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UPPER CRETACEOUS FORAMINIFERA

AND BIOSTRATIGRAPHY

OF C-Y CREEK,

WESTERN AUSTRALIA

By

FREDERICK EUGENE CLARK, B.Sc. (Hons.)

A thesis submitted to the Faculty of
Graduate Studies in partial fulfilment
of the requirements for the degree of
Master of Science

Carleton University

Ottawa, Ontario

October, 1979

The undersigned hereby recommend to the Faculty of Graduate Studies acceptance of this thesis, submitted by Frederick Eugene Clark, B.Sc. (Hons.), in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

A suite of thirty-six samples from the Upper Cretaceous of C-Y Creek in Western Australia is examined. Three formations, the Gearle Siltstone, Toolonga Calcilutite, and Korojon Calcareenite, are represented in the suite of samples. The foraminifera contained therein are identified and the systematic paleontology is presented.

Differences in the lithologies and the foraminiferal faunas between the calcilutite and the calcarenite are thought to establish the presence of the Toolonga Calcilutite as a formation distinct from the Korojon Calcareenite at C-Y Creek. Foraminiferal criteria for the distinction of the one formation from the other are determined, as well as a foraminiferal criterion that distinguishes the Gearle from both the Toolonga and the Korojon. In addition, the changes in the foraminiferal faunas that occur in the Upper Cretaceous succession are noted, and intervals characterized by certain species compositions are observed.

Several species, most of them planktonic, are used to correlate the formations with the standard European stages. The upper Gearle Siltstone is of possible Turonian age, the Toolonga Calcilutite ranges in age from Santonian to Campanian, and the Korojon Calcareenite is of Campanian to Early Maastrichtian age.

The Gearle Siltstone is interpreted as a shallow, lagoonal sediment, the final unit deposited by a regressing sea. The Toolonga Calcilutite is herein interpreted as a basal, shallow water unit, deposited as calcareous muds at the beginning of a transgressive regime. This interpretation is not in accord with that of previous authors. The Korojon Calcareenite is considered to be the record of shell banks dominated by the giant pelecypod Inoceramus, these shell banks having been founded on the sediments of the Toolonga Calcilutite.

The planktonic foraminifera place the foraminiferal faunas of the present study in the Transitional biogeoprovince of Sliter (1976).

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CHAPTER 1. INTRODUCTION.

1.1. PURPOSE OF THE STUDY.

There are quite considerable gaps in the literature concerning the foraminifera of the Upper Cretaceous system of the Carnarvon Basin of Western Australia, and also some points of controversy concerning the stratigraphy of that system. These points will be elaborated on in subsequent sections of this thesis.

There were a number of objectives to the present study. The present author hoped to accomplish (1) the identification and systematic description of the species comprising the foraminiferal fauna in a section embracing as much of the Upper Cretaceous system of the Carnarvon Basin as possible, and to document the changes that occur in that fauna through the section; (2) the construction of a stratigraphic column from a series of partial or abbreviated sections plus isolated samples i.e. a detailed local correlation; (3) the correlation of the section from the Carnarvon Basin with the standard European stages; (4) the establishment of foraminiferal criteria for the recognition of the stratigraphic units and intervals therein; (5) the identification of the environments of deposition of the units; and (6) the examination of hypotheses concerning the paleogeography of Australia during Late Cretaceous time, in the light of the foraminiferal faunas.

The section at C-Y Creek was chosen because it was believed to embrace the Turonian to Maastrichtian interval of the Upper Cretaceous system, and because it is the type locality of the Gearle Siltstone and Korojon Calcarenite (various authors. See section 2.2., Cretaceous Stratigraphy of the Carnarvon Basin.).

1.2. PREVIOUS FORAMINIFERAL STUDIES.

There have been quite a few studies that have dealt with Upper Cretaceous foraminifera from the Carnarvon Basin of Western Australia,

but most were quite limited in scope, or else had boundaries which resulted in only limited overlap with the present study.

Edgell (1954) reported on the occurrence and stratigraphical value of the genus Bolivinoidea from the Upper Cretaceous sediments of the Carnarvon Basin. Five species and subspecies were identified; described and distinguished, including the new subspecies B. decorata australis. Edgell discussed the phylogeny of the five forms, considering such morphologic details as outline and shape of test, cross section of test, and ornamentation. These forms were then related to the standard European stages, and their usefulness for precise local and intra-basinal correlation was noted.

A study by Edgell (1957) dealt in some detail with the occurrence of the genus Globotruncana and the species Rugoglobigerina rugosa (Plummer), which Edgell noted occurred "commonly with various Globotruncana species and has a morphological alliance with the Globotruncana group" (Edgell, 1957, p.101). Fourteen species and subspecies of Globotruncana were identified, described, and carefully distinguished, as was R. rugosa. The stratigraphic or vertical distribution of these forms was noted, and they were correlated with the standard European stages. Reference was also made to correlation based on other foraminifera, mostly benthonic, although Edgell considered that Globotruncana was a benthonic genus. Edgell made brief comments on the paleoecological significance of samples bearing the genus Globotruncana.

A brief paper was published by Belford (1958) that dealt with the genera Nuttallides Finlay and Nuttallina n. gen..

Belford (1959) produced a paper dealing with the stratigraphy and micropaleontology, particularly foraminifera, of the Upper Cretaceous of Western Australia, specifically the Carnarvon Basin. The foraminifera

are recorded only in incomplete lists which identify species thought by Belford to be important in characterizing the various formations and stratigraphic intervals. In some respects, then, that study and the present one are parallel in intent, that is, to characterize the stratigraphic units by their foraminiferal faunas and sequence thereof.

One of the most important works on Upper Cretaceous foraminifera of the Carnarvon Basin was Belford's (1960) paper on the foraminifera of the Toolonga Calcilutite of the Carnarvon Basin, and the Gingin Chalk of the Perth Basin. All species found by the author were identified, and the systematic paleontology consisted of full synonymies, descriptions when the species was not known from the literature and occasional remarks, and the local stratigraphic occurrence of each species was given. In all, 139 species and subspecies were so reported.

Belford (1961) reported and described the foraminifer Spirotecta pellicula, n.gen., n.sp., from the Carnarvon Basin.

Edgell's (1962) paper on the species Globotruncana concavata (Brotzen) dealt at some length with the distinction between that species and G. ventricosa White. The stratigraphic and geographic distribution of G. concavata in the Carnarvon Basin and worldwide was discussed, as well as the associated microfauna from Western Australia.

McGowran (1962), in an unpublished Ph.D. thesis, studied Maastrichtian and Paleocene foraminifera of Australia. The Maastrichtian was represented by the uppermost Korojon Calcarenite and the Miria Marl, and the species found therein were identified, systematically described, and differentiated. The biostratigraphy of these two formations was discussed only briefly, because McGowran felt that his study merely confirmed the conclusions reached by previous workers, although as will be demonstrated, not all workers are in

agreement as to the biostratigraphy of the Upper Cretaceous rocks of the Carnarvon Basin.

Finally, Wright and Apthorpe (1976) published a paper that dealt with 25 species of Maastrichtian planktonic foraminifera recovered from wells drilled in the Northwest Shelf. No systematic paleontology was given, and most species were illustrated either inadequately or not at all. The main thrust of the paper was a detailed zonal scheme for the Maastrichtian of the Carnarvon Basin and that scheme's relationship to Maastrichtian zonal schemes of other authors.

It is apparent, therefore, that there is a need for a study of the whole foraminiferal fauna of the entire Korojon Calcarenite, and for the detailed study of its relationship to and differentiation from that of the Toolonga Calcilutite. Although Belford (1960) dealt with the whole foraminiferal fauna of the Toolonga Calcilutite, its relationship to that of the Korojon Calcarenite was not discussed, as the Korojon Calcarenite does not occur in Belford's study area, the Murchison River and Shark Bay region.

1.3. PRESENT STUDY.

1.3.1. LOCATION AND DETAILS OF SAMPLING.

As part of an expedition in the summer of 1976 to collect samples from foraminifera-bearing units of Australia, Dr. K. Hooper, assisted by Mr. P. Jones and Mr. L. Spence, collected a suite of samples from C-Y Creek in Western Australia. C-Y Creek is located on the west limb of the Giralia Anticline, Lat. 22°53'S, Long. 114°07'E, and is normally dry, as it was at the time of sampling (Hooper, pers. comm.). The location of C-Y Creek is shown on Fig.1, and the position of the axis of the Giralia Anticline is shown on Fig.3.

The section at C-Y Creek is such that there is no continuous exposure at any one point of any of the three major formations involved,

the Gearle Siltstone, Toolonga Calcilutite (if indeed this formation is present at C-Y Creek), and Korojon Calcarenite. These units are, however, well exposed in gently westward dipping beds (Hooper, pers. comm.).

The workers began collecting at the northwestern end of C-Y Creek and came down through the Tertiary into the Upper Cretaceous units, finishing the collection towards the southeastern or source end of C-Y Creek. Where possible, partial sections were sampled, and measured, or if single samples were collected from one place, their vertical distance from nearby samples was recorded if known. Forty samples were considered in the course of the present study, numbered 76865 to 76904 inclusive, and their locations are shown on Fig.2. Where more than one sample number is given for a particular location, this normally indicates that a partial section was sampled and measured. Relatively large circles are used to indicate some uncertainty in the precise location of samples, as the sample locations were plotted, in the field, on a map that does not correspond in detail to the configuration of C-Y Creek as seen in airphotos, from which the present map was drawn. The feature referred to as "lithologic boundary" is a sharp ledge, clearly visible in airphotos, produced by a resistant bed. It is included for reference.

Sample lithologies, and the vertical relationships between samples where known, are detailed in Appendix I.

1.3.2. METHOD OF STUDY.

All forty samples were processed following the procedure outlined in Appendix II. Of the four mesh fractions obtained, the >230 mesh fraction was not examined further. For the remaining three mesh fractions, >35, >60, and >120, where present, the following method of examination was used.

The entire mesh fraction was scattered on a picking tray and examined briefly. A dry sediment microsplitter was then used, dividing the fraction by a factor of two each time, in a manner which avoids the introduction of operator and/or size bias. This process was repeated until the split so obtained contained, where possible, 300 or more foraminifera, but less than 700. The foraminifera were then picked and mounted on a single 60- square slide, one slide for each mesh fraction for each sample.

The number 300 was chosen, as it is thought to produce results that are statistically significant, and in terms of the labour required to pick and identify specimens, it is quite manageable. Beyond a number of specimens on the order of 300, the number of additional species detected in the split increases very slowly with respect to the increase in the number of specimens in the split (Tschudy, 1969). Tschudy (1969) felt that 200 specimens were sufficient, this for palynological studies, Sen Gupta (1971) would split a number greater than 600 to produce some number of specimens over 300, and Imbrie, van Donk, and Kipp (1973) said that a split containing 330 specimens was an ideal working sample.

As one of the aims of this study was to correlate samples based on the characteristics of the foraminiferal fauna, it was deemed desirable to obtain a representative and statistically significant association for each sample. However, this procedure fails to detect many of the species, especially those of low numerical abundance. For this reason, all remaining material (i.e. other than the split) was scanned to detect species not present in the so-called representative association, and these specimens were also picked, and mounted on the same slide as the split, but in such a way as to be kept separate from the representative association.

Samples 76865 to 76867 inclusive were identified in the field as "Miria Marl?". The present author decided to examine these samples to determine whether or not they belonged in the present study. They were processed in the usual fashion (see Appendix II), and the foraminifera were examined. Specimens belonging to Globorotalia sp. and Globigerina triloculinoides Plummer were identified in all three samples, which were thus clearly Paleocene in age (Postuma, 1971). These samples were consequently eliminated from this study, and are not considered further herein.

Sample 76869 consisted of unconsolidated material produced by weathering, and was on a surface littered with an ammonite and pelecypod macrofauna (Hooper, pers. comm.). This is characteristic of the Miria Marl (Condon et al. 1956). Examination of the processed sediment, which could not be scraped to remove contamination due to the inability to collect a large enough solid sample, revealed both abundant specimens of the Upper Cretaceous genus Globotruncana, as well as representatives of Globorotalia and Globigerina triloculinoides. The sample was apparently contaminated, and it was eliminated from this study, as no reliable results could be obtained from it.

The remaining 36 samples, 76868, and 76870 to 76904 inclusive, were examined in the manner outlined as follows, and as outlined in the introduction to the foraminiferal biostratigraphy.

All specimens were identified, using published literature on Upper Cretaceous foraminifera, as well as the volumes of the Treatise dealing with foraminifera by Loeblich and Tappan (1964), and the Catalogue of Foraminifera compiled by Ellis and Messina (1940 et seq.). All aspects of the morphology were considered, except for details of wall structure beyond the three basic categories agglutinated or arenaceous,

calcareous imperforate or porcellaneous, and calcareous perforate. It is the present author's opinion that studies of the various types of calcareous perforate wall structures requires an effort far in excess of the value of information to be derived therefrom.

The procedures followed to generate and compile the data used for the statistical work will be discussed in the introduction to Chapter 4, as will the statistical procedures themselves.

Fig. 3. Occurrence of Carnarvon Basin, Perth Basin, and location of axis of Giralda Anticline (after Condon *et al* 1956; Edgell, 1957; Belford, 1959).

CHAPTER 2. GEOLOGICAL SETTING OF THE STUDY.

2.1. INTRODUCTION: THE CARNARVON BASIN.

The Carnarvon Basin is a significant ancient depositional basin in Western Australia that occupies approximately one-half of the west coast of Australia (see Fig.3). On land it extends from a point just north of Onslow southward beyond the Murchison River to near Geraldton, and it is known up to 210 Km eastward from the present coast (Belford, 1959; Condon, 1968). Its extent offshore has not been traced. It is contiguous to the Perth Basin in the south, and is differentiated only with difficulty from that basin by a number of basement ridges, detailed by McWhae et al. (1958), and Condon (1968).

The Carnarvon Basin is divided into a number of minor basins by basement ridges that are structurally elevated at present and were likely so since the basin first became an area of active sedimentation on a Precambrian basement. The reader is referred to Condon et al. (1956), Konecki et al. (1958), McWhae et al. (1958), and Condon (1968) for details of these minor basins and ridges. They are not considered to be of significance in the present study.

Sediments were deposited in this epicontinental basin in each of the Proterozoic, Paleozoic, Mesozoic and Cenozoic eras (Konecki et al. 1958; McWhae et al. 1958, exclusive of Proterozoic; and Condon, 1968). No attempt is made herein to describe the pre-Cretaceous rocks of the Carnarvon Basin.

Sediments were laid down over small areas of the basin during Triassic and Jurassic times, with some continuous deposition through to the earliest Neocomian in the Exmouth and Onslow Basins as the Wogatti Sandstone (McWhae et al. 1958; Condon, 1968), a unit that will not be discussed further herein. A widespread transgression occurred with deposition of the first of two major Cretaceous rock successions.

This first succession is the Winning Group and is the lower Cretaceous succession of the Carnarvon Basin, although some of its units, notably the Gearle Siltstone and Alinga Formation, were likely deposited during Late Cretaceous time. The sediments of the Winning Group either rest "disconformably on Neocomian sediments or unconformably on Jurassic, Permian, Devonian, Lower Paleozoic, and Precambrian rocks" (Condon, 1968, p.13). This group of predominantly terrigenous clastics has a basal blanket sand followed by fine-grained terrigenous clastics and organic-siliceous rocks (Condon et al. 1956; Condon, 1968).

A period of shallowing, uplift, and erosion preceded the Late Cretaceous transgression, during which time the upper Cretaceous succession was deposited. These sediments are separated from the Winning Group by the first of two major disconformities in the Cretaceous succession of the Carnarvon Basin (Condon et al. 1956; McWhae et al. 1958; Condon, 1968), which in places is an unconformity proper (McWhae et al. 1958).

This upper Cretaceous succession of calcareous and bioclastic sediments has often been included in the term, "Cardabia Group", which also included the similar Tertiary calcareous sediments (Condon et al. 1956; McWhae et al. 1958). However, McWhae et al. (1958) pointed out that the "Cardabia Group is a rather unsatisfactory unit, as it extends from the Upper Cretaceous through two mild disconformities into the Paleocene and perhaps Eocene" (ibid., p.110). Rather than follow the practice of McWhae et al. of designating the Paleocene formations as the Upper Cardabia Group, Condon (1968) chose to restrict the term "Cardabia Group" to the upper part of the succession i.e. those units deposited after the time represented by the disconformity which lies above the

Miria Marl. The Miria Marl is bounded both above and below by disconformities.

