	1018	182	178	361	230
Lob. lobatula	0.00	0.00			0.02	0.01	
Melonis sp. A						0.01	
Anom. ammon.					0.02	0.01	0.02
Lin. semicrib.	0.00						0.00
C'doides mund.					0.01		
Astr. echolsi					0.08	0.04	0.11
Nonion sp. A					0.01		
Epistom. sp. A							
Gl'cass. sp. A							
Nuttal. brady.				0.01			0.06
Nuttal. umbon.							
Epist. exigua			0.00	0.01	0.09	0.03	0.02
Gl'cass. subg.	0.00	0.02	0.02	0.01	0.07	0.05	0.02
Cib'ides kul.		0.01	0.02		0.01	0.01	0.04
Ori. umbonat.			0.00	0.01	0.02	0.03	0.07
Pul. osloensis					0.02	0.03	0.07
Pul. subcarin.	0.00	0.00			0.01	0.01	0.00
Alab. weddel.		0.01	0.00	0.01	0.03	0.01	0.03
Turrilina sp. A							
Uvig. dirupta		0.00			0.02	0.00	
Valvul. sp. B							0.01
Agglutinated							
Ammobac. sp. A							
Am'disc. inc.							
Am'glob. glob.							
Astrorhizac.	0.00					0.01	0.02
Buz. galeata							
Cr'stom. sph.							
Cyst. pauci.							
Disc. compres.							
Glom. gordial.					0.01		
Haplo. bradyi							
Haplo. trull.							
Hormo. distans							
Hyper. laev.							
Kar'ulin apic.						0.00	
Lag'am. diff.							
Nod. membran.							
Ps'nod. nodul.							
Ps'troch. deh.							
Recurv. cont.				0.01			0.00
Reo. gracilis							
Rep. charoides							
Sp'amm. bif.							

APPENDIX III (cont.)

Sample No.	68	9	13	3	16	10	7
Depth (m)	1349	2255	2122	2681	2031	2157	1930
Total specimens	284	294	302	371	309	299	336
Trifar. bradyi							
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'des sp. C							
Disc'des sp. D							
Sagrin. lobata			0.00	0.00			
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.	0.00				0.00		
Sig. tortuosa	0.00			0.00			
Quinque. sp. B		0.00		0.00		0.00	
Amphi. madagas.				0.01			
Cib'ides umbon		0.00			0.00		
Cib'ides cicat					0.01		
Cib'ides plan.			0.00	0.00	0.00		0.00
Cib'ides reful	0.02		0.01	0.02	0.01	0.00	
S'uvig. inter.	0.02	0.02	0.01		0.00	0.08	0.10
Gl'cass. rari.	0.10	0.10	0.05	0.16	0.07	0.05	0.05
Bol. dilatata	0.03		0.01	0.03	0.02		
Cassid. carin	0.02	0.01	0.03		0.00	0.01	0.01
Valv. minuta							
Briz. beyrichi							
Melonis barlee	0.00	0.02	0.01	0.01	0.01	0.02	0.01
Pyrq'la globu.	0.03						
Cassid. teret				0.00			
Font. wueller.	0.03	0.03	0.02	0.02	0.01		0.01
Gavel'is lobat	0.04		0.00		0.01		
Hoeg. elegans		0.01	0.00				
Angu. earlandi	0.03			0.01			
Aster. miocen.	0.00		0.02		0.09		
Bol. compacta	0.04			0.02	0.00		
Bol. robusta	0.00		0.01	0.01			
Briz. oceanica				0.01			
Briz. pusilla		0.00	0.03	0.02	0.04	0.02	0.01
Bul. transluc.				0.01			
Cassid. laevi			0.00				0.03
Cerat. contrar							
Euuvig. probos	0.00		0.00	0.01		0.01	0.03
Gl'cass. minut	0.02	0.00	0.02	0.05	0.00	0.00	0.01
Gl'cass. oblon							
Gyroid. orbic.	0.01	0.03	0.02	0.01		0.01	0.02
Gyroid. subpl.	0.01	0.02	0.01	0.03	0.01	0.00	0.01
Ioan. tumidula	0.01		0.01	0.03		0.01	0.02

APPENDIX III (cont.)

Sample No.	68	9	13	3	16	10	7
Depth (m)	1349	2255	2122	2681	2031	2157	1930
Total specimens	284	294	302	271	309	299	336
Lob. lobatula		0.00	0.00	0.01			
Melonis sp. A		0.02					
Anom. ammon.	0.02		0.01	0.00	0.02	0.01	
Lin. semicrib.			0.00			0.01	0.00
C'doides mund.					0.00		
Astr. echolsi	0.01		0.02	0.01	0.01	0.02	0.02
Nonion sp. A	0.01	0.02	0.00	0.00	0.00	0.01	
Epistom. sp. A							
Gl'cass. sp. A							
Nuttal. brady.	0.04	0.10	0.15	0.12	0.08	0.22	0.06
Nuttal. umbon.		0.06	0.03		0.03	0.02	0.03
Epist. exigua	0.01	0.02	0.03	0.09	0.06	0.00	
Gl'cass. subg.	0.04	0.05	0.07	0.05	0.04	0.02	0.02
Cib'ides kul.	0.03	0.02	0.00	0.01	0.10	0.04	0.08
Ori. umbonat.	0.02	0.04	0.04	0.02	0.06	0.04	0.04
Pul. osloensis	0.00	0.09	0.01	0.01	0.05	0.06	0.03
Pul. subcarin.		0.01			0.01	0.03	0.01
Alab. weddel.		0.10	0.07	0.04	0.03	0.12	0.11
Turrilina sp. A							
Uvig. dirupta		0.00	0.00		0.00		
Valvul. sp. B			0.00			0.00	0.03
Agglutinated							
Ammobac. sp. A	0.00		0.00				
Am'disc. inc.							
Am'glob. glob.					0.00		
Astrorhizac.	0.01		0.00	0.00		0.00	0.01
Buz. galeata							
Cr'stom. sph.							
Cyst. pauci.	0.00						
Disc. compres.							
Glom. gordial.					0.00		0.00
Haplo. bradyi				0.00			
Haplo. trull.							
Hormo. distans							
Hyper. l v.							
Kar'ulin apic.							
Lag'am. diff.							
Nod. membran.					0.00		
Ps'nod. nodul.							
Ps'troch. deh.							
Recurv. cont.				0.01			
Reo. gracilis							
Rep. charoides	0.01		0.00	0.00			0.00
Sp'amm. bif.							

APPENDIX III (cont.)