The formations of the Winning Group and the upper Cretaceous succession of the Carnarvon Basin will now be described in greater detail, with particular emphasis on the upper Cretaceous succession. This discussion is organized on the basis of formations, not regions, and for the Winning Group the formations are considered in the order followed by Condon (1968). For the upper Cretaceous succession, however, the order has been modified to be consistent with the interpretation of the stratigraphic succession given by the present author and others.

2.2. CRETACEOUS STRATIGRAPHY OF THE CARNARVON BASIN.

2.2.1. THE LOWER CRETACEOUS SUCCESSION: THE WINNING GROUP.

i) Birdrong Formation.

The Birdrong Formation is 29.6 m (97 feet) thick at the type section which is 0.8 Km (one-half mile) southwest of Birdrong Spring, Lat. 24°15'S, Long. 114°50'E. (McWhae et al. 1958; Condon, 1968). It is known from Barrow Island and the Cape Range in the north to Murchison River in the south (Condon, 1968). At the type locality it unconformably overlies the Permian Coolkilya Greywacke, but in other areas may rest disconformably on the Neocomian Wogatti Sandstone, or unconformably on Jurassic, Carboniferous, Devonian, Lower Paleozoic, and Precambrian rocks (McWhae et al. 1958; Condon, 1968). At the type locality it is overlain gradationally and conformably by the Muderong Shale, but it may grade laterally into the Muderong and be conformably overlain by the Windalia Radiolarite (Condon, 1968). The Birdrong Formation is predominantly composed of friable medium- to coarse-grained sandstones, tending toward finer grain size up section. It has been interpreted as a transgressive marine sand upon a mature land surface (ibid). This formation is dated as Late Neocomian to Early Aptian on

the basis of microplankton, microflora, and pelecypods (McWhae et al. 1958; Condon, 1968). It is not reported by Condon et al. (1956).

ii) Muderong Shale.

The Muderong Shale is 12.2 m (40 feet) thick at its type locality near the Muderong Bore, Lat. 24°08'03"S, Long. 114°45'49"E, where it lies gradationally and conformably between the Birdrong Formation below and the Windalia Radiolarite above (McWhae et al. 1958; Condon, 1968). It may also grade laterally into the Birdrong Formation to the south (Condon, 1968). The Muderong Shale is known only north of the Gascoyne River (ibid.), and consists of shale, claystone which is often bentonitic, and siltstone as well as greensand interbeds (McWhae et al. 1958; Condon, 1968). It has been interpreted as an open marine unit deposited at moderate depth and derived from a mature hinterland with a reduced rate of sediment supply (Condon, 1968). Its age is reported as Aptian, based on foraminifera and microplankton (McWhae et al. 1958).

iii) Windalia Radiolarite (and Thirindine Formation).

The Windalia Radiolarite is not completely exposed at its type locality of Windalia Hill, Lat. 23°16'S, Long. 114°48'E, where the lower 30.5 m (100 feet) are intact but the remainder is weathered or removed by erosion. It is a formation consisting of vari-coloured radiolarite and radiolarian claystone, with minor thin beds of chert, limestone, and greensand (Condon et al. 1956; McWhae et al. 1958; Condon, 1968).

A unit composed of radiolarite, as well as radiolarian claystone and shale, is known from the lower Murchison River area (Konecki et al. 1958; McWhae et al. 1958), and has been designated the Thirindine Formation. It is 23.5 m (77 feet) thick at its type locality of Toolonga Point, Lat. 27°34'S, Long. 114°15'E (McWhae et al. 1958). Condon (1968) placed this formation in synonymy with the Windalia Radiolarite, a

practice followed in this paper, and one which seems well in agreement with McWhae et al. who correlated the two formations.

The Windalia Radiolarite conformably overlies the Muderong Shale where developed, or the Birdrong Formation south of the Gascoyne River, and is conformably overlain by the Gearle Siltstone, or the Alinga Formation to the south (Condon et al. 1956; McWhae et al. 1958; Condon, 1968). Konecki et al. (1958) mentioned that the Thirindine Formation in the area of the Murchison River was underlain by a claystone that may be correlatable with the Muderong Shale. This was likely the Birdrong Formation.

The Windalia Radiolarite has been interpreted as having been deposited in water of moderate depth with very little terrigenous influx from a low, mature land surface. The water had high silica and nutrient supply and diminishing water depth towards the close of deposition as the sea began to retreat (Condon et al. 1956; McWhae et al. 1958; Condon, 1968). Its age was reported as Aptian to Early Albian by McWhae et al. (1958), largely based on foraminifera, and Condon (1968), based on the similarity to other dated radiolarian-bearing sediments from other Australian basins. Condon et al. (1956) gave the age as Albian, possibly Late Albian, to Late Cenomanian, based on ammonites identified by Brunschweiler. Belford (1959) revised the identifications of Brunschweiler, and concluded that the ammonites indicated a Late Aptian to Early Albian age for the Windalia Radiolarite. This is in accord with the generally accepted age determination for the overlying Gearle Siltstone.

iv) Gearle Siltstone.

The Gearle Siltstone is exposed only in its uppermost part at the type locality of C-Y Creek, Lat. 22°54'S, Long 114°09'E. The thickness

of 163.1 m (535 feet) reported for the type section by McWhae et al. (1958) is in fact that of a reference section measured at Remarkable Hill and reported by Condon et al. (1956). The reference section reported by Condon (1968) from Remarkable Hill has 144.8 m (475 feet) of Gearle Siltstone. This formation is characterized by soft, dark grey and brown thinly laminated gypseous siltstones, claystones, and shales, often bentonitic, with some thin beds bearing radiolarians and some with barite nodules, particularly in the upper parts of the formation (Condon et al. 1956; McWhae et al. 1958; Condon, 1968). The Gearle Siltstone is presumed conformably to overlies the Windalia Radiolarite, and grades laterally into the Alinga Formation towards the Murchison River (ibid.). All authors agree that following the time of deposition of the Gearle, there was widespread regression followed by a transgression sometime later in the Late Cretaceous, during which time the upper Cretaceous succession of the Carnarvon Basin was deposited (Condon et al. 1956; McWhae et al. 1958; Belford, 1959; Condon, 1968).

The exact nature of the contact between the Gearle Siltstone and the base of the upper Cretaceous succession, and the identity of the formation that overlies the Gearle, are matters of controversy, however. It is important to remember that the Gearle Siltstone is replaced by the Alinga Formation towards the Murchison River.

The earliest published report consulted by the present author, that of Condon et al. (1956), stated that the Gearle Siltstone is disconformably overlain by the Korojon Calcarenite, a statement supported by Belford (1959) and in part only by McWhae et al. (1958), who stated that the Gearle Siltstone "is overlain disconformably or unconformably by the Toolonga Calcilutite or the Korojon Calcarenite" (ibid., p.112). Unfortunately, the authors did not detail the distribution of these relationships, and failed to mention what unit overlies the Gearle

Siltstone at C-Y Creek, the locality of the present study. Those authors recognized the Alinga Formation as a unit distinct from the Gearle, overlain by the Toolonga Calcilutite. Hence the Gearle Siltstone proper was thought to be overlain in places by the Toolonga Calcilutite. Condon (1968) wrote that the Gearle Siltstone "is overlain with erosional unconformity by the Korojon Calcarenite... usually a member of soft calcilutite" (*ibid.*, p.27). The base of the Korojon sensu Condon (1968) is marked by a phosphatic lag gravel that readily marks the boundary between the two formations. The nature of the Gearle at the base of this lag gravel of course depends on the depth of erosion produced before the Late Cretaceous transgression (Condon, 1968).

Further discussion of the overlying unit will be given in the section on the upper Cretaceous succession of the Carnarvon Basin.

The supposed environment of deposition of the Gearle Siltstone is consistent with the overall picture of a sea of only moderate depth that retreated during the deposition of the Gearle. Condon (1968) described it as "a neritic marine environment with reduced supply of fine-grained terrigenous sediment" (*ibid.*, p.29), but sufficient nutrients to support quite abundant micro-organisms.

In the northern area of the Carnarvon Basin, the Cape and Rough Ranges, Belford (1959) postulated that conditions were at first unfavourable to benthonic foraminifera, and so assemblages were dominated by planktonic foraminifera. Later, the environment changed to a fairly deep, open sea, with resultant more varied fauna. This, however, clearly contradicts Belford's previous conclusion that because "the Upper Cretaceous planktonic foraminifera occurring in the upper beds in subsurface section have never been recorded from outcrop [, it] suggests that the outcrop represents the lower part of the section" (Belford, 1959, p.635).

The age of the Gearle Siltstone has been determined primarily on the basis of its foraminiferal fauna. Condon et al. (1956) reported that deposition of the Gearle terminated in the Turonian, based on foraminiferal evidence. McWhae et al. (1958) gave the age as Albian to Turonian, based on pelecypods, the belemnite Dimilobelus, and the foraminifera. Belford (1959) was more specific, as he identified foraminiferal faunas from above the base of the Gearle that are undoubtedly of Albian age, and he also found Early Turonian age faunas from the upper Gearle. The Albian to Early Turonian age reported by Belford was supported by Condon (1968). Widespread regression with erosion occurred across the whole of the Carnarvon Basin toward the close of the Turonian, and was followed by a transgression, probably in the Santonian. This led to the deposition of the predominantly calcareous upper Cretaceous succession of the Carnarvon Basin, which succession is entirely Late Cretaceous in age.

v) Alinga Formation.

The Alinga Formation is correlative with the Gearle Siltstone (McWhae et al. 1958; Belford, 1959; Condon, 1968), and according to Condon (1968) "almost certainly grades laterally into the Gearle Siltstone" (ibid., p.30). The type section of the Alinga Formation is at Alinga Point, Lat. 27°37'S, Long. 114°00'07.5"E (McWhae et al. 1958), where it is 15.2 m (50 feet) thick. It consists of glauconitic and occasionally carbonaceous siltstone, with fine-grained sandstone, and greensand, and it conformably overlies the Windalia Radiolarite or Thirindine Formation. It is in turn disconformably overlain by the Toolonga Calcilutite (McWhae et al. 1958; Condon, 1968).

Belford (1959) considered the foraminiferal fauna, which is predominantly arenaceous, and the glauconite content, and concluded that the Alinga Formation was deposited in a rather shallow, near-shore

reducing environment with very slow deposition of fine-grained terrigenous material derived from a low, mature hinterland. Condon (1968) suggested that the Alinga Formation was deposited in a shallower part of the basin than the Gearle Siltstone, which would account for the glauconite, with clay and silt winnowed out and deposited in the Gearle, to account for the relative thinness of the Alinga Formation.

2.2.2. THE UPPER CRETACEOUS SUCCESSION.

i) Toolonga Calcilutite.

The type section of the Toolonga Calcilutite is on Murchison House Station, in the Murchison River Valley, Lat. $27^{\circ}35'30''$ S, Long. $114^{\circ}10'30''$ E, where it is 25.9 m (85 feet) thick (McWhae et al. 1958; Condon, 1968). The Toolonga consists primarily of soft pale grey and green calcilutite, with some chalk and minor thicknesses of calcarenite plus occasional hard beds of calcilutite (Konecki et al. 1958; McWhae et al. 1958; Condon, 1968).

The Toolonga Calcilutite and Korojon Calcarenite constitute the greatest controversy in the Cretaceous stratigraphy of the Carnarvon Basin. Most authors agree that in the area of the Murchison River, the Toolonga Calcilutite rests disconformably on the Alinga Formation (ibid.), and is overlain unconformably by Tertiary limestones (McWhae et al. 1958; Condon, 1968) which are named by McWhae et al. The Toolonga Calcilutite grades laterally into the Korojon Calcarenite, such that "the lateral boundary between the Korojon and the Toolonga must be arbitrary and might be placed where the overall grainsize changes from fine to medium" (Condon, 1968, p.31). McWhae et al. (1958) stated that the uppermost beds of the Toolonga are laterally equivalent to the Korojon.

North of the Wooramel River, where the Korojon Calcarenite is known (Condon, 1968), difficulties arise. Condon et al. (1956) did not

recognize the occurrence of the Toolonga Calcilutite in the Giralia or Marrilla Anticlines, nor did Edgell (1957) or Belford (1959). Condon (1968) maintained that the Korojon Calcarenite rested unconformably on the Gearle Siltstone, i.e. there was no Toolonga under the Korojon, and that the Toolonga and Korojon were laterally gradational, yet said, on p.33 (ibid.), that "in C-Y Creek the type section of the Korojon rests on 100 feet [30.5 m] of Toolonga - not directly on the Gearle Siltstone as reported by Condon et al. (1956)."

The present author agrees that the Toolonga Calcilutite is present at C-Y Creek and probably elsewhere north of the Gascoyne River, but does not agree with the thickness of Toolonga suggested by Condon. Reference to the type section of the Korojon Calcarenite described by Condon et al. (1956) shows that of the 38.4 m (126 feet), all but the lowermost 5.2 m (17 feet), which consists of alternating calcarenite and marl, is calcarenite, some marly, and nodule beds. One would expect, therefore, that the maximum development of the Toolonga Calcilutite at C-Y Creek would be on the order of 5.2 m. It is the present author's opinion that the soft calcilutite member of the Korojon Calcarenite that commonly overlies the Gearle Siltstone (Condon, 1968) is in fact the Toolonga Calcilutite. If this is the case, it would suggest that the Toolonga Calcilutite is overlain conformably by the Korojon Calcarenite. McWhae et al. (1958) noted that the Toolonga Calcilutite "is thin or absent on Giralia Anticline" (ibid., p.113) and that it may conformably underlie the Korojon Calcarenite. It is also the opinion of Hooper (pers. comm.) that the Toolonga Calcilutite is developed to a thickness of 3.7 to 6.4 m (12 to 21 feet) at C-Y Creek on the Giralia Anticline, and that it underlies the Korojon Calcarenite. It is the present author's opinion that the Toolonga Calcilutite conformably underlies

the Korojon Calcarenite at C-Y Creek and that the two can be reliably distinguished. This distinction will be discussed later in more detail.

The present author is aware of one problem caused by referring to the calcilutite at C-Y Creek as the "Toolonga Calcilutite." The type section of the Korojon Calcarenite includes the 5.2 m (17 feet) of calcilutite. It may perhaps be more sound to refer to this as the calcilutite member of the Korojon Calcarenite, and to make it a lateral equivalent of the Toolonga Calcilutite. It is, however, accepted practice among most authors, already referred to, to name this basal calcilutite the Toolonga. It is the present author's opinion that using the term "Toolonga Calcilutite" will not create confusion, as the problem has been fully explained herein. It may be that the type section of the Korojon needs to be emended.

The Toolonga Calcilutite is thought to represent deposition in the deeper portion of a shallow epicontinental sea, opening to the west, in the infraneritic portion with a rich pelagic fauna, and some benthos (Condon, 1968).

McWhae et al. (1958) dated the Toolonga as Santonian to Early Maastrichtian, based on foraminiferal evidence not cited by those authors, and Santonian on the basis of macrofossils. Belford (1959, 1960) used the foraminifera to date this formation as Santonian to Early Campanian, with a slight possibility of Late Campanian in the Shark Bay and Murchison River region, where the top of the Toolonga is removed by erosion (Belford, 1959). Condon (1968) agreed with the Santonian to Campanian age, and questioned the Maastrichtian age set forth by McWhae et al. (1958) as being unsubstantiated. He did note that as there was a hiatus in the Maastrichtian between the Korojon Calcarenite and Miria Marl, that perhaps deposition continued in the deeper part of the basin,

i.e., the Toolonga Calcilutite may have been deposited in part during the Maastrichtian. There is, however, no positive evidence of a Maastrichtian age for the Toolonga Calcilutite.

ii) Korojon Calcarenite.

The Korojon Calcarenite, which is known from the Wooramel River north to Onslow and in outcrop from the Gascoyne River to the north end of the Giralia Anticline, is 38.4 m (126 feet) thick in its type section at C-Y Creek, Lat. 22°53'S, Long. 114°07'E (Condon et al. 1956; McWhae et al. 1958; Condon, 1968). As originally defined, it "consists of friable white and cream calcarenite and hard cream coquinoïd calcarenite with abundant shells and fragments of Inoceramus" (Condon et al. 1956, p.21), and this was supported by McWhae et al. (1958). It is this presence in abundance of shells, shell fragments, and prisms of the giant bivalve Inoceramus that distinguishes the Korojon Calcarenite, particularly from the Toolonga Calcilutite. Condon (1968) referred to these prisms as aragonite, which they may well have been originally, but X-ray powder diffraction studies by Miss. J. Baker have shown them to be calcite, indicating that reversion has certainly occurred.

Condon (1968), however, emended the definition to include soft calcilutite, referring to the basal calcilutite member. In the present author's opinion, because the basal calcilutite member is the Toolonga Calcilutite, the type section of the Korojon Calcarenite includes the Toolonga, and the thickness of the Korojon proper (i.e. those beds characterized by remains of Inoceramus) is certainly less than 38.4 m at C-Y Creek.

The Korojon Calcarenite has been reported to lie disconformably on the Gearle Siltstone (Condon et al. 1956; Edgell, 1957; Belford, 1959), disconformably or unconformably on the Gearle Siltstone, or conformably on the Toolonga Calcilutite (McWhae et al. 1958), and unconformably on

the Gearle Siltstone (Condon, 1968). The only specific reference to the Korojon lying directly on the Gearle is at C-Y Creek, and as already discussed, the present author contends that in fact the Korojon conformably overlies the Toolonga which unconformably or disconformably overlies the Gearle at this locality. Until good evidence to the contrary is produced, the present author chooses to work with the hypothesis that the Korojon Calcarenite conformably overlies (McWhae et al. 1958) and is also laterally gradational with the Toolonga Calcilutite (McWhae et al. 1958; Condon, 1968). The Korojon is thought by most authors to be disconformably overlain by the Miria Marl, the disconformity having been caused by regression, erosion, and transgression in the Early to Mid Maastrichtian (Condon et al. 1956; Belford, 1959; Condon, 1968). Edgell (1957), by implication, and McWhae et al. (1958) suggested that the two formations were conformable. However, Condon et al. (1956) reported that the "contact between the Korojon Calcarenite and the Miria Marl is sharp and irregular, and in places there is a bed of calcareous nodules... at the contact" (ibid., p.22). The two formations are herein considered to be disconformable.

Belford (1959) thought that the Korojon Calcarenite, as well as the Toolonga Calcilutite and Miria Marl, were deposited in an environment with "a strong open-water influence" (ibid., p. 645), and cited a paper by Lowman of 1949 (not cited herein) that suggested it could have been the middle neritic zone, based on abundant rotaliid species of foraminifera. Condon (1968) postulated that "the Korojon Calcarenite was deposited in an open sea in fairly shallow water with an abundant supply of nutrients and lime, but very little terrigenous material. Some of the coquinoïd beds of Inoceramus have the appearance of shell banks, and may have developed on shoal banks in the Upper Cretaceous sea" (ibid., p.32).

The first published age determinations for the Korojon Calcarenite consulted by the present author were those of Condon et al. (1956). The authors referred to a very early foraminiferal study that assigned a Turonian age to the Korojon. A paper by Edgell in 1952 was cited which reported the occurrence of Bolivinoidea draco draco (Marsson), a well known Maastrichtian index species (Edgell, 1954), in the upper part of the Korojon. The authors chose to use the unpublished results of an ammonite study by Brunschweiler to date the Korojon as Santonian, based on a single ammonite species, lying between the Turonian Gearle Siltstone and the supposed Late Campanian basal part of the Miria Marl. The present author rejects the age determinations of Condon et al. (1956) in total. Edgell (1957) concluded, on the basis of its foraminiferal fauna, that the Korojon is of Campanian to Early Maastrichtian age, and McWhae et al. (1958) supported this conclusion. Belford (1959), in a detailed foraminiferal study, concluded that the Korojon Calcarenite was deposited beginning in the Campanian at some time, and terminating in the Early Maastrichtian. McGowran (1962), on the basis of foraminifera, included the uppermost Korojon in the Maastrichtian of Western Australia. Condon (1968) chose to reject all foraminiferal studies that dated the Korojon as Campanian to Early Maastrichtian, and again used Brunschweiler's ammonite evidence (cited in Condon et al. 1956) to date the Korojon as Santonian. Condon considered that the Maastrichtian age of the Miria Marl, coupled with the disconformity between it and the Korojon Calcarenite, made it likely that the Korojon was at the youngest Campanian. There is, however, no basis for such an assumption. The disconformity by itself has no particular absolute time significance at all, and Condon's conclusion that the Korojon could only be Campanian at the youngest is the result of unsound reasoning.

iii) Miria Marl.

The Miria Marl, which is 1.2 m (4 feet) thick in its type section on Toothawara Creek, Lat. 22°50'S, Long. 114°08'E (Condon et al. 1956; McWhae et al. 1958), is known only in outcrop north of Salt Lake to the north end of the Giralia Anticline (Condon, 1968). It is composed of soft fossiliferous marl and friable calcarenite with a thin nodule zone at the base (Condon et al. 1956; McWhae et al. 1958; Condon, 1968). Its contact with the underlying Korojon Calcarenite has already been discussed under the latter formation. The Miria Marl is disconformably overlain by the Paleocene Boongerooda Greensand (ibid.).

Only the very general hypothesis given by Belford (1959) for the environment of deposition of the upper Cretaceous succession is available, and has been referred to in the discussion of the Korojon.

All foraminiferal studies suggest that the Miria Marl is Maastrichtian in age (Condon et al. 1956; Edgell, 1957; McWhae et al. 1958; Belford, 1959; McGowran, 1962; Condon, 1968), although the ammonite studies of Spath and of Brunnenschweiler (both cited in Condon et al. 1956 and McWhae et al. 1958) suggest that the Miria is Late Campanian to Early Maastrichtian. The almost certain Early Maastrichtian age of the uppermost Korojon suggests that the Miria Marl is in fact Maastrichtian.

2.3. THE GIRALIA ANTICLINE.

The structural elements of the Carnarvon Basin have been reported on in some detail by Condon et al. (1956), Konecki et al. (1958), and Condon (1968). It lies beyond the scope of the present paper to examine them in any detail, because they have not been studied in the field by the present author, nor are they regarded as having much significance in the present study.

A summary of some features of the Giralia Anticline will be given herein, however, because C-Y Creek, the locality of the present study, is situated on the west limb of the Giralia Anticline. All information presented herein is from Condon et al. (1956).

The Giralia Anticline, whose axial trend is 015° , is one of two in the Giralia Range. The other is the more easterly Marrilla Anticline, whose axial trend is 025° . The Giralia Anticline is 129 Km long and 24 to 32 Km wide, running from Exmouth Gulf south to Salt Lake (see Fig.3). In general, it is asymmetrical both along and transverse to its axis. The west limb, which is 24 Km wide from anticlinal axis to adjacent synclinal axis, is the more gently dipping. Dips are in the range of 0.75° to 3.0° W, and tend to steepen slightly in the middle of the flank, gradually levelling towards the adjacent syncline. The strata of the east limb, which is 3.2 to 14.5 Km wide from anticlinal axis to adjacent synclinal axis, dip more steeply, the dips ranging from as little as 3.0° E to as high as 60.0° E.

The sedimentary strata have been breached along the crest, such that the western limb of the Giralia Anticline is characterized by "westward-sloping dip-slopes and steep eastward-facing scarps" (Condon et al. 1956), with a corresponding but reversed situation on the east limb.

There are many streams which drain the western limb, and the dissected topography which they produce is responsible for the excellent exposure of most of the units in the area of the Giralia Anticline, with the Windalia Radiolarite being the oldest formation found in outcrop.

The Giralia Anticline was thought by Condon et al. (1956) to be the result of faulting in the Paleozoic and basement rocks.

CHAPTER 3. SYSTEMATIC PALEONTOLOGY.

3.1. INTRODUCTION TO SYSTEMATIC PALEONTOLOGY.

3.1.1. CLASSIFICATION.

The classification of foraminifera proposed by Loeblich and Tappan (1964) in the two-volume work Sarcodina chiefly "Thecamoebians" and Foraminifera in the Treatise on Invertebrate Paleontology has been followed herein. This has been done for two reasons. The first is that this classification is the most widely used at present. The second is that the present author has acquired some familiarity with it in the course of previous studies and work.

Although descriptions of genera as given by Loeblich and Tappan (1964) are followed herein, the ranges are not. For example, the genera Reussella Galloway and Planorbulina d'Orbigny have reported ranges of Paleocene to Recent in the Treatise, yet occur in the present study of Upper Cretaceous material with no possibility, in the present author's opinion, of confusion or uncertainty regarding the generic assignment of these forms.

No consideration was given to the wall structure of the foraminifera, beyond the categories agglutinated or arenaceous, calcareous imperforate or porcellaneous, and calcareous perforate. No attempt was made to distinguish between walls of radial or granular calcite in calcareous perforate forms, because the work required would have been vastly out of proportion to the value of the results that might have been obtained. In addition, this author questions the taxonomic significance of this distinction. McGowran (1962) examined the wall structure of calcareous perforate forms, and found in some cases that both granular and radial calcite were present in single specimens. A good example of this was the genus Cibicides de Montfort, and the reader is referred to McGowran's paper for more details.

Genera are arranged according to the order in which they appear in Loeblich and Tappan's (1964) classification, and species are arranged alphabetically within genera.

3.1.2. SYNONYMIES.

The synonymies are not intended to be complete. Because of the high number of species and number of references consulted, it was decided to produce abbreviated synonymies, in the interest of brevity. The synonymy for any given species always contains the reference for the type description and figures for that species, if the species has previously been reported. Due to the high number of species reported in old (pre-1940) papers, or foreign language papers not available to this author, extensive use was made of the microfilm edition of the Catalogue of Foraminifera, compiled by Ellis and Messina (1940 et seq), in order to consult type descriptions and type figures. Credit is given in these cases to Ellis and Messina, so that no confusion should exist concerning what original references were used by the present author.

Other references included in the synonymy for any given species are usually chosen for one or both of the following reasons. They have a good description and/or figures, or include an excellent and quite complete synonymy. The references, especially more recent ones, in the synonymy normally will direct the reader to other references for a particular species. Thus, with a minimum of references in the present paper, the reader should be well equipped to find his way through the literature on Upper Cretaceous foraminifera to obtain a clear idea of what morphology and range of variation is intended for each species by the present author.

3.1.3. DESCRIPTIONS.

The majority of species reported herein have previously been described. Usually an English or French language description is available

that adequately describes the forms found in the present study. This author sees no need to reproduce the description in such cases, and in the interest of brevity, the description that has been deemed adequate is referred to in the "Remarks" section and is always included in the synonymy. Where minor corrections need to be made, or where the present specimens exhibit features not mentioned in the description chosen, these are noted.

If an adequate description is not available, or where to this author's knowledge a species has not previously been reported, then a full description is given, following the conventional style used by Loeblich and Tappan (1964) and Sliter (1968), in particular.

After the description, if one is given, or immediately after the synonymy, if no description is given, is a set of dimensions. These dimensions are maxima and apply to a numbered specimen or numbered specimens for each species. These numbered specimens were chosen for their relatively good state of preservation and the degree to which they typify the species as found in the present study. It was not always possible to satisfy both conditions. The(se) numbered specimen(s) was (were) mounted in the left hole of two-holed slides, and a collection of specimens representing the range of variation of that species was mounted in the right hole. These slides are deposited in the Carleton University paleontological laboratory, Room 491, Tory Building. The sample from which each numbered specimen was obtained is given immediately following the specimen number and before the dimensions.

Finally, there is a section titled "Remarks" for each species. Where necessary, this refers to the description followed for a particular species, with corrections or additions where appropriate. Then, the species is distinguished from other similar or related species using

as few and as distinct morphological parameters as possible. Other remarks may then be given relevant to the species under consideration.

3.2. SYSTEMATIC PALEONTOLOGY.

Phylum	PROTISTA
Subphylum	SARCODINA Schmarda, 1871
Order	FORAMINIFERIDA Eichwald, 1830
Suborder	TEXTULARIINA Delage and Hérouard, 1896
Superfamily	AMMODISCACEA Reuss, 1862
Family	ASTRORHIZIDAE Brady, 1881
Subfamily	RHIZAMMININAE Rhumbler, 1895
Genus	BATHYSIPHON M. Sars in G.O. Sars, 1872

Bathysiphon alexanderi Cushman

Bathysiphon alexanderi Cushman, 1946b, p.49, pl.5, fig.1 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.14, pl.1, fig.5. --- TAKAYANAGI, 1960, p.64, pl.1, fig. 3.

Dimensions of specimen CUFC 1, sample 76880: length 0.86 mm, diameter 0.23 mm.

Remarks: The description of Cushman (1946) is followed herein. B. alexanderi is distinguished from B. vitta Nauss, which is compressed, and from B. taurinensis Sacco, which is subcylindrical, and irregular in transverse section. According to Tappan (1962), the type specimens of B. alexanderi are in fact limonitic sticks, not foraminifera. The species B. broegei Tappan is, however, not as consistently straight and uniform as B. alexanderi.

Family	SACCAMMINIDAE Brady, 1884
Subfamily	HEMISPHAERAMMININAE Loeblich and Tappan, 1961
Genus	WEBBINELLOIDEA Stewart and Lampe, 1947

Webbinelloidea similis Stewart and Lampe (Plate 1, Figs. 1-3)

Webbinelloidea similis STEWART AND LAMPE, 1947, p. 535, pl.78, fig.8
(fide Ellis and Messina; 1940 et seq.).---LOEBLICH AND TAPPAN,
1964, p. C205, fig. 117(8).

Test attached, composed of two planoconvex chambers arranged in the same plane. Chambers nearly hemispherical, of subequal height, joined along plane of attachment. Suture distinct, depressed, straight to gently curved, and transverse to axis of test. Wall quite finely agglutinated, with much cement, strongly rugose on exterior of chambers, smooth on interior, with a variably developed smooth imperforate calcareous flange on plane of attachment. Aperture terminal, rounded, with phialine lip, just above flange on convex free side of test.

Dimensions of specimen CUFC 2, sample 76868: length 0.61 mm, width 0.42 mm, thickness 0.16 mm; dimensions of specimen CUFC 288, sample 76871: length 0.56 mm, width 0.37 mm, thickness 0.16 mm.

Remarks: The description of Stewart and Lampe (1947) is emended to conform to the conventional format for systematic descriptions, and to include details of the aperture, about which the authors said "no definite aperture visible" (ibid., p.535), and the flange which may develop at the surface of attachment. This species is distinguished from other species of Webbinelloidea by its two chambers.

Webbinelloidea sp.
(Plate 1, Figs.4, 5)

Test attached, composed of a linear series of up to five chambers in the same plane. Chambers nearly hemispherical, increasing very gradually in size as added, joined along plane of attachment. Sutures distinct, depressed, straight to gently curved, transverse to axis of test. Wall quite finely agglutinated, with much cement, strongly rugose on exterior of chambers, smooth on interior, with a variably developed smooth imperforate calcareous flange on plane of attachment. Aperture

terminal, rounded, with phialine lip, just above flange on convex free side of test.

Dimensions of specimen CUFC 3, sample 76870: length 1.46 mm, width 0.61 mm, thickness 0.18 mm.

Remarks: This species differs from other species of Webbinelloidea by its large number of chambers in a linear series.

Family AMMODISCIDAE Reuss, 1862

Subfamily AMMODISCINAE Reuss, 1862

Genus AMMODISCUS Reuss, 1862

Ammodiscus cretaceus (Reuss)

Operculina cretacea REUSS, 1845, p.35, pl.13, figs.64, 65a-b (fide Ellis and Messina, 1940 et seq.).

Ammodiscus cretaceus (Reuss). CUSHMAN, 1946, p.17, pl.1, fig.35.---
HANZLIKOVÁ, 1972, p.34, pl.3, figs.1, 9.

Involutina cretacea (Reuss). BELFORD, 1960, p.22, pl.6, fig.1.

Dimensions of specimen CUFC 4, sample 76872: diameter 0.76 mm, thickness 0.24 mm.