Sample No.	11	6	19	67	1	30	56
Depth (m)	2245	3447	1738	1832	2000	2220	2260
Total specimens	338	373	234	627	212	403	278
Trifar. bradyi							
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'ides sp. C							
Disc'ides sp. D							
Sagrin. lobata				0.00			
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.				0.00			
Sig. tortuosa			0.00				
Quinque. sp. B							0.01
Amphi. madagas.				0.01		0.00	0.06
Cib'ides umbon			0.01	0.00	0.01		
Cib'ides cicat						0.00	0.01
Cib'ides plan.				0.01	0.01		
Cib'ides reful			0.00	0.00	0.00	0.01	0.01
S'uvig. inter.	0.08		0.06		0.01		
Gl'cass. rari.	0.06	0.03	0.04	0.09	0.07	0.12	0.07
Bol. dilatata			0.00	0.01	0.01		0.04
Cassid. carin	0.00		0.00	0.04		0.00	0.05
Valv. minuta							
Briz. beyrichi							
Melonis barlee	0.02	0.01	0.02	0.00	0.03	0.01	0.01
Pyrq'la globu.							
Cassid. teret							
Font. wueller.	0.02	0.03	0.03	0.00	0.00	0.06	0.00
Gavel'is lobat			0.00	0.02			
Hoeg. elegans				0.01		0.01	0.01
Angu. earlandi				0.06	0.00	0.00	
Aster. miocen.				0.00			
Bol. compacta				0.01			0.01
Bol. robusta			0.01	0.00	0.02	0.01	0.00
Briz. oceanica				0.01		0.01	0.03
Briz. pusilla			0.00	0.03		0.01	0.01
Bul. transluc.		0.01			0.00	0.00	
Cassid. laevi			0.00	0.00	0.01		
Cerat. contrar				0.01		0.01	0.01
Euuvig. probos			0.01		0.01		
Gl'cass. minut		0.01	0.03	0.02	0.02	0.02	0.05
Gl'cass. oblon		0.00			0.00		
Gyroid. orbic.	0.01		0.03	0.01	0.02	0.03	0.00
Gyroid. subpl.	0.01	0.00	0.03		0.03	0.00	0.00
Ioan. tumidula	0.01	0.01		0.02		0.02	0.02

APPENDIX III (cont.)

Sample No.	11	6	19	67	1	30	56
Depth (m)	2245	3447	1738	1832	2000	2220	2260
Total specimens	338	373	234	627	212	403	278
Lob. lobatula					0.00		0.01
Melonis sp. A			0.03	0.00	0.01	0.00	
Anom. ammon.	0.01			0.00		0.01	
Lin. semicrib.			0.03	0.00		0.00	
C'doides mund.	0.00	0.01	0.05		0.01	0.01	
Astr. echolsi	0.02		0.03	0.01		0.02	0.01
Nonion sp. A	0.02	0.02		0.00	0.01		
Epistom. sp. A		0.00					
Gl'cass. sp. A		0.06					
Nuttal. brady.	0.04	0.04	0.04	0.01	0.06	0.06	0.06
Nuttal. umbon.	0.02	0.02	0.00			0.01	
Epist. exigua		0.13	0.01	0.03	0.02	0.05	0.03
Gl'cass. subg.	0.11	0.23	0.10	0.08	0.13	0.15	0.03
Cib'ides kul.	0.05	0.01	0.00			0.01	
Ori. umbonat.	0.04	0.06	0.05	0.01	0.03	0.04	0.03
Pul. osloensis	0.06	0.09	0.06	0.00	0.02	0.04	0.01
Pul. subcarin.	0.02	0.02	0.01	0.00	0.02	0.00	0.00
Alab. weddel.	0.12	0.06	0.01	0.02	0.02	0.06	0.00
Turrilina sp. A							
Uvig. dirupta		0.00	0.00	0.00			
Valvul. sp. B				0.01			
Agglutinated						0.00	0.00
Ammobac. sp. A		0.00					0.00
Am'disc. inc.				0.00			
Am'glob. glob.							
Astrorhizac.		0.00		0.00	0.00	0.00	0.04
Buz. galeata		0.00					
Cr'stom. sph.		0.00					
Cyst. pauci.							
Disc. compres.							
Glom. gordial.		0.00		0.00		0.00	
Haplo. bradyi							0.00
Haplo. trull.		0.00					
Hormo. distans							
Hyper. laev.							0.01
Kar'ulin apic.		0.01	0.00				0.00
Lag'am. diff.		0.01					
Nod. membran.		0.01					
Ps'nod. nodul.						0.00	
Ps'troch. deh.							
Recurv. cont.							0.01
Reo. gracilis							
Rep. charoides				0.00			0.01
Sp'amm. bif.							

APPENDIX III (cont.)

Sample No.	21	36	29	53	37	5	55
Depth (m)	2556	2783	3617	3900	3148	3487	3075
Total specimens	368	12	252	525	287	310	205
Trifar. bradyi			0.00	0.01		0.00	
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'des sp. C				0.00			
Disc'des sp. D							
Sagrin. lobata							
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.					0.00	0.00	
Sig. tortuosa			0.00	0.01	0.00	0.01	
Quinque. sp. B							
Amphi. madagas.							
Cib'ides umbon							
Cib'ides cicat					0.00		
Cib'ides plan.	0.00				0.01		
Cib'ides reful			0.01	0.02		0.00	0.01
S'uvig. inter.	0.01			0.01			
Gl'cass. rari.	0.06	0.08	0.08	0.07	0.10	0.11	0.11
Bol. dilatata		0.08	0.02	0.01			
Cassid. carin			0.00	0.03		0.00	
Valv. minuta							
Briz. beyrichi							
Melonis barlee	0.01		0.04	0.00	0.01	0.00	
Pyrq'la globu.							
Cassid. teret	0.00		0.03		0.00		
Font. wueller.	0.01	0.08	0.01	0.01	0.00	0.01	
Gavel'is lobat			0.00		0.00		0.00
Hoeg. elegans							
Angu. earlandi			0.02	0.00		0.01	
Aster. miocen.							
Bol. compacta			0.01	0.02		0.05	
Bol. robusta			0.02	0.06			
Briz. oceanica			0.02	0.00		0.00	0.04
Briz. pusilla	0.00		0.02	0.00			
Bul. transluc.	0.00		0.02	0.00	0.03	0.01	0.00
Cassid. laevi			0.04				
Cerat. contrar							
Euuvig. probos	0.01			0.01			
Gl'cass. minut	0.04		0.02	0.04	0.03	0.02	0.02
Gl'cass. oblon	0.04					0.01	
Gyroid. orbic.	0.01		0.01	0.01	0.00	0.01	0.02
Gyroid. subpl.	0.02		0.04	0.01	0.01		0.01
Ioan. tumidula	0.01		0.01	0.01		0.00	0.01

APPENDIX III (cont.)