Remarks: The description of Cushman (1946) is followed herein. The test is occasionally compressed perpendicular to the axis of coiling to produce an elliptical, rather than circular, outline. The proloculus is most often broken out.

Genus GLOMOSPIRA Rzehak, 1885

Glomospira charoides (Jones and Parker)

Trochammina squamata Jones and Parker var. charoides JONES AND PARKER, 1860, p.304 (fide Ellis and Messina, 1940 et seq.).

Glomospira charoides (Jones and Parker). MELLO, 1969, p.42, pl.4, fig.4.

Dimensions of specimen CUFC 5, sample 76876: diameter 0.52 mm, thickness 0.24 mm.

Remarks: The description of Mello (1969) is followed herein. This species is distinguished from G. charoides var. corona Cushman and Jarvis, which is subglobular with a high crown of irregular coils on the upper portion of the test, and from G. gordialis (Jones and Parker), which is very low streptospiral.

Glomospira gordialis (Jones and Parker)

Trochammina squamata Jones and Parker var. gordialis JONES AND PARKER, 1860, p.304 (fide Ellis and Messina, 1940 et seq).

Glomospira gordialis (Jones and Parker). CUSHMAN, 1946, p.18, pl.1, figs.38-40.

Dimensions of specimen CUFC 6, sample 76891: diameter 0.37 mm, thickness 0.23 mm.

Remarks: The description of Cushman (1946) is followed herein. G. gordialis is distinguished by the coiling style, which is almost planispiral. The aperture is at the open end of the tube and is crescentic.

Genus TURRITELLELLA Rhumbler, 1904

Turritellella sp.
(Plate 1, Fig.6)

Test free, elongate, high trochospiral, diameter of test increasing with growth. Chamber a long undivided tube. Spiral suture distinct, depressed. Wall quite coarsely agglutinated, with calcareous cement. Aperture at open end of tube.

Dimensions of specimen CUFC 7, sample 76870: diameter 0.39 mm, height 0.54 mm.

Remarks: This species is represented by a single broken specimen, hence identification at the species level is not possible.

Superfamily LITUOLACEA de Blainville, 1825

Family RZEHA KINIDAE Cushman, 1933

Genus SILICOSIGMOILINA Cushman and Church, 1929

Silicosigmoilina californica Cushman and Church

Silicosigmoilina californica CUSHMAN AND CHURCH, 1929, p.502, pl.36, figs.10-12 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.43, pl.1, figs.13-15.

Dimensions of specimen CUFC 8, sample 76887: length 0.52 mm, width 0.38 mm, thickness 0.19 mm.

Remarks: The description of Cushman and Church (1929) is followed herein. The types and the present forms differ from the forms described by Sliter (1968) in having sutures which are frequently distinct throughout. Usually, one side of the test is nearly flat, the other markedly convex. S. californica differs from S. futabaensis Asano which is more strongly compressed and elongate.

Family LITUOLIDAE de Blainville, 1825

Subfamily HAPLOPHRAGMOIDINAE Maync, 1952

Genus HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides advenus (Cushman and Applin)

Ammobaculites advenus CUSHMAN AND APPLIN, 1947, p.53, pl.13, fig.1 (fide Ellis and Messina, 1940 et seq).

Haplophragmoides advenus (Cushman and Applin). FRIZZELL, 1954, p.59, pl.1, fig.25.

Dimensions of specimen CUFC 9, sample 76897: diameter 0.46 mm, thickness 0.12 mm.

Remarks: The description of Cushman and Applin (1947) is followed herein. H. advenus is distinguished from other species of Haplophragmoides by its extremely compressed test and acute axial periphery.

Haplophragmoides formosus Takayanagi

Haplophragmoides formosus TAKAYANAGI, 1960, p.71, pl.1, fig.22.

Haplophragmoides sp. cf. H. famosus Takayanagi. SLITER, 1968, p.44, pl.1, fig.17.

Dimensions of specimen CUFC 10, sample 76903: diameter 0.61 mm, thickness 0.27 mm.

Remarks: The description of Takayanagi (1960) is followed herein, with the exception that there may be as few as 5 chambers in the final whorl. This species is readily distinguished by its involute, finely arenaceous test and the number of chambers. Note that Sliter (1968) was in error in using the specific name famosus.

Haplophragmoides fraseri Wickenden

Haplophragmoides fraseri WICKENDEN, 1932, p.86, pl.1, (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, pl.3, fig.1.
---SLITER, 1968, p.44, pl.2, fig.1.

Dimensions of specimen CUFC 11, sample 76901: diameter 0.54 mm, thickness 0.25 mm.

Remarks: The description of Wickenden (1932) is followed herein. The wall is more coarsely finished than implied by the type description. H. fraseri is distinguished from the other species of Haplophragmoides found in the present study by its partially evolute test, rounded periphery, and gradually enlarging chambers.

Haplophragmoides sp. A
(Plate 1, Figs. 7, 8)

Test planispiral, partially evolute; equatorial periphery nearly entire, axial periphery rounded to narrowly rounded. Chambers 6 or 7 in final whorl, increasing slowly in size as added, with margins gently elevated with respect to the rest of chamber. Sutures becoming increasingly distinct and depressed, nearly straight and radial. Wall finely agglutinated, quite smoothly finished. Aperture a low, interior-marginal, peripheral arch.

Dimensions of specimen CUFC 12, sample 76897: diameter 0.52 mm, thickness 0.19 mm.

Remarks: This species is distinguished from other partially evolute species of Haplophragmoides by its smoothly finished wall and

elevated chamber margins, and from H. formosus Takayanagi, which is involute.

Haplophragmoides sp. B
(Plate 1, Figs. 9, 10)

Test planispiral, wholly involute, subglobular; equatorial periphery nearly entire, axial periphery broadly rounded. Chambers 5 or 6 in final whorl, increasing very gradually in size as added. Sutures becoming increasingly distinct and depressed, essentially straight and radial. Wall finely agglutinated, quite smoothly finished. Aperture a fairly high interiomarginal slit confined to the periphery.

Dimensions of specimen CUFC 13, sample 76899: diameter 0.46 mm, thickness 0.23 mm.

Remarks: This species of Haplophragmoides is distinguished by the wholly involute test, few chambers, and very broadly rounded periphery. It is almost invariably distorted, being "sheared," but its planispiral chamber arrangement is readily apparent and distinguishes it from Recurvoides Earland.

Haplophragmoides sp. C
(Plate 1, Figs. 11, 12)

Test planispiral, partially evolute, equatorial periphery nearly entire, axial periphery broad and flattened. Chambers 9 or 10 in final whorl, increasing only slightly in height and width, but quite rapidly in thickness, as added, such that final chamber is typically 2 to 2-1/2 times as thick as initial chamber in final whorl. Sutures distinct, increasingly depressed, very gently curved and nearly radial. Wall finely agglutinated, quite smoothly finished. Aperture a very low interiomarginal slit, confined to the periphery.

Dimensions of specimen CUFC 14, sample 76899: diameter 0.27 mm, thickness 0.19 mm.

Remarks: This species is readily distinguished from other species by the smoothly finished evolute test, and the chambers which are significantly thicker than high. It is distinguished from H. flagleri Cushman and Hedberg, which is closely similar in all other respects, by the former's very rapid increase in chamber thickness throughout the final whorl.

Genus RECURVOIDES Earland, 1934

Recurvoides sp. A
(Plate 2, Figs.1,2)

Test free, compressed, streptospiral; equatorial periphery mildly lobulate, axial periphery narrowly rounded. Chambers commonly 3, occasionally 4, per whorl, increasing quite rapidly in size as added; on spiral side all chambers of previous whorl visible only as a single central raised area, on umbilical side with thickened margins and depressed center. Sutures distinct, depressed, straight to gently curved, radial. Wall finely agglutinated, quite smoothly finished. Aperture indeterminate.

Dimensions of specimen CUFC 15, sample 76901: diameter 0.31 mm, thickness 0.15 mm.

Remarks: This species may in fact not belong to Recurvoides, as the apertural details are not discernible. According to Loeblich and Tappan (1964), the range of this genus is Miocene to Recent, but Hanzlikova (1972) reported numerous species of this genus from the Upper Cretaceous of Carpathia. The present forms are distinguished by the compressed test, and distinct chambers, especially on the umbilical side.

Recurvoides sp. B
(Plate 2, Figs.3,4)

Test free, subglobular, streptospiral; equatorial periphery mildly lobulate, axial periphery broadly rounded. Chambers 4 per whorl, increasing slowly in size as added, gently inflated; on spiral side chambers of previous whorl visible only as a raised boss. Sutures distinct, gently depressed, straight to gently curved, nearly radial. Wall agglutinated, coarse grains in much cement, quite smoothly finished. Aperture areal, low on apertural face, a low arch with a very fine lip.

Dimensions of specimen CUFC 16, sample 76900: diameter 0.26 mm, thickness 0.22 mm.

Remarks: This species is distinguished by the subglobular test.

Subfamily LITUOLINAE de Blainville, 1825

Genus AMMOBACULITES Cushman, 1910

Ammobaculites subcretaceus Cushman and Alexander

Ammobaculites subcretaceus CUSHMAN AND ALEXANDER, 1930, p.6, pl.2, figs.9-10 (fide Ellis and Messina, 1940 et seq.)---CUSHMAN, 1946, p.23, pl.3, figs.18-20.

Dimensions of specimen CUFC 17, sample 76898: length 0.39 mm, width 0.18 mm, thickness 0.10 mm.

Remarks: The description of Cushman (1946) is followed herein. The sutures are quite distinct, depressed, and are radial in the coiled portion, which has four full chambers and a fairly large umbilicus.

Genus HAPLOPHRAGMIUM Reuss, 1860

Haplophragmium lueckei (Cushman and Hedberg)

Ammobaculites lueckei CUSHMAN AND HEDBERG, 1941, p.83, pl.21, fig.4 (fide Ellis and Messina, 1940 et seq.).

Haplophragmium lueckei (Cushman and Hedberg). SLITER, 1968, p.45, pl.2, fig.6.---HANZLIKOVÁ, 1972, p.46, pl.9, fig.8.

Dimensions of specimen CUFC 18, sample 76886: length 1.08 mm, diameter 0.32 mm.

Remarks: The description of Sliter (1968) is followed herein. These forms, as well as those of Sliter (1968) and Hanzliková (1972), lack the short apertural neck described by Cushman and Hedberg (1941). H. lueckei is distinguished from the otherwise similar Ammobaculites coprolithiformis Schwager by the former's streptospiral, rather than planispiral, initial portion.

Subfamily PLACOPSILININAE Rhumbler, 1913

Genus PLACOPSILINA d'Orbigny, 1850

Placopsilina sp.
(Plate 2, Figs. 7-9)

Ammobaculites sp. nov. McGOWRAN, 1962, p.30, pl.1, fig.12, pl.14, fig.4.

Test attached, planoconvex, chambers initially trochospirally coiled, later added irregularly; equatorial periphery lobulate, axial periphery acute with a flange at the surface of attachment. Chambers increasing steadily in size as added, somewhat inflated; involute on convex umbilical side, flat and completely evolute on attached spiral side, with thin chamber walls that usually are broken out in preservation, leaving extensions of the flange at all sutures to partially cover the chambers. Sutures distinct, gently depressed, nearly straight and radial on umbilical side; flush, curved on spiral side. Wall finely agglutinated, with much cement, coarsely rugose on umbilical side, smooth on spiral side and interior of chambers. Aperture on final chamber, rounded, with phialine lip; on upper, convex free side of test.

Dimensions of specimen CUFC 19, sample 76892: diameter 0.75 mm, thickness 0.34 mm.

Remarks: There is a very strong resemblance of the wall structure, style of attachment, axial flange, and aperture between these forms and

Webbinelloidea Stewart and Lampe. The two genera are at present in different superfamilies, Lituolacea and Ammodiscacea, respectively. Webbinelloidea cannot be placed in the family Lituolacae with Placopsilina, however, as the definition of the Lituolidae includes "early stage coiled" (Loeblich and Tappan, 1964, p.C225).

Family	TEXTULARIIDAE Ehrenberg, 1838
Subfamily	SPIROPECTAMMININAE Cushman, 1927
Genus	SPIROPECTAMMINA Cushman, 1927

Spiropectammina grzybowskii Frizzell

Spiropecta clotho GRZYBOWSKI, 1901, p.224, pl.8, fig.18 (fide Ellis and Messina, 1940 et seq).

Spiropectammina grzybowskii FRIZZELL, 1943, p.337, pl.55, figs.12,13 (fide Ellis and Messina, 1940 et seq).---McGUGAN, 1964, p.939, pl.150, figs.1,2.

Bolivinopsis ? clotho (Grzybowski). CUSHMAN, 1946, p.103, pl.44, figs.10-13.

Test free, elongate, compressed although markedly thicker along median suture, initially planispiral, becoming biserial; in the megaspheric form the coiled portion is as wide as or wider than the biserial portion, which has a maximum of 6 or 7 pairs of chambers; in the microspheric form the coiled portion is very small in diameter, after which the biserial portion rapidly flares, eventually becoming parallel-sided, only slightly enlarging with growth, or even quite irregular, with a maximum development of over 14 pairs of chambers; margins acute to narrowly rounded. Chambers rather indistinct in coiled portion, and initially 2 to 2-1/2 times as broad as high in the megaspheric form, but up to 3 times as broad as high in the microspheric, becoming 1-1/2 times as high as broad in the adult. Sutures distinct, gently depressed, resulting in a mildly lobulate periphery in face view, gently

curved. Wall coarsely agglutinated, with much cement, quite coarsely finished, with a rather distinct, hyaline appearance. Aperture an equant interiomarginal arch.

Dimensions of megalospheric specimen CUFC 20, sample 76889: length 1.12 mm, width 0.33 mm, thickness 0.18 mm; dimensions of microspheric specimen CUFC 21, sample 76904: length 1.32 mm, width 0.45 mm, thickness 0.28 mm.

Remarks: This species is distinguished from S. laevis (Roemer) by its elongate, nearly parallel-sided test, and gently depressed sutures, from S. semicomplanata (Carsey) by its coarse wall structure, and from Spiroplectammina sp. which has a marked increase in test thickness as well as width with growth.

Spiroplectammina laevis (Roemer)

Textularia laevis ROEMER, 1841, p.97, pl.15, fig.17 (fide Ellis and Messina, 1940 et seq).

Spiroplectammina laevis (Roemer) var. cretosa CUSHMAN, 1932, p.87, pl.11, fig.3 (fide Ellis and Messina, 1940 et seq).

Spiroplectammina laevis (Roemer). SLITER, 1968, p.46, pl.2, fig.9.

Spiroplectammina cretosa Cushman. HANZLIKOVÁ, 1972, p.47, pl.10, fig.9.

Dimensions of specimen CUFC 22, sample 76881: length 0.72 mm, width 0.50 mm, thickness 0.35 mm.

Remarks: The description of Cushman (1932) is followed herein. S. laevis is readily distinguished by the raised, arched sutures, acute margins, rapidly flaring initial portion, and smoothly finished wall.

Spiroplectammina semicomplanata (Carsey)

Textularia semicomplanata CARSEY, 1926, p.25, pl.3, fig.4 (fide Ellis and Messina, 1940 et seq).

Spiroplectammina semicomplanata (Carsey). PLUMMER, 1931, p.129, pl.8, figs.7,8.---GRAHAM AND CHURCH, 1963, p.23, pl.1, figs.10,11.

Dimensions of specimen CUFC 23, sample 76872: length 0.36 mm, width 0.15 mm, thickness 0.09 mm.

Remarks: The description of Plummer (1931) is followed herein. S. semicomplanata is distinguished from S. grzybowskii Frizzel by its much more finely agglutinated test, and from Spiroplectammina sp. by its more rounded margins and more nearly horizontal sutures.

Spiroplectammina sp.
(Plate 2, Figs.5,6)

Test free, elongate, strongly compressed, tapering quite rapidly, initially planispiral, later biserial, periphery in face view mildly lobulate, margins narrowly rounded to subacute. Chambers 4 or 5 in initial coil, subequant, becoming 2 to 2-1/2 times as broad as high, increasing gradually in size as added. Sutures distinct, depressed, radial in coiled portion, straight and angled downwards towards periphery in biserial portion. Wall finely agglutinated, quite smoothly finished. Aperture a fairly high and narrow interiomarginal arch.