Sample No.	21	36	29	53	37	5	55
Depth (m)	2556	2783	3617	3900	3148	3487	3075
Total specimens	368	12	252	525	287	310	205
Lob. lobatula	0.00			0.01	0.00	0.01	
Melonis sp. A			0.00		0.00	0.03	0.00
Anom. ammon.						0.00	
Lin. semicrib.							
C'doides mund.			0.00				
Astr. echolsi							
Nonion sp. A				0.00		0.01	0.01
Epistom. sp. A				0.00	0.03	0.04	0.03
Gl'cass. sp. A			0.01	0.01	0.00	0.03	0.00
Nuttal. brady.	0.09		0.02	0.02	0.04	0.04	0.03
Nuttal. umbon.	0.01		0.01	0.02	0.02	0.02	0.02
Epist. exigua	0.07	0.08	0.07	0.02	0.22	0.08	0.12
Gl'cass. subg.	0.17	0.08	0.08	0.12	0.08	0.17	0.17
Cib'ides kul.			0.01	0.02	0.01		
Ori. umbonat.	0.03		0.02	0.02	0.04	0.02	0.05
Pul. osloensis	0.06	0.08	0.01	0.02	0.04	0.03	0.04
Pul. subcarin.	0.01		0.00	0.02	0.01	0.01	0.01
Alab. weddel.	0.10		0.05	0.01	0.06	0.04	0.07
Turrilina sp. A							
Uvig. dirupta	0.00			0.02			
Valvul. sp. B	0.00		0.00				
Agglutinated		0.08					
Ammobac. sp. A				0.00			0.00
Am'disc. inc.							
Am'glob. glob.							
Astrorhizac.	0.01			0.00		0.01	0.01
Buz. galeata							
Cr'stom. sph.		0.08					
Cyst. pauci.							
Disc. compres.							
Glom. gordial.							
Haplo. bradyi							
Haplo. trull.							
Hormo. distans							
Hyper. laev.							0.00
Kar'ulin apic.							
Lag'am. diff.						0.00	0.01
Nod. membran.				0.00		0.00	
Ps'nod. nodul.							
Ps'troch. deh.							
Recurv. cont.						0.00	
Reo. gracilis							
Rep. charoides							
Sp'amm. bif.	0.00						

APPENDIX III (cont.)

Sample No.	15	31	41	22	54	43	42
Depth (m)	2982	3182	3403	3055	3140	3489	3549
Total specimens	627	386	250	297	212	240	240
Trifar. bradyi							
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'des sp. C							
Disc'des sp. D							
Sagrin. lobata							
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.							
Sig. tortuosa							
Quinque. sp. B							
Amphi. madagas.							
Cib'ides umbon	0.00	0.01	0.01				
Cib'ides cicat		0.00		0.00			
Cib'ides plan.	0.01						
Cib'ides reful			0.00				
S'uvig. inter.	0.00			0.00			
Gl'cass. rari.	0.03	0.06	0.00	0.01	0.02	0.02	0.03
Bol. dilatata			0.00				
Cassid. carin	0.00			0.00			
Valv. minuta							
Briz. beyrichi							
Melonis barlee	0.00	0.02	0.02	0.04	0.00	0.02	0.00
Pyrq'la globu.							
Cassid. teret		0.00					
Font. wueller.	0.01	0.01	0.02	0.01	0.00	0.03	0.02
Gavel'is lobat	0.00				0.00		
Hoeg. elegans		0.01	0.00				
Angu. earlandi							0.00
Aster. miocen.							
Bol. compacta	0.00		0.00				
Bol. robusta	0.00						
Briz. oceanica	0.00	0.00	0.01				
Briz. pusilla							
Bul. transluc.	0.00	0.03	0.01	0.01	0.03	0.04	0.01
Cassid. laevi	0.00						
Cerat. contrar							
Euvig. probos	0.00						
Gl'cass. minut	0.00	0.01					0.02
Gl'cass. oblon	0.00		0.02			0.00	
Gyroid. orbic.	0.00	0.02		0.01	0.00	0.05	0.01
Gyroid. subpl.	0.02	0.01	0.04	0.01	0.01	0.04	0.03
Ioan. tumidula	0.01	0.03	0.01	0.01	0.01	0.00	0.07

APPENDIX III (cont.)

Sample No.	15	31	41	22	54	43	42
Depth (m)	2982	3182	3403	3055	3140	3489	3549
Total specimens	627	386	250	297	212	240	240
Lob. lobatula	0.01						0.00
Melonis sp. A				0.00	0.00		
Anom. ammon.	0.00						
Lin. semicrib.							
C'doides mund.	0.00	0.01	0.00		0.01	0.00	0.01
Astr. echolsi	0.01	0.01		0.01	0.01		0.01
Nonion sp. A	0.01		0.03		0.01		0.00
Epistom. sp. A	0.03			0.04			
Gl'cass. sp. A	0.00	0.01		0.01	0.06	0.03	0.03
Nuttal. brady.	0.03	0.01	0.02	0.02	0.03	0.01	0.01
Nuttal. umbon.	0.03	0.01	0.02	0.01	0.03	0.08	0.11
Epist. exigua	0.28	0.13	0.19	0.15	0.11	0.08	0.12
Gl'cass. subg.	0.11	0.08	0.04	0.05	0.07	0.07	0.10
Cib'ides kul.	0.01	0.01	0.03	0.01	0.01	0.03	0.03
Ori. umbonat.	0.04	0.07	0.03	0.09	0.06	0.07	0.05
Pul. osloensis	0.03	0.05	0.04	0.07	0.06	0.08	0.09
Pul. subcarin.	0.02	0.02	0.01	0.02	0.04	0.03	0.04
Alab. weddel.	0.10	0.12	0.10	0.11	0.09	0.10	0.10
Turrilina sp. A							
Uvig. dirupta		0.03	0.01	0.00		0.02	
Valvul. sp. B					0.00		
Agglutinated							
Ammobac. sp. A	0.02			0.01	0.00	0.00	
Am'disc. inc.							
Am'glob. glob.			0.02				0.00
Astrorhizac.	0.00	0.00	0.00		0.05	0.02	
Buz. galeata							
Cr'stom. sph.							
Cyst. pauci.		0.00	0.00				
Disc. compres.							
Glom. gordial.	0.00				0.01	0.00	
Haplo. bradyi							
Haplo. trull.			0.00				
Hormo. distans						0.00	
Hyper. laev.							
Kar'ulin apic.		0.00	0.01			0.00	0.00
Lag'am. diff.					0.02		
Nod. membran.					0.00		
Ps'nod. nodul.							
Ps'troch. deh.		0.00					
Recurv. cont.			0.01	0.00			
Reo. gracilis							
Rep. charoides			0.01				
Sp'amm. bif.							