Dimensions of specimen CUFC 24, sample 76897: length 0.49 mm, width 0.20 mm, thickness 0.14 mm.

Remarks: This species is distinguished from S. grzybowskii Frizzell by its much smoother and generally smaller (a maximum length of 0.75 mm for the former, and 2.35 mm for the latter species) test, and from S. semicomplanata (Carsey) by its broader chambers and backwards-directed sutures.

Subfamily TEXTULARIINAE Ehrenberg, 1838

Genus TEXTULARIA DeFrance, in de Blainville, 1824

Textularia subconica Franke

Textularia trochus d'Orbigny forma subconica FRANKE, 1828, p.131, pl.12, fig.1 (fide Ellis and Messina, 1940 et seq).

Textularia subconica Franke. CUSHMAN, 1946, p.30, pl.6, figs.21,22. — HANZLIKOVA, 1972, p.48, pl.10, fig.1.

Dimensions of specimen CUFC 25, sample 76872: length 0.67 mm, width 0.66 mm, thickness. 0.49 mm.

Remarks: The description of Cushman (1946) is followed herein. The present forms differ slightly from those reported in the literature by virtue of being more strongly compressed initially, with resultant acute margin, and in possessing a markedly inflated final pair of chambers that are 1-1/2 times as thick as the penultimate pair. They also have rounded margins.

Textularia sp.
(Plate 2, Figs.10,11)

Test free, elongate, biserial throughout, tapering quite rapidly from the apex but eventually becoming parallel-sided; periphery in side view becoming lobulate, margins initially narrowly rounded, later broadly rounded, such that transverse section is nearly circular. Chambers initially twice as broad as high, eventually as high as broad and quite strongly inflated. Sutures distinct, initially nearly flush, later strongly depressed, straight and horizontal. Wall finely agglutinated, smoothly finished. Aperture a low interiomarginal arch in a re-entrant formed by the crescentic apertural face.

Dimensions of specimen CUFC 26, sample 76898: length 0.43 mm, width 0.22 mm, thickness 0.16 mm.

Remarks: The strongly inflated, equant final chambers, parallel-sided test, and smoothly finished wall distinguish this species.

Family TROCHAMMINIDAE Schwager, 1877
Subfamily TROCHAMMININAE Schwager, 1877
Genus TROCHAMMINA Parker and Jones, 1859

Trochammina texana Cushman and Waters

Trochammina texana CUSHMAN AND WATERS, 1927, p.85, pl.11, fig.8 (fide Ellis and Messina, 1940, et seq).---FRIZZELL, 1954, p.79, pl.7, fig.21.---SLITER, 1968, p.47, pl.2, fig.11.

Dimensions of specimen CUFC 27, sample 76898: diameter 0.35 mm, thickness 0.14 mm.

Remarks: The description of Sliter (1968) is followed herein. In the present forms, the chambers are occasionally produced towards the umbilical side, such that the spiral side becomes convex, with the chambers taking on an imbricate appearance.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Subfamily VERNEUILININAE Cushman, 1911

Genus VERNEUILINA d'Orbigny, in de la Sagra, 1839

Verneuilina cretosa Cushman

Verneuilina cretosa Cushman, 1933b, p.51, pl.5, fig.7 (fide Ellis and Messina, 1940, et seq). — PHIZZELL, 1954, p.69, pl.5, fig.7.

Dimensions of specimen CUFC 28, sample 76876: length 1.33 mm, width 0.50 mm.

Remarks: The description of Cushman (1933b) is followed herein, except that the aperture in the present forms is quite narrow and high. The acute, serrate test margins distinguish this species.

Verneuilina parri Cushman

Verneuilina parri CUSHMAN, 1936d, p.2, pl.1, fig.3 (fide Ellis and Messina, 1940 et seq).

Verneuilina aff. parri Cushman. MCGOWRAN, 1962, p.40, pl.1, fig.5.

Dimensions of specimen CUFC 29, sample 76868: length 0.66 mm, width 0.37 mm.

Remarks: The description of McGowran (1962) is followed herein. This species is distinguished by the subterminal aperture, subangular to rounded margins, and inflated chambers.

Genus GAUDRYINA d'Orbigny, in de la Sagra, 1839

Gaudryina austinana Cushman

Gaudryina (Siphogaudryina) austinana CUSHMAN, 1936d, p.10, pl.2, fig.6 (fide Ellis and Messina, 1940 et seq).

Gaudryina austinana Cushman. McGUGAN, 1964, p.940, pl.150, fig.5.

Dimensions of specimen CUFC 30, sample 76872: length 0.37 mm, width 0.28 mm, thickness 0.15 mm.

Remarks: The description of Cushman (1936d) is followed herein. G. austinana is readily distinguished by the sharply angled test with rectangular section to the biserial portion, and its gently depressed sutures. The aperture is quite variable, ranging from a low interio-marginal arch, to a subterminal arch, in some cases surrounded by a fine lip.

Gaudryina convexa Cushman

Gaudryina convexa CUSHMAN, 1911, p.66, t.f.105 (fide Ellis and Messina, 1940 et seq.).

Test free, 1-1/2 times as long as broad, tapering quite uniformly from the acute base to the blunt apertural end; initially triserial and triangular in section, becoming biserial, with one side flattened and continuous with one face of the triangular triserial portion, the other two sides of the triserial portion joining the convex sides of the biserial portion such that the narrowest face of the triserial portion becomes the margin of one side of the test, resulting in a somewhat inflated triangular section. Chambers initially triserial, later biserial, increasing slowly in size as added, becoming very mildly inflated. Sutures indistinct, eventually becoming very gently depressed, straight and nearly horizontal. Wall very coarsely agglutinated, little cement, roughly finished. Aperture a low interomarginal arch.

Dimensions of specimen CUFC 31, sample 76876: length 0.67 mm, width 0.54 mm, thickness 0.39 mm.

Remarks: The extremely coarse wall, which obscures most chamber and suture detail, and uninterrupted transition from the triserial to

the approximately triangular, or as Cushman (1911) described it, plano-convex, biserial portion, serve to distinguish G. convexa.

Gaudryina faujasi (Reuss)

Textilaria faujasi REUSS, 1862, p.320, pl.3, fig.9 (fide Ellis and Messina, 1940 et seq).

Gaudryina faujasi (Reuss). CUSHMAN, 1946, p.32, pl.7, fig.14.

Dimensions of megalospheric specimen CUFC 32, sample 76885: length 0.68 mm, width 0.26 mm, thickness 0.18 mm; dimensions of microspheric specimen CUFC 33, sample 76885: length 0.80 mm, width 0.27 mm, thickness 0.19 mm.

Remarks: The description of Cushman (1946) is followed herein. There are two forms present, a megalospheric form in which the triserial portion comprises approximately 1/3 of the test, and a microspheric form in which the triserial portion is greatly reduced, with but a few chambers. This species is readily distinguished from most species of Gaudryina by the finely agglutinated wall and elongate, flattened, parallel-sided biserial portion with only very mildly depressed sutures and subequant chambers. G. glabrella (Cushman) is often closely similar but has a more quadrate biserial portion that tends to taper more noticeably than in G. faujasi.

Gaudryina ? glabrella (Cushman)

Dorothia glabrella CUSHMAN, 1933b, p.56, pl.6, fig.9 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.45, pl.12, figs.18, 19.

Dimensions of specimen CUFC 34, sample 76875: length 0.57 mm, width 0.25 mm, thickness 0.18 mm.

Remarks: The description of Cushman (1946) is followed herein, although the present author questions whether a quadriserial chamber arrangement can actually be distinguished in the initial portion. The

well-developed, compressed biserial portion suggests that this species indeed belongs to Gaudryina. It is distinguished from G. austinana Cushman by the former's rounded margins, and from G. faujasi (Reuss) which has a rounded, rather than quadrate, section.

Gaudryina laevigata Franke

Gaudryina laevigata FRANKE, 1914, p.431, pl.27, figs.1,2 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.33, pl.8, fig.4.
---GRAHAM AND CHURCH, 1963, p.20, pl.1, fig.12.

Dimensions of specimen CUFC 35, sample 76904: length 0.90 mm, width 0.49 mm, thickness 0.40 mm.

Remarks: The description of Cushman (1946) is followed herein. This species is distinguished from most other species of Gaudryina by the smoothly finished, quite coarsely arenaceous wall, rounded margins, and nearly circular cross-section in the biserial portion, which has strongly inflated chambers. It is distinguished from G. rugosa d'Orbigny by the former's more rapidly tapering test and more strongly depressed sutures that are also quite strongly arched along the median suture.

Gaudryina pulvina Belford

Gaudryina pulvina BELFORD, 1960, p.10, pl.2, figs.1-7.

Dimensions of specimen CUFC 36, sample 76895: length 0.55 mm, width 0.32 mm, thickness 0.25 mm.

Remarks: The description of Belford (1960) is followed herein. G. pulvina is readily distinguished from most species of Gaudryina by the sharply angled triserial portion with concave faces, and from G. austinana Cushman by the former's strongly depressed sutures that produce the ridged appearance to the chambers throughout the biserial portion.

Gaudryina pyramidata Cushman

Gaudryina laevigata Franke var. pyramidata CUSHMAN, 1926a, p.587,
pl.16, fig.8 (fide Ellis and Messina, 1940 et seq).

Gaudryina (Pseudogaudryina) pyramidata Cushman. CUSHMAN, 1946, p.36,
pl.8, fig.14.

Gaudryina pyramidata Cushman. SLITER, 1968, p.48, pl.3, fig.9.

Dimensions of specimen CUFC 37, sample 76882: length 0.43 mm,
width 0.32 mm, thickness 0.25 mm.

Remarks: The description of Cushman (1946) is followed herein.

This species is readily distinguished by the triangular test whose margins are not interrupted at all in the transition from the triserial to biserial portion, by the carinate margins, the nearly flush sutures, and the two wide convex and one narrow concave sides to the test.

Gaudryina rugosa d'Orbigny

Gaudryina rugosa d'ORBIGNY, 1840, p.44, pl.4, figs.20,21 (fide Ellis and Messina, 1940 et seq).---SCHIJFSMA, 1946, p.32, pl.1, fig.6.---BELFORD, 1960, p.13, pl.2, figs.17-20.

Dimensions of specimen CUFC 38, sample 76878: length 1.54 mm,
width 0.79 mm, thickness 0.61 mm.

Remarks: The description of Schijfsma (1946) is followed herein.

G. rugosa is distinguished from the very similar G. laevigata Franke by the former's more strongly developed, angled triserial portion, less strongly depressed sutures throughout, and essentially straight sutures in the biserial portion. The large test and quite coarsely agglutinated wall serve to distinguish this species from most other species of Gaudryina.

Gaudryina sp.
(Plate 2, Figs.12,13)

Test free, elongate, triserial becoming biserial; triserial portion well developed, angles rounded, almost circular in section, biserial

portion never developed beyond initial pair of chambers, margins broadly rounded, nearly circular in section. Chambers mildly inflated throughout, with a somewhat fringed lower margin projecting over chamber of previous whorl. Sutures distinct, depressed, straight throughout. Wall finely agglutinated, quite smoothly finished. Aperture a small, equant interiomarginal arch.

Dimensions of specimen CUFC 39, sample 76898: length 0.53 mm, width 0.35 mm, thickness 0.31 mm.

Remarks: The base of the test is never preserved, nor is the biserial portion developed beyond the initial pair of chambers. Hence the biseriality is not pronounced. The species is readily distinguished by the quite finely agglutinated test, and the strongly rounded angles throughout, with little distinction between the triserial and biserial portions.

Genus HETEROSTOMELLA Reuss, 1862

Heterostomella austinana Cushman

Heterostomella austinana CUSHMAN, 1933b, p.53, pl.6, figs.1-3 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.41, pl.11, figs.2-7.

Dimensions of specimen CUFC 40, sample 76892: length 0.70 mm, width 0.32 mm, thickness 0.27 mm.

Remarks: The description of Cushman (1946) is followed herein. H. austinana is distinguished readily from H. foveolata (Marsson) which has rounded rather than angled margins, and differs from H. americana Cushman in having few, pronounced eroded ridges rather than the numerous ridges that characterize the latter species. There is never more than a very short neck in the present specimens, whereas Cushman (1946) mentioned the presence of a long neck.

Genus PSEUDOSPIROPLECTINATA Gorbenko, 1957

Pseudospiroplectinata compressiuscula (Chapman)

Bigenerina compressiuscula CHAPMAN, 1917, p.19, pl.2, figs.13,14 (fide Ellis and Messina, 1940 et seq).

Spiroplectinata compressiuscula (Chapman), emended. BELFORD, 1960, p.15, pl.3, figs.9-19.

Pseudospiroplectinata compressiuscula (Chapman). HANZLIKOVÁ, 1972, p.53, pl.11, fig.7.

Dimensions of specimen CUFC 41, sample 76895: length 0.76 mm, width 0.31 mm, thickness 0.20 mm.

Remarks: The emended description of Belford (1960) is followed herein. This species is readily distinguished by the broad, strongly compressed biserial and uniserial stages, and the short apertural neck.

Genus TRITAXIA Reuss, 1860

Tritaxia trifida (Belford)

Clavulinoides trifidus BELFORD, 1960, p.13, pl.3, figs.1-4.

Dimensions of specimen CUFC 42, sample 76894: length 1.09 mm, diameter 0.24 mm.

Remarks: The description of Belford (1960) is followed herein. The triangular test with concave sides, occasional development of globular final chambers, and apertural neck are distinctive of this species.

Subfamily GLOBOTEXTULARIINAE Cushman, 1927

Genus DOROTHIA Plummer, 1931

Dorothia biformis Finlay

Dorothia biformis FINLAY, 1939, p.313, pl.25, figs.26-28 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.19, pl.4, figs. 14-18.---McGOWRAN, 1962, p.48, pl.2, fig.6.

Dimensions of specimen CUFC 43, sample 76881: length 1.10 mm, width 0.63 mm, thickness 0.56 mm.

Remarks: The description of McGowran (1962) is followed herein. D. biformis is distinguished from most species by its finely arenaceous wall and rapidly tapering test with rounded apex, and from D. pupa (Reuss) by the former's slightly coarser wall, very weakly inflated chambers, and more strongly rounded apex.

Dorothia bulletta (Carsey)

Gaudryina bulletta CARSEY, 1926, p.28, pl.4, fig.4 (fide Ellis and Messina, 1940 et seq).

Dorothia bulletta (Carsey). PLUMMER, 1931, p.132, pl.8, figs.13-17.---
SLITER, 1968, p.49, pl.3, fig.11.

Dimensions of specimen CUFC 44, sample 76885: length 1.46 mm,
width 0.51 mm, thickness 0.43 mm.

Remarks: The description of Sliter (1968) is followed herein. This species is readily distinguished by the elongate, parallel-sided test with its inflated chambers, depressed oblique sutures, and rounded base.

Dorothia confraga Belford

Dorothia confraga BELFORD, 1960, p.20, pl.5, figs.1-7.

Dimensions of specimen CUFC 45, sample 76881: length 1.63 mm,
width 0.68 mm, thickness 0.62 mm.

Remarks: The description of Belford (1960) is followed herein. D. confraga is distinguished from most species of Dorothia by the large, coarsely finished test, and from D. conicula Belford by the former's broadly rounded base and gently compressed test.

Dorothia conicula Belford

Dorothia conicula BELFORD, 1960, p.20, pl.5, figs.8-13.

Dimensions of specimen CUFC 46, sample 76870: length 1.93 mm,
diameter 0.98 mm.

Remarks: The description of Belford (1960) is followed herein. D. conicula is distinguished from most species of Dorothia by the large, coarsely finished test, and from D. confraga Belford by the former's acute apex and rounded section.

Dorothia conula (Reuss)

Textularia conulus REUSS, 1844, p.215 (fide Ellis and Messina, 1940 et seq).---REUSS, 1845, pl.8, fig.59, pl.13, fig.75 (fide Ellis and Messina, 1940 et seq).

Dorothia conula (Reuss). CUSHMAN, 1946, p.44, pl.12, figs.12-14.

Dorothia cf. D. conulus (Reuss). SAID AND KENAWY, 1956, p.128, pl.1, fig.54.