APPENDIX III (cont.)

Sample No.	25	20	69	63	27	28	50
Depth (m)	3558	3565	3914	4290	3566	3566	4110
Total specimens	482	370	298	240	114	123	339
Trifar. bradyi							
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'des sp. C							
Disc'des sp. D							
Sagrin. lobata							
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.					0.01		
Sig. tortuosa							
Quinque. sp. B				0.00			
Amphi. madagas.							
Cib'ides umbon							
Cib'ides cicat						0.01	
Cib'ides plan.	0.00	0.00					
Cib'ides reful							
S'uvig. inter.							
Gl'cass. rari.	0.02		0.04		0.02	0.06	
Bol. dilatata	0.02				0.11	0.08	
Cassid. carin	0.01						
Valv. minuta							
Briz. beyrichi					0.01	0.02	
Melonis barlee	0.00	0.03	0.02	0.01			0.02
Pyrq'la globu.	0.00						
Cassid. teret							
Font. wueller.	0.01	0.01	0.00	0.00	0.01		0.00
Gavel'is lobat	0.00						
Hoeg. elegans							
Angu. earlandi	0.01				0.01		
Aster. miocen.							
Bol. compacta					0.01		
Bol. robusta	0.01		0.00		0.01		0.01
Briz. oceanica	0.00				0.05		
Briz. pusilla	0.01		0.01				
Bul. transluc.	0.04	0.01	0.03		0.01		0.01
Cassid. laevi							
Cerat. contrar							
Euuvig. probos	0.00						0.00
Gl'cass. minut	0.06					0.02	
Gl'cass. oblon		0.00				0.01	0.00
Gyroid. orbic.	0.02	0.01	0.02	0.01			0.01
Gyroid. subpl.	0.01	0.02	0.05	0.04	0.02	0.03	0.04
Ioan. tumidula	0.00	0.01	0.01	0.02	0.02	0.01	0.03

APPENDIX III (cont.)

Sample No.	25	20	69	63	27	28	50
Depth (m)	3558	3565	3914	4290	3566	3566	4110
Total specimens	482	370	298	240	114	123	339
Lob. lobatula			0.00				0.00
Melonis sp. A							0.00
Anom. ammon.							
Lin. semicrib.							
C'doides mund.	0.00				0.02	0.01	
Astr. echolsi				0.00			0.00
Nonion sp. A		0.01	0.01	0.05	0.02	0.01	0.02
Epistom. sp. A	0.03	0.08		0.00	0.02		0.00
Gl'cass. sp. A	0.01	0.03	0.04	0.01	0.01		0.04
Nuttal. brady.	0.03	0.01	0.01		0.01	0.02	0.00
Nuttal. umbon.	0.09	0.05	0.10	0.11	0.17	0.11	0.10
Epist. exigua	0.27	0.22	0.10	0.15	0.03	0.02	0.18
Gl'cass. subg.	0.04	0.03	0.06	0.09	0.01	0.01	0.13
Cib'ides kul.	0.01	0.04	0.02	0.03	0.02	0.04	0.02
Ori. umbonat.	0.05	0.05	0.06	0.06	0.03		0.05
Pul. osloensis	0.01	0.06	0.09	0.07	0.02	0.01	0.05
Pul. subcarin.		0.02	0.02	0.01		0.02	0.04
Alab. weddel.	0.05	0.07	0.12	0.09	0.01	0.05	0.03
Turrilina sp. A							
Uvig. dirupta		0.00	0.00		0.01		0.00
Valvul. sp. B					0.01	0.02	
Agglutinated			0.00				0.00
Ammobac. sp. A		0.01	0.00	0.01			0.00
Am'disc. inc.							
Am'glob. glob.							
Astrorhizac.	0.01			0.00			0.00
Buz. galeata							
Cr'stom. sph.	0.00						
Cyst. pauci.				0.00		0.01	
Disc. compres.							
Glom. gordial.			0.00	0.02			0.00
Haplo. bradyi				0.00			
Haplo. trull.							
Hormo. distans							
Hyper. laev.							
Kar'ulin apic.					0.02		
Lag'am. diff.							0.00
Nod. membran.							0.00
Ps'nod. nodul.				0.00			
Ps'troch. deh.				0.00			
Recurv. cont.	0.00			0.00			
Reo. gracilis							0.00
Rep. charoides	0.00			0.00		0.01	
Sp'amm. bif.							

APPENDIX III (cont.)

Sample No.	23	45	14	39	12	40	26
Depth (m)	3600	4260	4070	4275	4441	4780	4582
Total specimens	279	401	356	274	609	35	224
Trifar. bradyi							
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'des sp. C							
Disc'des sp. D							
Sagrin. lobata							
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.							
Sig. tortuosa					0.00		
Quinque. sp. B			0.00				
Amphi. madagas.							
Cib'ides umbon							
Cib'ides cicat							
Cib'ides plan.							
Cib'ides reful							
S'uvig. inter.							
Gl'cass. rari.	0.01	0.00	0.01	0.00			
Bol. dilatata							
Cassid. carin							
Valv. minuta							
Briz. beyrichi							
Melonis barlee	0.03	0.01	0.01		0.01		0.03
Pyrq'la globu.							
Cassid. teret							
Font. wueller.	0.01	0.00	0.01		0.00		0.01
Gavel'is lobat							
Hoeg. elegans							
Angu. earlandi							
Aster. miocen.							
Bol. compacta							
Bol. robusta							0.00
Briz. oceanica							
Briz. pusilla							
Bul. transluc.			0.01		0.00		0.00
Cassid. laevi				0.01			
Cerat. contrar							
Euuvig. probos							
Gl'cass. minut			0.00				
Gl'cass. oblon	0.02	0.03		0.00			
Gyroid. orbic.	0.01	0.01	0.01	0.00	0.01		0.00
Gyroid. subpl.	0.01	0.02	0.01	0.01	0.03		0.01
Ioan. tumidula		0.01	0.02	0.01	0.05		0.03

APPENDIX III (cont.)

Sample No.	23	45	14	39	12	40	26
Depth (m)	3600	4260	4070	4275	4441	4780	4582
Total specimens	279	401	356	274	609	35	224
Lob. lobatula							
Melonis sp. A			0.01		0.01		
Anom. ammon.							
Lin. semicrib.		0.00	0.00				
C'doides mund.		0.00		0.00			
Astr. echolsi	0.00		0.00				
Nonion sp. A		0.00			0.00		
Epistom. sp. A	0.06		0.09		0.00		
Gl'cass. sp. A		0.00	0.01	0.01	0.01	0.03	
Nuttal. brady.	0.00	0.00	0.01				0.00
Nuttal. umbon.	0.09	0.12	0.17	0.16	0.19	0.66	0.17
Epist. exigua	0.13	0.07	0.07	0.05	0.20		0.20
Gl'cass. subg.	0.04	0.09	0.16	0.27	0.01	0.03	0.01
Cib'ides kul.	0.02	0.02	0.01	0.02	0.02		0.00
Ori. umbonat.	0.08	0.05	0.03	0.06	0.06	0.03	0.04
Pul. osloensis	0.08	0.02	0.03	0.02	0.05		0.02
Pul. subcarin.	0.01	0.05	0.04	0.03	0.03	0.03	0.10
Alab. weddel.	0.19	0.33	0.12	0.02	0.10	0.14	0.20
Turrilina sp. A				0.05			
Uvig. dirupta		0.02					
Valvul. sp. B							
Agglutinated					0.00		
Ammobac. sp. A	0.00		0.00		0.00		
Am'disc. inc.							
Am'glob. glob.			0.00		0.00		
Astrorhizac.				0.01	0.01		
Buz. galeata				0.00			
Cr'stom. sph.							
Cyst. pauci.							
Disc. compres.							
Glom. gordial.				0.00	0.00		
Haplo. bradyi					0.00		
Haplo. trull.				0.01			
Hormo. distans							
Hyper. laev.					0.00		
Kar'ulin apic.							
Lag'am. diff.					0.00		
Nod. membran.							
Ps'nod. nodul.					0.00		
Ps'troch. deh.							
Recurv. cont.		0.00			0.00		
Reo. gracilis				0.00			
Rep. charoides			0.00		0.00		
Sp'amm. bif.							

APPENDIX III (cont.)

Sample No.	62	48	49	2	17	18	60
Depth (m)	4951	4470	4470	4783	4850	4850	5105
Total specimens	247	13	59	169	34	61	3

Trifar. bradyi							
Triloc. austr.							
Gavel'is sp. A							
Cornu. involv.							
Disc'des sp. C							
Disc'des sp. D							
Sagrin. lobata							
Cymbal. bradyi							
Cymbal. squam.							
Briz. abbrev.							
Sig. tortuosa							
Quinque. sp. B							
Amphi. madagas.							
Cib'ides umbon							
Cib'ides cicat							
Cib'ides plan.							
Cib'ides reful							
S'uvig. inter.							
Gl'cass. rari.							
Bol. dilatata							
Cassid. carin							
Valv. minuta							
Briz. beyrichi							
Melonis barlee	0.03			0.01			
Pyrg'la globu.				0.01			
Cassid. teret							
Font. wueller.			0.03				
Gavel'is lobat							
Hoeg. elegans							
Angu. earlandi							
Aster. miocen.							
Bol. compacta							
Bol. robusta							
Briz. oceanica							
Briz. pusilla							
Bul. transluc.							
Cassid. laevi							
Cerat. contrar							
Euuvig. probos							
Gl'cass. minut							
Gl'cass. oblon							
Gyroid. orbic.							
Gyroid. subpl.	0.02						
Ioan. tumidula	0.01						

APPENDIX III (cont.)

Sample No.	62	48	49	2	17	18	60
Depth (m)	4951	4470	4470	4783	4850	4850	5105
Total specimens	247	13	59	169	34	61	3
Lob. lobatula							
Melonis sp. A	0.00						
Anom. ammon.							
Lin. semicrib.							
C'doides mund.							
Astr. echolsi							
Nonion sp. A			0.02				
Epistom. sp. A							
Gl'cass. sp. A							
Nuttal. brady.	0.00						
Nuttal. umbon.	0.26	0.31	0.14	0.05			
Epist. exigua	0.16			0.01			
Gl'cass. subg.	0.04			0.01			
Cib'ides kul.	0.02						
Ori. umbonat.	0.03						
Pul. osloensis	0.02						
Pul. subcarin.	0.03			0.01		0.02	
Alab. weddel.	0.25			0.01			
Turrilina sp. A							
Uvig. dirupta							
Valvul. sp. B							
Agglutinated				0.01			0.33
Ammobac. sp. A		0.08	0.05	0.12	0.09	0.07	
Am'disc. inc.				0.03		0.02	
Am'glob. glob.			0.02	0.01		0.02	
Astrorhizac.	0.00	0.15	0.08	0.21	0.24	0.36	
Buz. galeata						0.02	
Cr'stom. sph.					0.06	0.02	
Cyst. pauci.			0.03			0.02	
Disc. compres.	0.00			0.01	0.03		
Glom. gordial.	0.00	0.15	0.10	0.01			
Haplo. bradyi					0.09		
Haplo. trull.	0.00						
Hormo. distans				0.01		0.10	
Hyper. laev.			0.15	0.02	0.03	0.03	
Kar'ulin apic.				0.06			
Lag'am. diff.			0.02	0.01			
Nod. membran.		0.15	0.19	0.09		0.02	
Ps'nod. nodul.			0.02		0.09	0.05	
Ps'troch. deh.					0.09	0.03	
Recurv. cont.	0.00		0.03	0.10	0.06	0.02	
Reo. gracilis		0.08		0.07	0.06	0.02	
Rep. charoides				0.04	0.15	0.07	0.33
Sp'amm. bif.			0.05	0.01	0.03	0.02	

APPENDIX III (cont.)

Sample No.	61	57	58	65	66	51	52
Depth (m)	5105	5265	5265	5490	5490	8900	8900
Total specimens	6	4	17	14	38	16	20

Trifar. bradyi
 Triloc. austr.
 Gavel'is sp. A
 Cornu. involv.
 Disc'des sp. C
 Disc'des sp. D
 Sagrin. lobata
 Cymbal. bradyi
 Cymbal. squam.
 Briz. abbrev.
 Sig. tortuosa
 Quinque. sp. B
 Amphi. madagas.
 Cib'ides umbon
 Cib'ides cicat
 Cib'ides plan.
 Cib'ides reful
 S'uvig. inter.
 Gl'cass. rari.
 Bol. dilatata
 Cassid. carin
 Valv. minuta
 Briz. beyrichi
 Melonis barlee
 Pyrg'la globu.
 Cassid. teret
 Font. wueller.
 Gavel'is lobat
 Hoeg. elegans
 Angu. earlandi
 Aster. miocen.
 Bol. compacta
 Bol. robusta
 Briz. oceanica
 Briz. pusilla
 Bul. transluc.
 Cassid. laevi
 Cerat. contrar
 Euuvig. probos
 Gl'cass. minut
 Gl'cass. oblon
 Gyroid. orbic.
 Gyroid. subpl.
 Ioan. tumidula

APPENDIX III (cont.)