Test free, elongate, compressed, initial whorl with 4 chambers, next whorl triserial, with up to six pairs of chambers occurring in the biserial portion of the test, which has a lobulate outline, and rounded margins. Chambers inflated, subglobular, increasing steadily in size as added. Sutures distinct, depressed, gently curved and slightly oblique. Wall finely agglutinated, smoothly finished. Aperture a low, fairly wide interiomarginal arch, bordered above by a fine lip.

Dimensions of specimen CUFC 47, sample 76886: length 0.50 mm, width 0.28 mm, thickness 0.24 mm.

Remarks: This species is readily distinguished by the reduced early quadriserial and triserial portions, and the well-developed biserial portion with subglobular, inflated chambers. It is not as stout as the description of Cushman (1946) suggests.

Dorothia ellisorae (Cushman)

Marssonella ellisorae Cushman, 1936d, p.44, pl.4, fig.11 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.17, pl.4, figs.4-7.

Dorothia ellisorae (Cushman). TRUJILLO, 1960, p.309, pl.44, fig.4.

Dimensions of specimen CUFC 48, sample 76904: length 0.79 mm, diameter 0.56 mm.

Remarks: The description of Trujillo (1960) is followed herein. D. ellisoriae is distinguished from D. bulletta (Carsey) by the former's acute apex and tapering test, and from D. oxycona (Reuss) by its inflated chambers and gently depressed sutures.

Dorothia oxycona (Reuss)

Gaudryina oxycona REUSS, 1860, p.229, pl.12, fig.3 (fide Ellis and Messina, 1940 et seq).

Marssonella oxycona (Reuss). BANDY, 1951, p.492, pl.72, fig.8.

Dorothia oxycona (Reuss). TRUJILLO, 1960, p.309, pl.44, fig.5.--- HANZLIKOVÁ, 1972, p.57, pl.11, figs.8,10.

Marssonella aff. ellisoriae Cushman. MCGOWRAN, 1962, p.53, pl.2, figs. 9-11, pl.14, figs.8,9.

Marssonella trochus (d'Orbigny). GRAHAM AND CHURCH, 1963, p.21, pl.1, fig.6.

Dimensions of specimen CUFC 49, sample 76872: length 1.84 mm, diameter 0.73 mm.

Remarks: The description of Bandy (1951) is followed herein, with the exception that the sutures are frequently thickened and raised, rather than flush. D. oxycona is distinguished by its elongate, conical test with acute apex, and from D. ellisoriae (Cushman) by the flush to raised sutures and uninflated chambers of the former. This produces the characteristic flat to gently concave apertural end of the test.

Dorothia pupa (Reuss)

Textularia pupa REUSS, 1860, p.232, pl.13, figs.4,5 (fide Ellis and Messina, 1940 et seq).

Dorothia pupa (Reuss). MCGUGAN, 1964, p.941, pl.150, figs.15,16.--- HANZLIKOVÁ, 1972, p.57, pl.12, fig.8, pl.13, figs.3,8.

Dimensions of specimen CUFC 50, sample 76875: length 0.85 mm, width 0.62 mm, thickness 0.55 mm.

Remarks: The description of McGugan (1964) is followed herein. D. pupa is distinguished by its stout, rapidly flaring test, subacute apex, and markedly inflated, overlapping chambers from the similar D. biformis Finlay.

Genus MOOREINELLA Cushman and Waters, 1928

Mooreinella sp. cf. M. biserialis Cushman and Waters

Mooreinella biserialis CUSHMAN AND WATERS, 1928, p.50, pl.6, figs.9,10
(fide Ellis and Messina, 1940 et seq).

Dimensions of specimen CUFC 51, sample 76887: length 0.74 mm,
width 0.47 mm, thickness 0.28 mm.

Remarks: The description of Cushman and Waters (1928) is followed herein. This species is represented in the present study by a number of poorly preserved and apparently distorted specimens. The biserial portion appears to be more regular than in the type figure, and the initial trochospiral portion is somewhat obscure. In fact, these forms may be initially planispiral or biserial throughout. Also, the aperture does not achieve the terminal position described by Cushman and Waters.

Subfamily VALVULININAE Berthelin, 1880

Genus GOESELLA Cushman, 1933

Goëssella rugulosa Cushman

Goëssella rugulosa CUSHMAN, 1933b, p.55, pl.6, fig.7 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.47, pl.13, fig.13.

Dimensions of specimen CUFC 52, sample 76901: length 0.54 mm,
diameter 0.16 mm.

Remarks: The description of Cushman (1946) is followed herein. The transition from quadriserial through triserial and biserial to uniserial chamber arrangement, roughly finished test, and terminal rounded aperture readily distinguish this species.

Suborder MILIOLINA Delage and Hérourard, 1896
 Superfamily MILIOLACEA Ehrenberg, 1839
 Family NUBECULARIIDAE Jones, 1875
 Subfamily SPIROLOCULININAE Wiesner, 1920
 Genus SPIROLOCULINA d'Orbigny, 1826

Spiroloculina sp.

Spiroloculina sp. cf. S. cretacea Reuss, 1854. BELFORD, 1960, p.24, pl.6, figs.8-13.

Test free, strongly compressed, broadly fusiform in outline, periphery rounded. Chambers added 2 per whorl, in same plane and 180° apart, increasing slowly in size as added. Sutures distinct, depressed, curved. Wall porcellaneous, smooth. Aperture terminal, slightly produced, tooth not seen.

Dimensions of specimen CUFC 53, sample 76895: length 0.32 mm, width 0.21 mm, thickness 0.04 mm.

Remarks: The preservation of the aperture does not allow identification of any tooth structure. This species has been referred to S. cretacea Reuss by some authors, but Reuss' (1854) type figures show a truncate periphery and raised chamber margins, an observation supported by Cushman's (1946) description of that species. Cushman then went on, in his remarks, to suggest that the periphery could be rounded. Some uncertainty is thus evident in Cushman's assignment of forms with rounded peripheries to S. cretacea.

Family MILIOLIDAE Ehrenberg, 1839
 Subfamily QUINQUELOCULININAE Cushman, 1917
 Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina sphaera Nauss

Quinqueloculina sphaera NAUSS, 1947, p.340, pl.48, fig.14 (fide Ellis and Messina, 1940 et seq.).

NOT Quinqueloculina sphaera Nauss. TAPPAN, 1962, p.157, pl.37, fig.6.

Dimensions of specimen CUFC 54, sample 76870: length 0.37 mm, width 0.34 mm, thickness 0.21 mm.

Remarks: The description of Nauss (1947) is followed herein. Tappan (1962) was clearly in error, for in her description the sutures are flush, not depressed as originally defined by Nauss. In addition, the specimen figured by Tappan is rounded, not subtriangular, in section. The present forms are slightly more compressed than the type specimen of Nauss, and are rarely preserved in their entirety. Specimens are usually a combination of original material and internal mold, or are completely internal molds, as is specimen CUFC 54.

Suborder	ROTALIINA Delage and Hérourard, 1896
Superfamily	NODOSARIACEA Ehrenberg, 1838
Family	NODOSARIIDAE Ehrenberg, 1838
Subfamily	NODOSARIINAE Ehrenberg, 1838
Genus	NODOSARIA Lamarck, 1812

Nodosaria affinis Reuss

Nodosaria (Dentalina) affinis REUSS, 1845, p.26, pl.13, fig.16 (fide Ellis and Messina, 1940 et seq).

Nodosaria affinis Reuss. CUSHMAN, 1946, p.70, pl.25, figs. 8-23.

Dimensions of specimen CUFC 55, sample 76871: length 1.16 mm, diameter 0.21 mm.

Remarks: The description of Cushman (1946) is followed herein. N. affinis is distinguished from N. obscura Reuss, which has flush sutures, from N. proboscidea Reuss which has a long, slender apertural neck, and with some difficulty from Dentalina alternata (Jones) which has discontinuous ribs inserted between continuous primary or major costae.

Nodosaria aspera Reuss

Nodosaria aspera REUSS, 1845, p.26, pl.13, figs.14,15 (fide Ellis and Messina, 1940 et seq).--SLITER, 1968, p.52, pl.4, fig.11.

Stilostomella aspera (Reuss). BELFORD, 1960, p.69, pl.19, figs.1,2.

Dimensions of specimen CUFC 56, sample 76892: length 1.00 mm, diameter 0.29 mm.

Remarks: The description of Sliter (1968) is followed herein. The combination of spinose or hispid globular chambers, and slender, elongate apertural neck is distinctive of N. aspera.

Nodosaria limbata d'Orbigny

Nodosaria limbata d'ORBIGNY, 1840, p.12, pl.1, fig.1 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.53, pl.4, fig.15.

Dimensions of specimen CUFC 57, sample 76871: length 1.67 mm, diameter 0.49 mm.

Remarks: The description of Sliter (1968) is followed herein. N. limbata is distinguished from most species by the globular to pyriform chambers and strongly depressed, limbate sutures. It is distinguished from Dentalina catenula Reuss by the fact that its chambers are rectilinear and the aperture is central, not eccentric as in the latter species. The proloculus of N. limbata may be mistaken for Oolina simplex Reuss, which is unornamented, or O. apiculata Reuss, which has an apical spine. The apical spine found on some specimens of N. limbata, however, is generally more stout.

Nodosaria obscura Reuss

Nodosaria (Nodosaria) obscura REUSS, 1845, p.26, pl.13, figs.7-9 (fide Ellis and Messina, 1940 et seq).

Nodosaria obscura Reuss. POZARYSKA, 1957, p.68, pl.8, fig.5.

Dimensions of specimen CUFC 58, sample 76899: length 0.45 mm, diameter 0.14 mm.

Remarks: The description of Pożaryska (1957) is followed herein, with the exception that the number of costae is observed to be 7 or 8, versus the maximum of 14 reported by Pożaryska. N. prismatica Reuss is more elongate and parallel-sided, and has fewer costae. N. obscura, which is fusiform, is distinguished from the elongate N. affinis Reuss

by its shape as well as flush sutures of the former. There is also a number of closely similar species. N. clausa Marsson has a broadly rounded base, N. amphioxys Reuss has elongate chambers, N. nana Reuss has its greatest diameter near the base, rather than the apertural end, and N. septemcostata Geinitz is inadequately illustrated.

Nodosaria proboscidea Reuss

Nodosaria proboscidea REUSS, 1851b, p.23, pl.2, fig.6 (fide Ellis and Messina, 1940 et seq).--- MELLO, 1969, p.61, pl.6, fig.16.

Dimensions of specimen CUFC 59, sample 76874: length 1.14 mm, diameter 0.34 mm.

Remarks: The description of Mello (1969) is followed herein. This species is readily distinguished by the costate test, the collar against which the costae terminate, and the elongate apertural neck. The nature of the aperture i.e. round or radiate, is unknown.

Genus ASTACOLUS de Montfort, 1808

Astacolus cretaceus (Cushman)

Marginulina cretacea CUSHMAN, 1937a, p.94, pl.13, figs.12-15 (fide Ellis and Messina, 1940 et seq).

Astacolus cretaceus (Cushman). POZARYSKA, 1957, p.98, pl.11, figs.11,12, pl.13, fig.7, t.f.21,22.

Hemicristellaria cretacea (Cushman). TAKAYANAGI, 1960, p.108, pl.6, fig.13.

NOT Astacolus cretaceus (Cushman). MELLO, 1969, p.56, pl.6, fig.2.--- HANZLIKOVÁ, 1972, p.63, pl.14, fig.2.

Dimensions of specimen CUFC 60, sample 76889: length 0.65 mm, width 0.19 mm, thickness 0.12 mm.

Remarks: The description of Cushman (1937a) is followed herein. The species varies quite considerably in the degree to which it is coiled, like Lenticulina Lamarck, or uncoiled. As a general rule, the strongly coiled forms are larger, and have a slightly polygonal outline.

In strongly uncoiled forms, the ventral margin may be nearly straight as opposed to concave, and the width of the apertural face and degree to which the initial coil is produced are also highly variable. The specimens figured by Mello (1969) and Hanzliková (1972) are too thick to be assigned to this species.

Astacolus sp.
(Plate 3, Figs. 1, 2)

Test free, small, planispiral, in outline strongly polygonal, periphery very narrowly rounded on the convex dorsal margin, rounded on the ventral margin. Chambers low, broad, increasing gradually in size as added. Sutures distinct, somewhat limbate and raised, especially at the periphery. Wall calcareous, perforate, smooth. Aperture radiate, at peripheral angle.

Dimensions of specimen CUFC 61, sample 76870: length 0.26 mm, width 0.18 mm, thickness 0.10 mm.

Remarks: This species is represented by a single juvenile specimen. The strongly polygonal outline is distinctive.

Genus CHRYSALOGONIUM Schubert, 1907

Chrysalogonium cretaceum Cushman and Church

Chrysalogonium cretaceum CUSHMAN AND CHURCH, 1929, p. 513, pl. 39, figs. 23, 24 (fide Ellis and Messina, 1940 et seq.)---POZARYSKA, 1957, p. 94, pl. 10, fig. 4, t. f. 19.

Dimensions of specimen CUFC 62, sample 76887: length 1.07 mm, diameter 0.25 mm.

Remarks: The description of Cushman and Church (1929) is followed herein. C. cretaceum has less elongate chambers than C. texanum Cushman. It also has a rounded base and the apertural sieve plate is in a cone-shaped end. C. texanum has a basal spine, and the aperture is produced and narrower.

Genus CITHARINA d'Orbigny, in de la Sagra, 1839

Citharina geisendorferi (Franke)

Vaginulina geisendorferi FRANKE, 1928, pp.78,80, pl.7, fig.18 (fide Ellis and Messina, 1940 et seq).

Citharina geisendorferi (Franke). BELFORD, 1960, p.40, pl.11, figs.14,15.

Test free, elongate, uniserial, may be rectilinear or gently arcuate to either the dorsal or ventral side; sides flattened, periphery truncate, angles carinate. Chambers up to a maximum of 5, inflated, proloculus usually larger than succeeding chambers, which increase very gradually in size, if at all, as added. Sutures distinct, depressed, limbate, gently curved and oblique, higher on dorsal side. Wall calcareous, perforate, usually smooth, but occasionally with numerous fine longitudinal to oblique costae confined to the surface of the chambers, and often with a stout basal spine. Aperture terminal, produced, eccentric towards dorsal side, radiate.

Dimensions of specimen CUFC 63, sample 76894: length 0.50 mm, width 0.13 mm, thickness 0.11 mm.

Remarks: The inflated, subequant chambers in a linear series with carinate angles distinguish this species.

Citharina sp. cf. C. strigillata Reuss

Citharina strigillata REUSS, 1845, p.106, pl.24, fig.29 (fide Pożaryska, 1957).---SCHIJFSMA, 1946, p.41, pl.2, fig.21.

Citharina cf. strigillata (Reuss). POZARYSKA, 1957, p.172, pl.14, fig.11.

Dimensions of specimen CUFC 64, sample 76883: length 1.45 mm, width 0.19 mm, thickness 0.12 mm.

Remarks: The description of Pożaryska (1957) is followed herein. The description and figures of Reuss (1845) were not present in the Carleton University copy of the Catalogue of Foraminifera (Ellis and

Messina, 1940 et seq), and thus the present author could not determine whether the outline of the test of C. strigillata is as figured by Schijfsma (1946) or Pożaryska (1957). The present forms resemble that of Pożaryska (1957), in having the greatest width near the apertural end. C. strigillata has continuous costae running across chambers and often across sutures, whereas C. suturalis (Cushman) has costae confined to the sutures.

Citharina sp. A
(Plate 3, Fig.3)

Test free, strongly compressed, teardrop-shaped in outline, with a spine at midpoint of rounded base; inner periphery truncate, outer periphery subacute, both with carinate angles. Chambers as many as 9, low, broad, reaching back towards base of test, curved slightly under, but not reaching proloculus, increasing steadily in size as added. Sutures distinct, flush, limbate, gently curved and becoming more nearly parallel to outer margin of test as formed. Wall calcareous, perforate, with numerous fine, longitudinal, discontinuous costae parallel to outer margin of test. Aperture radiate, at outer margin of final chamber.

Dimensions of Specimen CUFC 65, sample 76875: length 0.67 mm, width 0.17 mm, thickness 0.04 mm.

Remarks: The flattened, teardrop-shaped test, nearly bilaterally symmetrical in outline, with numerous fine costae and basal spine, readily distinguishes this species from other species of Citharina.