Sample No.	61	57	58	65	66	51	52
Depth (m)	5105	5265	5265	5490	5490	8900	8900
Total specimens	6	4	17	14	38	16	20
Lob. lobatula							
Melonis sp. A							
Anom. ammon.							
Lin. semicrib.							
C'doides mund.							
Astr. echolsi							
Nonion sp. A							
Epistom. sp. A							
Gl'cass. sp. A							
Nuttal. brady.							
Nuttal. umbon.							
Epist. exigua							
Gl'cass. subg.							
Cib'ides kul.							
Ori. umbonat.							
Pul. osloensis						0.06	
Pul. subcarin.							
Alab. weddel.							
Turrilina sp. A							
Uvig. dirupta							
Valvul. sp. B							
Agglutinated	0.16		0.06	0.14	0.18		0.05
Ammobac. sp. A		0.25	0.06	0.07			
Am'disc. inc.							
Am'glob. glob.			0.06				
Astrorhizac.			0.06		0.08	0.06	0.55
Buz. galeata			0.12		0.03		
Cr'stom. sph.							
Cyst. pauci.							
Disc. compres.					0.11		
Glom. gordial.			0.12				
Haplo. bradyi				0.14			
Haplo. trull.	0.17		0.12		0.03		
Hormo. distans							
Hyper. laev.							
Kar'ulin apic.							
Lag'am. diff.			0.06				
Nod. membran.							
Ps'nod. nodul.	0.17		0.06	0.07	0.18		
Ps'troch. deh.							
Recurv. cont.	0.50	0.25	0.12	0.43	0.32		
Reo. gracilis							
Rep. charoides			0.06	0.07			
Sp'amm. bif.		0.25	0.06		0.05		

APPENDIX III (cont.)

Sample No.	44	46	38	47	24	64
Depth (m)	2968	7740	4321	8900	5000	5426
Total specimens	27	7	4	34	0	0

Trifar. bradyi	
Triloc. austr.	
Gavel'is sp. A	
Cornu. involv.	
Disc'des sp. C	
Disc'des sp. D	
Sagrin. lobata	
Cymbal. bradyi	
Cymbal. squam.	
Briz. abbrev.	
Sig. tortuosa	
Quinque. sp. B	
Amphi. madagas.	
Cib'ides umbon	
Cib'ides cicat	0.04
Cib'ides plan.	
Cib'ides reful	
S'uvig. inter.	
Gl'cass. rari.	0.15
Bol. dilatata	0.12
Cassid. carin	0.06
Valv. minuta	
Briz. beyrichi	
Melonis barlee	0.09
Pyrq'la globu.	
Cassid. teret	
Font. wueller.	0.07
Gavel'is lobat	
Hoeg. elegans	
Angu. earlandi	
Aster. miocen.	
Bol. compacta	
Bol. robusta	
Briz. oceanica	
Briz. pusilla	
Bul. transluc.	
Cassid. laevi	0.03
Cerat. contrar	
Euuvig. probos	
Gl'cass. minut	0.09
Gl'cass. oblon	
Gyroid. orbic.	
Gyroid. subpl.	0.04
Ioan. tumidula	

APPENDIX III (cont.)

Sample No.	44	46	38	47	24	64
Depth (m)	2968	7740	4321	8900	5000	5426
Total specimens	27	7	4	34	0	0
Lob. lobatula						
Melonis sp. A						
Anom. ammon.						
Lin. semicrib.						
C'doides mund.	0.04					
Astr. echolsi						
Nonion sp. A						
Epistom. sp. A						
Gl'cass. sp. A						
Nuttal. brady.						
Nuttal. umbon.						
Epist. exigua	0.04			0.03		
Gl'cass. subg.	0.04			0.03		
Cib'ides kul.	0.04			0.03		
Ori. umbonat.	0.15		0.25			
Pul. osloensis						
Pul. subcarin.				0.03		
Alab. weddel.				0.12		
Turrilina sp. A						
Uvig. dirupta	0.15					
Valvul. sp. B						
Agglutinated	0.04					
Ammobac. sp. A						
Am'disc. inc.						
Am'glob. glob.	0.04					
Astrorhizac.						
Buz. galeata						
Cr'stom. sph.						
Cyst. pauci.						
Disc. compres.						
Glom. gordial.						
Haplo. bradyi						
Haplo. trull.						
Hormo. distans						
Hyper. laev.		0.29				
Kar'ulin apic.						
Lag'am. diff.						
Nod. membran.						
Ps'nod. nodul.						
Ps'troch. deh.						
Recurv. cont.						
Reo. gracilis						
Rep. charoides						
Sp'amm. bif.						

APPENDIX IV

Depth Ranges for all Species Used in the Cluster Analysis

APPENDIX IV

Depth range (m)

APPENDIX IV (cont.)

	Depth range (m)			
	0	3000	6000	9000
Anom. ammonoides				
Anguloger. earlandi				
Brizalina oceanica				
Brizalina pusilla				
Astrononion echolsi				
Karreru. apicularis				
Melonis sp. A				
Epistomin. exigua				
Oridors. umbonatus				
Pullenia osloensis				
C'doides mundulus				
Nonion sp. A				
Glomospira gordialis				
Cystamm. pauciloc.				
Ammobaculites sp. A				
Repman. charoides				
Glob'cassid. oblonga				
Bulimin. translucens				
Valvulineria sp. B				
Cassidul. laevigata				
Nuttall. bradyanus				
Recurv. contortus				
Ammodisc. incertus				
Nuttal. umboniferus				
Nodellum membran.				
Ammogl. glob'formis				
Pseudonod. nodulosa				
Agglutinated				
Haplophrag. bradyi				
Hyperamm. laevigata				
Valvulineria minuta				
Brizalina beyrichi				
Spiroplect. biformis				
Cribrostom. sph'loc.				
Epistominella sp. A				
Globocassid. sp. A				
Lagenamm. difflug.				
Ps'troch. dehiscens				
Haplophr. trullissata				
Buzasina galeata				
Hormosinella distans				
Reophax gracilis				
Turritina? sp. A				
Discamm. compressa				