Citharina sp. B
(Plate 3, Fig.4)

Test free, lanceolate, nearly parallel-sided; periphery on inner and outer margins narrowly rounded. Chambers quite low, broad, increasing very gradually in size as added. Sutures distinct, gently raised, limbate, nearly parallel to outer margin of test. Wall calcareous, perforate, smooth. Aperture indeterminate.

Dimensions of specimen CUFC 66, sample 76903: length 0.69 mm, width 0.18 mm, thickness 0.10 mm.

Remarks: This species is represented by three incomplete specimens, none with the base or aperture preserved. It is distinguished by its smooth, lanceolate test.

Genus DENTALINA Risso, 1826

Dentalina alternata (Jones)

Nodosaria zippei Reuss var. alternata JONES, 1886, p.330, pl.27, fig.10, (fide Ellis and Messina, 1940 et seq).

Dentalina alternata (Jones). CUSHMAN, 1946, p.64, pl.22, figs.29,30.--- HANZLIKOVÁ, 1972, p.64, pl.14, fig.6.

Dimensions of specimen CUFC 67, sample 76876: length 1.63 mm, diameter 0.29 mm.

Remarks: The description of Cushman (1946) is followed herein. Occasional specimens have a proloculus that is larger than the succeeding chamber. D. alternata is distinguished from D. pertinens Cushman, which has an acute initial end, rather than a rounded proloculus with basal spine, and from both D. pertinens and Nodosaria affinis Reuss by the presence of secondary costae in this species. The distinction between D. alternata and N. affinis is often difficult as the secondary costae of D. alternata are not always clearly interrupted at the sutures.

Dentalina basiplanata Cushman

Dentalina reussi Neugeboren. PLUMMER, 1931, p.151, pl.11, fig.5.

Dentalina basiplanata CUSHMAN, 1938b, p.38, pl.6, figs.6-8 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.57 (partim), pl. 5, figs.10,11.

Dimensions of specimen CUFC 68, sample 76873: length 1.85 mm, diameter 0.24 mm.

Remarks: The description of Cushman (1938b) is followed herein. This species is distinguished from D. gracilis (d'Orbigny) which has more elongate chambers and a smaller proloculus, and from the otherwise very similar D. luma Belford which has a basal spine. The specimen figured by Sliter (1968) in plate 5, figure 9 is assignable to D. megalopolitana Reuss which has a basal spine and a more steadily tapering test than D. basiplanata.

Dentalina sp. cf. D. basitorta Cushman

Dentalina basitorta CUSHMAN, 1938b, p.37, pl.6, figs.4,5 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.31, pl.9, figs.4,5.

Dimensions of specimen CUFC 69, sample 76904: Length 1.10 mm, diameter 0.26 mm.

Remarks: The description of Cushman (1938b) is followed herein, with the additional note that the irregularly biserial portion is not observed in the few specimens found in the present study. D. basitorta is distinguished from D. legumen (Reuss) by the former's more nearly parallel-sided test, and more strongly depressed sutures.

Dentalina catenula Reuss

Dentalina catenula REUSS, 1860, p.185, pl.3, fig.6 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.57, pl.5, fig.14.

Dentalina soluta Reuss. PLUMMER, 1931, p.150, pl.11, fig.14.

Dimensions of specimen CUFC 70, sample 76887: length 0.86 mm, diameter 0.24 mm.

Remarks: The description of Sliter (1968) is followed herein. D. catenula is readily distinguished from most species by the subglobular to pyriform chambers and strongly depressed sutures, and from Nodosaria limbata d'Orbigny by the gently arcuate test and eccentric aperture of the former species. Plummer (1931) was in error in assigning these

forms to D. soluta Reuss, which is characterized by very strongly separated chambers.

Dentalina cylindroides Reuss

Dentalina cylindroides REUSS, 1860, p.185, pl.1, fig.8 (fide Ellis and Messina, 1940 et seq).---GRAHAM AND CHURCH, 1963, p.28, pl.2, fig.13.

Test free, elongate, uniserial, often with basal spine. Chambers few, elongate, closely appressed, proloculus larger than or same size as succeeding chamber, chambers then increasing gradually in size as added. Sutures distinct, limbate, flush, horizontal. Wall calcareous, perforate, smooth. Aperture terminal, radiate, slightly eccentric.

Dimensions of specimen CUFC 71, sample 76878: length 0.45 mm, diameter 0.13 mm.

Remarks: The low number of chambers (a maximum of three in the present study), flush horizontal sutures, and basal spine readily distinguish this species.

Dentalina gracilis (d'Orbigny)

Nodosaria (Dentalina) gracilis d'ORBIGNY, 1840, p.14, pl.1, fig.5 (fide Ellis and Messina, 1940 et seq).

Dentalina gracilis (d'Orbigny). SLITER, 1968, p.57, pl.5, figs.15,16.

Dimensions of specimen CUFC 72, sample 76889: length 1.27 mm, diameter 0.15 mm.

Remarks: The description of Sliter (1968) is followed herein. D. gracilis is distinguished by its slender, arcuate test with elongate chambers that are increasingly inflated as added. There may or may not be a basal spine.

Dentalina legumen (Reuss)

Nodosaria (Dentalina) legumen REUSS, 1845, p.28, pl.13, figs.23,24 (fide Ellis and Messina, 1940 et seq).

Dentalina legumen (Reuss). POZARYSKA, 1957, p.81, t.f.16.---GRAHAM AND CHURCH, 1963, p.29, pl.2, figs.14-16.

Dimensions of specimen CUFC 73, sample 76871: length 0.67 mm, diameter 0.17 mm.

Remarks: The description of Pożaryska (1957) is followed herein. D. legumen is distinguished by its nearly straight outer margin and convex inner margin, resulting in a bean-shaped test. The sutures are less strongly oblique and less strongly depressed than in the similar D. basitorta Cushman.

Dentalina luma Belford

Dentalina luma BELFORD, 1960, p.34, pl.10, figs.6-11.

Dentalina basiplanata Cushman. SLITER, 1968, p.57 (partim), pl.5, fig.8.

Dimensions of specimen CUFC 74, sample 76892: length 1.76 mm, diameter 0.30 mm.

Remarks: The description of Belford (1960) is followed herein. D. luma is distinguished from D. basiplanata Cushman which has no basal spine, and from D. megalopolitana Reuss which has less strongly depressed sutures and a more strongly tapering test. The specimen figured by Sliter (1968) as D. basiplanata in plate 5, figure 8 is likely D. luma based on the presence of a basal spine with rounded proloculus.

Dentalina megalopolitana Reuss

Dentalina megalopolitana REUSS, 1855, p.267, pl.8, fig.10 (fide Ellis and Messina, 1940 et seq).---POZARYSKA, 1957, p.84, pl.7, figs.12,13, t.f.17.

NOT Dentalina megalopolitana Reuss. HANZLIKOVÁ, 1972, p.64, pl.14, fig.10.

Dimensions of specimen CUFC 75, sample 76885: length 0.66 mm, diameter 0.14 mm.

Remarks: The description of Pożaryska (1957) is followed herein. D. megalopolitana is distinguished by its flush sutures and cylindrical chambers, except for the last two which are inflated, with depressed sutures. The proloculus is small, and furnished with a basal spine. The specimen figured by Hanzliková (1972) is not assignable to D. megalopolitana because it has no basal spine, and is finely costate.

Dentalina pertinens Cushman

Dentalina pertinens CUSHMAN, 1933b, p.40, pl.6, figs.15-18 (fide Ellis and Messina, 1940 et seq).---MELLO, 1969, p.60, pl.6, fig.12.

Dimensions of specimen CUFC 76, sample 76870: length 1.10 mm, diameter 0.29 mm.

Remarks: The description of Mello (1969) is followed herein. The small test, chambers which become inflated, and the twisted costae are distinctive of this species. Marginulina navarroana Cushman is very similar, but the chambers are markedly inflated throughout, and the test is more strongly curved. Figured specimens of D. pertinens have convex outer margins and concave inner margins, but numerous specimens in the present study have a straight to concave outer margin, and convex inner margin. The twisted costae never extend above the middle of the final chamber.

Genus DENTALINOIDES Marie, 1941

Dentalinoides canulina Marie

Dentalinoides canulina MARIE, 1941, p.208, pl.32, figs.306,307 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.70, pl.19, figs.6-8.

Dimensions of specimen CUFC 77, sample 76893: length 0.96 mm, diameter 0.14 mm.

Remarks: The description of Marie (1941) is followed herein. The slender, arcuate test, rounded proloculus, and chambers which become higher than broad and mildly inflated distinguish this species from most

others, and the eccentric, round aperture distinguishes this species from Dentalina gracilis (d'Orbigny).

Dentalinoides sp.
(Plate 3, Figs.6,7)

Test free, elongate, uniserial and arcuate. Chambers 7 or 8, proloculus rounded, larger than succeeding chamber; chambers initially broader than high, soon becoming higher than broad, increasing steadily in size as added, and becoming inflated. Sutures distinct, initially flush and horizontal, becoming gently depressed and mildly oblique. Wall calcareous, perforate, ornamented by numerous fine longitudinal costae that may initially cover entire test, but later are confined to sutural areas. Aperture terminal, round, eccentric and connected to previous aperture by a thin, straight internal tube.

Dimensions of specimen CUFC 78, sample 76875: length 0.78 mm, diameter 0.12 mm.

Remarks: The terminal, round, eccentric aperture, and costae that become confined to the sutural areas distinguish this species.

Genus FRONDICULARIA DeFrance, in d'Orbigny, 1826

Frondicularia bicuspidata Reuss

Frondicularia bicuspidata REUSS, 1845, p.32, pl.13, fig.46 (fide Ellis and Messina, 1940 et seq).

Frondicularia sp. aff. F. bicuspidata Reuss. GRAHAM AND CHURCH, 1963, p.32, pl.2, fig.24.

Test free, elongate, uniserial, consisting of a rectilinear series of 2 or 3 chambers; periphery indented in face view, with two quite closely spaced, thin keels. Chambers inflated, with subglobular proloculus, succeeding chamber smaller in all dimensions, lower than broad if a third chamber present, which chamber is elongate, usually as large as or larger than proloculus. Sutures distinct, depressed, limbate, quite strongly arched. Wall calcareous, perforate, with numerous fine

longitudinal costae prominent on lower half of proloculus, may extend across first suture onto second chamber. Aperture terminal, radiate, may have slight lip, produced on a neck that is triangular in face view, thicker than upper portion of final chamber, with two peripheral keels continuing from margins of test.

Dimensions of specimen CUFC 79, sample 76892: length 0.41 mm, width 0.18 mm, thickness 0.16 mm.

Remarks: This species is distinguished from other species of Fronicularia by the subglobular rather than arched chambers, well developed carinae on the margins, basal costae, and low number of chambers. Citharina geisendorferi (Franke) is in some respects similar, but is distinguished by the asymmetry of the test in face view, the oblique rather than curved but horizontal sutures of F. bicuspidata, and the lack of an apertural neck.

Fronicularia bulla Belford

Fronicularia bulla BELFORD, 1960, p.49, pl.13, figs.9-11.

Dimensions of specimen CUFC 80, sample 76903: length 3.23 mm, width 0.58 mm, thickness 0.25 mm.

Remarks: The description of Belford (1960) is followed herein. The aperture and proloculus are not preserved in any of the present specimens. F. bulla is distinguished from several species by its lanceolate, nearly parallel-sided test, from F. olszewskii Pozaryska by the former's raised, thickened sutures in the middle of the test, from F. verneuilliana d'Orbigny by its angular or narrowly truncate periphery, and from F. lanceola var. bidentata Cushman which has a rounded to sub-angular periphery.

Fronicularia clarki Bagg

Fronicularia clarki BAGG, 1895, p.11, (fide Ellis and Messina, 1940, et seq).---CUSHMAN, 1946, p.92, pl.38, figs.1-5.

NOT Fronidularia cf. F. clarki Bagg. SAID AND KENAWY, 1956, p.136,
pl.2, fig.37.

Test free, flattened, outline elliptical in the megalospheric form, palmate in the microspheric; margins carinate. Chambers 6 or more, proloculus globular, followed by a single subglobular chamber, succeeding chambers low, broad, strongly arched and embracing, in the megalospheric form reaching back nearly to base of test, in microspheric form less so; mildly inflated, increasing steadily in size as added. Sutures distinct, limbate, and raised, with paired ridges in center of test marking previous apertures. Wall calcareous, perforate, with 3 or 4 longitudinal costae on proloculus. Aperture terminal, radiate, produced on short neck.

Dimensions of specimen CUFC 81, sample 76887: length 1.75 mm, width 0.63 mm, thickness 0.22 mm.

Remarks: F. clarki is distinguished from F. mucronata Reuss which has an elongate proloculus ornamented by a single longitudinal costa. The form figured by Said and Kenawy (1956) as F. clarki is parallel-sided and the chambers are not embracing. It thus does not belong to this species.

Fronidularia costulifera Belford

Fronidularia costulifera BELFORD, 1960, p.51, pl.14, figs.1-3.

Dimensions of specimen CUFC 82, sample 76887: length 1.05 mm, width 0.78 mm, thickness 0.15 mm.

Remarks: The description of Belford (1960) is followed herein, with the following additional notes. In the present specimens, the sutures are occasionally observed to be marked by pairs of parallel, closely spaced ridges. The sutures are also gently curved, and the test tends to flare more rapidly than in the specimens figured by Belford. The strongly raised double suture lines, and short longitudinal ribs readily distinguish this species.

Fronicularia intermittens Reuss

Fronicularia intermittens REUSS, 1866, p.460, pl.1, fig.11 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.61, pl.6, fig.5.

Dimensions of specimen CUFC 83, sample 76903: length 1.66 mm, width 0.55 mm, thickness 0.16 mm.

Remarks: The description of Sliter (1968) is followed herein. The costae may not be observed on some specimens. F. intermittens is distinguished from most other species by the lanceolate test and raised sutures, and from F. verneuilliana d'Orbigny, which has a much less rapidly flaring test.

Fronicularia mucronata Reuss

Fronicularia mucronata REUSS, 1845, p.31, pl.13, figs.43-44 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.62, pl.6, fig.7.

Dimensions of specimen CUFC 84, sample 76876: length 1.52 mm, width 0.67 mm, thickness 0.11 mm.

Remarks: The description of Sliter (1968) is followed herein. F. mucronata is distinguished from most species by the compressed, ovate test, from F. clarki Bagg by the former's elongate proloculus, and from F. watersi Cushman by the single longitudinal rib on the proloculus of the present species.

Fronicularia sp. cf. F. olszewskii Pożaryska

Fronicularia olszewskii POŻARYSKA, 1957, p.152, pl.25, fig.7.

Dimensions of specimen CUFC 85, sample 76894: length 0.89 mm, width 0.27 mm, thickness 0.18 mm.

Remarks: The description of Pożaryska (1957) is followed herein, although there are no complete specimens in the present study. F. olszewskii is distinguished by the inflated costate proloculus, extremely fine longitudinal striae, and indistinct sutures. The present

forms have an acute, rounded, or narrowly truncate periphery, and so are not assigned with certainty to F. olszewskii.

Fronidicularia teuria Finlay

Fronidicularia teuria FINLAY, 1939, p.316, pl.26, figs.60,61 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.47, pl.13, figs.1,2.

Test free, lanceolate, uniserial; periphery gently indented in face view, truncate, with well developed keels on angles of test. Chambers few, proloculus globular, usually followed by narrower and less strongly inflated second chamber, chambers increasing gradually in size thereafter, and mildly inflated. Sutures distinct to indistinct, limbate, and very gently depressed to flush, not too strongly arched. Wall calcareous, perforate, ornamented by numerous bifurcating, anastomosing and sinuous coarse costae that are essentially longitudinal, running from short basal spine to base of aperture, often obscuring sutures but occasionally depressed at sutures. Aperture terminal, radiate, produced on neck.

Dimensions of specimen CUFC 86, sample 76893: length 0.78 mm, width 0.32 mm, thickness 0.21 mm.

Remarks: The low number of quite high chambers, and rather complex arrangement of longitudinal costae distinguish F. teuria from most species of Fronidicularia. F. frankei Cushman has stout, discontinuous costae, and F. linguiformis Marsson has finer costae and but 3 costae on the proloculus.