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Planodiscorbis	291	pusilla, Spiroloculina	72
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Planulina	314	hispidulum	121
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caribaea	315	sp. A	122
gigas	315	sp. B	122
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recens	261	murrhina	83
schuberti	262	sarsi	84
subnodosa	262	yabei	84
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polykamptarion, Homalohedra	138	Pyrgoella	86
Polymorphina	123	globula	86
inflata	123	Pyrulina	124
minima	123	angusta	124
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porrecta, Siphouvigerina	246	quadricarinata, Fissurina	162
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pressa, Lagenosolenia	171	Quadrimorphina	351
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Procerolagena	120	? sp. A	352
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<i>trochamminiforme</i>	46	<i>scitulus</i> , <i>Cribrostomoides</i>	38
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<i>gracilis</i>	33	<i>semilineata</i> , <i>Bolivina</i>	200
<i>sp. cf. rostratus</i>	34	<i>semisculpta</i> , <i>Lagnea</i>	143
<i>scorpiurus</i>	34	<i>sesquistriata</i> , <i>Lagnea</i>	117
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<i>rhomboidalis</i> , <i>Bolivinita</i>	211	<i>Sigmoilina</i>	90
<i>ringens</i> , <i>Buzasina</i>	36	<i>sigmoidea</i>	90
<i>Robertinoides</i>	197	<i>Sigmoilinita</i>	91
<i>bradyi</i>	197	<i>asperula</i>	91
<i>robertsonianus</i> , <i>Cibicides</i>	322	<i>tenuis</i>	91
<i>robusta</i> , <i>Bolivina</i>	199	<i>Sigmoilopsis</i>	92
<i>Rosalina</i>	291	<i>schlumbergeri</i>	92
<i>sp. cf. bahamaensis</i>	291	<i>simplex</i> , <i>Elphidium</i>	375
<i>globularis</i>	292	<i>simplex</i> , <i>Fijiella</i>	252
<i>isabelicana</i>	293	<i>simplex</i> , <i>Fissurina</i>	162
<i>subaraucana</i>	293	<i>Siphonina</i>	305
<i>subvilardeboana</i>	294	<i>tubulosa</i>	305
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substriata, Lagna	118	tuberosa, Bolivina	200
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PLATES I - II

Plate 1

Bolivina dilatata - Siphouvigerina interrupta Assemblage

- Figs. 1,2. **Bolivina dilatata** Reuss; specimen GSC 98386, sample NOVA-H 5G; 1. side view X94; 2. edge view X94.
- Figs. 3,4. **Siphouvigerina interrupta** (Brady); specimen GSC 98387, sample NOVA-H 5G; 3. side view X103; 4. edge view X103.
- Figs. 5,6. **Globocassidulina rarilocula** (Cushman); specimen GSC 98389, sample NOVA-H 5G; 5. side view X294; 6. axial view X294.
- Figs. 7,8. **Trifarina bradyi** Cushman; specimen GSC 98392, sample NOVA-H 5G; 7. side view X123; 8. apertural view X197.
- Figs. 9-11. **Cibicides refulgens** (de Montfort); specimen GSC 98393, sample NOVA-H 5G; 9. ventral view X129; 10. axial view X129; 11. dorsal view X129.

Plate 2

Cymbaloporetta squamosa - Brizalina abbreviata Assemblage

- Figs. 1-3. Cymbaloporetta squamosa (d'Orbigny); specimen GSC 98394, sample NOVA-H 12G; 1. ventral view X129; 2. axial view X129; 3. dorsal view X129.
- Figs. 4,5. Brizalina abbreviata (Heron-Allen and Earland); specimen GSC 98396, sample NOVA-H 12G; 4. side view X82; 5. edge view X82.
- Figs. 6,7. Globocassidulina rarilocula (Cushman); specimen GSC 98390, sample NOVA-H 12G; 6. side view X135; 7. axial view X135.
- Figs. 8-10. Triloculinella australis (Parr); specimen GSC 98397, sample NOVA-H 12G; 8. side view, 4-chambered side, X129; 9. edge view X129; 10. side view, 3-chambered side, X129.
- Figs. 11-13. Quinqueloculina sp. B; specimen GSC 98398, sample NOVA-H 12G; 11. side view, 4-chambered side, X155; 12. edge view X155; 13. side view, 3-chambered side, X155.

Plate 3

Amphistegina madagascariensis - Globocassidulina rarilocula Assemblage

- Figs. 1-3. Amphistegina madagascariensis (Fornasini); specimen GSC 98399, sample PROA 71D; 1. ventral view X165; 2. axial view X165; 3. dorsal view X165.
- Figs. 4,5. Globocassidulina rarilocula (Cushman); specimen GSC 98391, sample PROA 71D; 4. side view X208; 5. axial view X208.
- Figs. 6-8. Cymbaloporella squamosa (d'Orbigny); specimen GSC 98395, sample PROA 71D; 6. ventral view X136; 7. axial view X136; 8. dorsal view X136.
- Figs. 9,10. Sigmavirgulina tortuosa (Brady); specimen GSC 98400, sample PROA 71D; 9. side view X126; 10. edge view X126.
- Figs. 11,12. Bolivina compacta Sidebottom; specimen GSC 98401, sample PROA 71D; 11. side view X118; 12. edge view X118.

Plate 4

Brizalina beyrichi - Melonis barleeanum Assemblage

- Figs. 1,2. Brizalina beyrichi (Reuss); specimen GSC 98402, sample DODO 52G; 1. side view X 103; 2. edge view X103.
- Figs. 3,4. Melonis barleeanum (Williamson); specimen GSC 98403, sample DODO 52G; 3. side view X60; 4. axial view X 60.
- Figs. 5-7. Valvulineria minuta (Schubert); specimen GSC 98404, sample DODO 52G; 5. ventral view X68; 6. axial view X68; 7. dorsal view X68.
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Plate 5

Cassidulina teretis - Fontbotia wuellerstorfi Assemblage

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- Figs. 4,5. Cassidulina teretis Tappan; specimen GSC 98408, sample NOVA-H 2G; 4. side view X233; 5. axial view X233.
- Figs. 6-8. Hoeglundina elegans (d'Orbigny); specimen GSC 98409, sample NOVA-H 1G; 6. ventral view X50; 7. axial view X50; 8. dorsal view X50.
- Figs. 9,10. Astrononion echolsi Kennett; specimen GSC 98410, sample NOVA-H 2G; 9. side view X 129; 10. axial view X129.
- Figs. 11-13. Gyroidinoides orbicularis (d'Orbigny); specimen GSC 98412, sample NOVA-H 2G; 11. ventral view X112; 12. axial view X112; 13. dorsal view X112.

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Nuttallides bradyanus Assemblage

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- Figs. 4-6. Cibicides kullenbergi Parker; specimen GSC 98414, sample ERDC 20G; 4. ventral view X76; 5. axial view X76; 6. dorsal view X76.
- Figs. 7,8. Siphouvigerina interrupta (Brady); specimen GSC 98388, sample ERDC 87BX; 7. side view X76; 8. edge view X76.
- Figs. 9,10. Brizalina pusilla (Schwager); specimen GSC 98415, sample LSDH 58G; 9. side view X77; 10. edge view X77.
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Plate 7

Globocassidulina subglobosa - Epistominella exigua Assemblage

- Figs. 1,2. Globocassidulina subglobosa (Brady); specimen GSC 98416, sample LSDH 77G; 1. side view X137; 2. axial view X137.
- Figs. 3-5. Epistominella exigua (Brady); specimen GSC 98417, sample ERDC 19G; 3. ventral view X140; 4. axial view X140; 5. dorsal view X140.
- Figs. 6-8. Epistominella sp. A; specimen GSC 98418, sample NOVA-H 30QV; 6. ventral view X172; 7. axial view X172; 8. dorsal view X172.
- Figs. 9,10. Globocassidulina minuta (Cushman); specimen GSC 98419, sample LSDH 77G; 9. side view X161; 10. axial view X161.
- Figs. 11,12. Bulimina translucens Parker; specimen GSC 98420, sample NOVA-A 64G; 11. side view, showing aperture, X145; 12. edge view X145.

Plate 8

Oridorsalis umbonatus - Nuttallides umboniferus Assemblage

- Figs. 1-3. Oridorsalis umbonatus (Reuss); specimen GSC 98421, "~~tenor~~" morphotype, sample NOVA-A 31P; 1. ventral view X111; 2. axial view X111; 3. dorsal view X111.
- Figs. 4-6. Oridorsalis umbonatus (Reuss); specimen GSC 98422, "umbonatus" morphotype, sample NOVA-A 31P; 4. ventral view X97; 5. axial view X97; 6. dorsal view X97.
- Figs. 7-9. Nuttallides umboniferus (Cushman); specimen GSC 98423, sample PROA 83PG; 7. ventral view X85; 8. axial view X85; 9. dorsal view X85.
- Figs. 10,11. Pullenia osloensis Feyling-Hanssen; specimen GSC 98426, sample NOVA-A 31P; 10. side view X158; 11. axial view X158.
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Plate 9

Nuttallides umboniferus Assemblage

- Figs. 1-3. Nuttallides umboniferus (Cushman); specimen GSC 98424, sample LSDH 64G; 1. ventral view X83; 2. axial view X83; 3. dorsal view X83.
- Figs. 4-6. Alabaminella weddellensis (Earland); specimen GSC 98428, sample NOVA-A 32G; 4. ventral view X261; 5. axial view X261; 6. dorsal view X261.
- Figs. 7,8. Pullenia subcarinata (d'Orbigny); specimen GSC 98429, "subcarinata" morphotype, sample LSDH 64G; 7. side view X128; 8. axial view X128.
- Figs. 9,10. Pullenia subcarinata (d'Orbigny); specimen GSC 98430, "quinqueloba" morphotype, sample NOVA-H 57G; 9. side view X157; 10. axial view X157.
- Figs. 11-13. Ioanella tumidula (Brady); specimen GSC 98431, sample NOVA-A 32G; 11. ventral view X197; 12. axial view X197; 13. dorsal view X197.

Plate 10

Mixed Calcareous/Agglutinated Abyssal Assemblage

- Figs. 1-3. Nuttallides umboniferus (Cushman); specimen GSC 98425, heavily etched, sample DODO 48D; 1. ventral view X133; 2. axial view X133; 3. dorsal view X133.
- Figs. 4,5. Pullenia bulloides (d'Orbigny); specimen GSC 98432, with evident corrosion, sample DODO 48D; 4. side view X150; 5. axial view X150.
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- Fig. 8. Nodellum membranaceum (Brady); specimen GSC 98434, sample PROA 40G; 8. side view X66.
- Fig. 9. Astrorhizacean; specimen GSC 98435, coarse-grained test, sample DODO 48D; 9. side view X34.
- Fig. 10. Astrorhizacean; specimen GSC 98436, spicular fine-grained test, sample DODO 48D; 10. side view X36.
- Figs. 11-13. Ammobaculites sp. A; specimen GSC 98437, sample DODO 48D; 11. side view X131; 12. edge view X131; 13. apertural view X224.

Plate 11

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- Figs. 1,2. Pseudotrochammina dehiscens (Frerichs); specimen GSC 98438, sample LSDH 69G; 1. umbilico-lateral view X128; 2. spiral view X128.
- Fig. 3. Reomanina charoides (Jones and Parker); specimen GSC 98439, sample LSDH 69G; 3. side view X305.
- Figs. 4,5. Cribrostomoides subglobosus (Sars); specimen GSC 98440, sample PROA 63PG; 4. side view X113; 5. axial view X113.
- Fig. 6. Pseudonodosinella nodulosa (Brady); specimen GSC 98441, sample PROA 107PG; 6. side view X29.6.
- Figs. 7,8. Haplophragmoides bradyi (Robertson); specimen GSC 98442, sample LSDH 69G; 7. side view X140; 8. axial view X140.
- Figs. 9,10. Haplophragmoides trullissata (Brady); specimen GSC 98443, sample PROA 63PG; 9. side view X67; 10. axial view X67.
- Figs. 11,12. Buzasina galeata (Brady); specimen GSC 98444, sample PROA 63PG; 11. side view X124; 12. axial/apertural view X124.

LEGEND

ISOBATHS, in m

ASSEMBLAGE NUMBERS AND SYMBOLS

1 ○	5 ●	9 ◇
2 X	6 △	10 +
3 ●	7 ▲	11 ■
4 ○	8 ◆	12 □

Adapted from Scripps Institution of Oceanography
"Bathymetry of the South Pacific", Charts 11 and 12 of 21.

BENTHIC FORAMINIFERAL TROPICAL SOUTHWEST

ENTHIC FORAMINIFERAL ASSEMBLAGES, TROPICAL SOUTHWEST PACIFIC OCEAN

FRED CLARK

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