Fronidicularia undulosa Cushman

Fronidicularia undulosa CUSHMAN, 1936a, p.13, pl.3, figs.7-11 (fide Ellis and Messina, 1940 et seq).---POZARYSKA, 1957, p.155, pl.21, fig.7.

Dimensions of specimen CUFC 87, sample 76892: length 0.92 mm, width 0.35 mm, thickness 0.07 mm.

Remarks: The description of Cushman (1936a) is followed herein. The sutures are marked by thin carinae, as noted by Pożaryska (1957). This species is readily distinguished by the undulose and carinate periphery, and in many specimens, the width actually decreases after the first 3 or 4 chambers.

Fronicularia sp. cf. F. verneuilliana d'Orbigny

Fronicularia verneuilliana d'ORBIGNY, 1840, p.20, pl.1, figs.32,33
(fide Ellis and Messina, 1940 et seq.)---CUSHMAN, 1946, p.90,
pl.36, figs.12-15.---SLITER, 1968, p.62, pl.6, figs.8-10.

Dimensions of specimen CUFC 88, sample 76902: length 1.26 mm,
width 0.28 mm, thickness 0.25 mm.

Remarks: The description of Cushman (1946) is followed herein. There is quite a range of variation in the degree of tapering of the test, and in the thickness of the truncate margin. F. verneuilliana is distinguished by the costate globular proloculus, raised sutures, and truncate periphery. A few specimens which may belong to this species have costae on the sutures.

Fronicularia sp.
(Plate 3, Fig.5)

Test free, large, palmate, compressed; periphery undulose in face view, rounded in section. Chambers few, proloculus globular, followed by low, broad, strongly arched chambers that initially embrace proloculus entirely, eventually embracing only previous chamber at most, increasing erratically in size as added. Sutures somewhat indistinct, thickened and raised, especially in middle of test, and rounded; very gently curved except at periphery, and interrupted in middle of test at previous apertures. Wall calcareous, perforate, smooth except for proloculus which may possess a single very blunt longitudinal rib. Aperture terminal, radiate, produced only slightly if at all.

Dimensions of specimen CUFC 89, sample 76888: length 1.73 mm, width 1.11 mm; thickness 0.45 mm.

Remarks: This species is represented by a few large specimens, and is readily distinguished by the completely embraced globular proloculus, undulose and rounded periphery, and bluntly raised sutures.

Genus LAGENA Walker and Jacob, in Kanmacher, 1798

Lagena costifera subsp. Terquem and Terquem, 1886

Lagena costifera TERQUEM AND TERQUEM, 1886, p.330, pl.11, figs.3,4 (fide Ellis and Messina, 1940 et seq).

Fissurina costifera (Terquem and Terquem). POZARYSKA, 1957, p.60, pl.6, fig.8.

Dimensions of specimen CUFC 90, sample 76868: length 0.25 mm, diameter 0.16 mm.

Remarks: These forms differ somewhat from the description of Pozaryska (1957). Secondary costae are inserted between the primary costae, and in some specimens these primary costae are in fact two closely spaced costae of equal prominence. The test is barely compressed, rendering definite assignment to either Lagena or Fissurina difficult. These forms are distinguished mainly by the well developed collar around the aperture, without a prominent neck.

Lagena geometrica Reuss

Lagena geometrica REUSS, 1863b, p.334, pl.5, fig.74 (fide Ellis and Messina, 1940 et seq).—POZARYSKA, 1957, p.43, pl.2, fig.3.

Lagena hexagona (Williamson). CUSHMAN, 1946, p.95, pl.39, fig.16.

Dimensions of specimen CUFC 91, sample 76885: length 0.37 mm, diameter 0.30 mm.

Remarks: The description of Pozaryska (1957) is followed herein. The conical collar at the base of the long thin neck may be continuous with the test or distinctly separated by an indentation. The neck may be surrounded by rings at irregular intervals. L. geometrica is

characterized by raised hexagonal ornament in which the hexagons lie on their sides, whereas L. hexagona (Williamson) is characterized by hexagons standing on their angles i.e. at 90° to those of L. geometrica. Reference to Cushman's (1946) figured specimen of L. hexagona reveals that in fact, the form belongs to L. geometrica.

Lagena globosa (Montagu)

Serpula (Lagena) laevis globosa WALKER AND BOYS, 1784, p.3, pl.1, fig.8, (fide Ellis and Messina, 1940 et seq).

Vermiculum globosa MONTAGU, 1803, p.523 (fide Ellis and Messina, 1940 et seq).

Lagena sp. cf. L. globosa (Montagu). SAID AND KENAWY, 1956, p.136, pl.3, fig.7.

NOT Lagena globosa (Montagu). SCHIJFSMA, 1946, p.54, pl.2, fig.16.

Test free, small, unilocular, globular to elliptical to subpyriform, with or without short apical spine. Wall calcareous, perforate, smooth. Aperture terminal, rounded, often on a neck.

Dimensions of specimen CUFC 92, sample 76871: length 0.35 mm, diameter 0.26 mm.

Remarks: The aperture is always rounded, and may be produced on a thin neck. This neck may be very short, with or without a phialine lip, may join the test directly or may be on the end of a bluntly conical collar separated slightly from the rest of the test, and may even be gently curved. On some specimens a short tube is observed projecting into the chamber. Thus some doubt is cast on the reliability of using presence or absence of an entosolenian tube to distinguish between Fissurina and Lagena. The two genera are herein distinguished on the basis of the aperture being slit-like in a markedly bilaterally symmetric test for Fissurina, or rounded for Lagena. L. globosa is readily distinguished by the smooth, essentially globular test. Schijfsma (1946) was clearly in error in assigning forms with radiate apertures

to this species and genus. They more properly belong to Oolina simplex Reuss.

Lagena sp. cf. L. hispida Reuss

Lagena hispida REUSS, 1863b, p.335, pl.6, figs.77-79 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968. p.64, pl.6, fig.21.

Dimensions of specimen CUFC 93, sample 76883: length 0.31 mm, diameter 0.27 mm.

Remarks: The description of Sliter (1968) is followed herein. A few specimens occur in the present study that may be referred to L. hispida. The neck is very poorly developed, and the surface ornament is not truly hispid, but consists rather of short pillars with wide, flattened terminations.

Lagena semiinterrupta Berry

Lagena sulcata (Walker and Jacob) var. semiinterrupta BERRY in BERRY AND KELLY, 1929, p.5, pl.3, fig.19 (fide Ellis and Messina, 1940, et seq).

Lagena semiinterrupta Berry. SLITER, 1968, p.64, pl.16, figs.19,20.

Dimensions of specimen CUFC 94, sample 76879: length 0.28 mm, diameter 0.18 mm.

Remarks: The description of Sliter (1968) is followed herein. The shoulder at the base of the apertural neck may be a prominent or subtle feature, although the neck itself is usually quite short. L. acuticosta Reuss is not pyriform, and L. paucicosta Franke has fewer costae. L. semiinterrupta is distinguished from L. sulcata Walker and Jacob by possessing fewer, more widely spaced primary costae, and where developed, by its secondary and tertiary costae. The apertural neck and conical collar distinguish this species from L. costifera Terquem and Terquem.

Lagena semiornata Terquem and Terquem

Lagena semi-ornata TERQUEM AND TERQUEM, 1886, p.330, pl.11, fig.2 (fide Ellis and Messina, 1940 et seq).---POZARYSKA, 1957, p.51, pl.1, fig.6.

Lagena semilineata Wright. CUSHMAN, 1946, p.95, pl.39, fig.25.

Dimensions of specimen CUFC 95, sample 76871: length 0.20 mm, diameter 0.16 mm.

Remarks: The description of Pozaryska (1957) is followed herein. This species is distinguished from L. semilineata Wright which has an elongate neck. The pyriform test, with only the lower half costate, distinguishes this species. The basal spine observed by Terquem and Terquem (1886) is not observed in the present specimens. The specimen figured by Cushman (1946) as L. semilineata lacks the elongate neck characteristic of that species, and should be referred to L. semiornata. Pozaryska's (1957) figured specimen of L. semilineata also lacks the elongate neck, but it appears to have been broken off.

Lagena sulcata (Walker and Jacob)

Serpula (Lagena) sulcata WALKER AND JACOB, in KANMACHER, 1798, p.634, pl.14, fig.5 (fide Ellis and Messina, 1940 et seq).

Lagena sulcata (Walker and Jacob). PLUMMER, 1931, p.159, pl.10, fig.11.

Lagena sulcata Walker and Jacob. BELFORD, 1960, p.55, pl.14, figs.12, 13.

Lagena cf. L. cayeuxi Marie. MCGUGAN, 1957, p.339, pl.31, fig.22.

Lagena sulcatiformis Pozaryska and Urbanek. POZARYSKA, 1957, p.55, pl.1, figs.8-10, t.f.5-8.---HANZLIKOVÁ, 1972, p.66, pl.16, fig.1.

Lagena acuticosta Reuss. SLITER, 1968, p.63, pl.6, figs.22,23.

Test free; unilocular, globular to ellipsoidal. Wall calcareous, perforate, ornamented by numerous (on the order of 21) longitudinal costae. Costae typically reach the base, bifurcating just above this point, terminating in a long spine or at a single, slight, acute projection, or may join a very small, open ring at base; in several specimens, costae terminate well before base and do not merge with test, but

project downward, forming a distinct fringe around the base of the chamber, which often is provided with a short, blunt spine. Aperture terminal, round, at the end of a neck which may be quite short or as long as the chamber, tapering or of constant diameter, with or without a lip at the tip. Neck usually on a bluntly conical base that may be smoothly transitional from the chamber, or may be distinctly separate, forming a shoulder.

Dimensions of specimen CUFC 96, sample 76873: length 0.35 mm, diameter 0.28 mm.

Remarks: Only one adequate description of these forms was found in the literature, that being Pożaryska's (1957) description of L. sulcatiformis. Unfortunately, that description did not deal with the variation of the apertural neck, and it includes forms in which the costae extend right to the aperture. This is not observed in the present specimens. Nor does Pożaryska's description allow for forms in which the costae fail to reach the base. L. sulcata is distinguished by the numerous closely spaced longitudinal costae, without secondary costae, that extend from the top of the chamber to below the midpoint of the chamber.

Lagena trigona Koch

Lagena trigona KOCH, 1923, p.345, t.f.2 (fide Ellis and Messina, 1940 et seq).

Test free, unilocular, pyriform, tricarinate, with convex sides. Wall calcareous, perforate, with three equally spaced costae that extend from the base, without spine, to the apertural neck, where they fuse. Aperture terminal, round, at end of short neck.

Dimensions of specimen CUFC 97, sample 76881: length 0.28 mm, diameter 0.17 mm.

Remarks: This species is distinguished from L. trigono-elliptica Balkwill and Millett which is elliptical in side view, has concave sides, and an aperture that is not produced on a neck.

Lagena sp. A
(Plate 3, Figs. 10-12)

Test free, unilocular, pyriform, with a horizontal ring surrounding the test above the base, and a very small depression at the base. Wall calcareous, perforate, smooth. Aperture terminal, round, on the end of a very blunt, slightly produced neck.

Dimensions of specimen CUFC 98, sample 76887: length 0.31 mm, diameter 0.28 mm.

Remarks: The pyriform test with horizontal ring is very distinctive, and quite common in the present study.

Lagena sp. B
(Plate 3, Figs. 8, 9)

Test free, unilocular, subglobular. Wall calcareous, perforate, ornamented with 7 evenly spaced longitudinal costae that actually are initially rows of spines that reach near base of test, fusing to form true costae near the equator of test, extending nearly halfway up slender, elongate neck. Aperture terminal, round, on end of neck which is as long as chamber.

Dimensions of specimen CUFC 99, sample 76874: length 0.41 mm, diameter 0.23 mm.

Remarks: The unusual ornamentation, consisting of rows of spines that fuse to form costae, is distinctive of this species.

Genus LENTICULINA Lamarck, 1804

Lenticulina davisii (Bandy)

Robulus davisii BANDY, 1949, p. 59, pl. 8, fig. 4 (fide Ellis and Messina, 1940 et seq.).

Lenticulina macrodisca (Rauss). TRUJILLO, 1960, pl. 45, fig. 1.

Lenticulina davis (Bandy). SLITER, 1968, p.66, pl.7, fig.4.

Dimensions of specimen CUFC 100, sample 76870: diameter 0.67 mm, thickness 0.39 mm.

Remarks: The description of Bandy (1949) is followed herein. L. davis is distinguished by the very thick test, rounded periphery, very large umbos, and its 8 to 10 chambers with nearly radial sutures. There is some problem with the form assigned by Trujillo (1960) to L. macrodisca (Reuss). Although his description agrees quite well with L. macrodisca, the figured specimen clearly belongs to L. davis based on the number of chambers, and radial sutures.

Lenticulina isidis (Schwager)

Cristellaria isidis SCHWAGER, 1883, p.110, pl.26(3), fig.12 (fide Ellis and Messina, 1940 et seq).

Robulus isidis (Schwager). CUSHMAN, 1946, p.54, pl.17, fig.10.

NOT Robulus isidis (Schwager). SAID AND KENAWY, 1956, pl.129, pl.2, fig.7.

Test free, lenticular, planispiral, involute, biumbonate, umbos very small if at all apparent; periphery entire, narrowly rounded with a blunt keel. Chambers wedge shaped, broader than high, increasing steadily in size as added, seven in final whorl. Sutures indistinct, flush to very gently depressed, oblique, curved. Wall calcareous, perforate, smooth. Apertural face rather narrow, convex, heart shaped. Aperture at peripheral angle, radiate, without robuline slit.

Dimensions of specimen CUFC 101, sample 76872: diameter 0.59 mm, thickness 0.31 mm.

Remarks: The low number of chambers, blunt keel, convex apertural face, and very small umbos distinguish this species, which almost appears umbilicate. The specimen figured by Said and Kenawy (1956) as R. isidis has large umbos, a well developed keel, and raised sutures, and thus should not be referred to this species.

Lenticulina macrodisca (Reuss)

Cristellaria (Cristellaria) macrodisca REUSS, 1863a, p.78, pl.9, fig.5
(fide Ellis and Messina, 1940 et seq).

Robulus macrodiscus (Reuss). CUSHMAN, 1946, p.54, pl.17, fig.14.

Robulus tumidus TAKAYANAGI, 1960, p.116, pl.7, fig.11.

Lenticulina macrodisca (Reuss). TRUJILLO, 1960, p.312, NOT pl.45,
fig.1.

NOT Lenticulina macrodisca (Reuss). TAPPAN, 1962, p.162, pl.40,
figs.5-8.

Dimensions of specimen CUFC 102, sample 76878: diameter 0.78 mm,
thickness 0.49 mm.

Remarks: The description for R. tumidus of Takayanagi (1960) is followed herein, although the apertural face is bordered by what would be described as quite prominent ridges. The form figured by Trujillo (1960) as L. macrodisca is thick, with a rounded periphery, 9 chambers, large umbos and nearly radial sutures, and thus clearly belongs to L. davisii (Bandy). The forms referred by Tappan (1962) to L. macrodisca have too many chambers, the umbos are too small, the sutures are distinctly curved, and the periphery is narrowly rounded. L. macrodisca is distinguished by its large umbos, six or seven chambers in the final whorl, nearly straight, tangential sutures, carinate periphery, and strongly embracing whorls, such that the bordered apertural face is quite low.

Lenticulina mediolodensis (Israelsky)

Cristellaria mediolodensis ISRAELSKY, 1955, p.33, pl.12, figs.24,25.

Dimensions of specimen CUFC 103, sample 76885: diameter 0.56 mm,
thickness 0.24 mm.

Remarks: The description of Israelsky (1955) is followed herein.
L. mediolodensis is distinguished most readily by the final chamber

which merges quite smoothly into the periphery, the apertural face which is convex and passes smoothly into the sides of the final chamber, and the periphery, which is initially keeled but becomes subacute.

Planularia howelli Olsson (1960) has a robuline slit, but is otherwise very similar. It may be distinguished by the more pronounced indentation of the periphery at the base of the apertural face.

Lenticulina modesta (Bandy)

Robulus modestus BANDY, 1951, p.493, pl.72, fig.9.

Lenticulina modesta (Bandy). SLITER, 1968, p.66, pl.7, fig.5.

Dimensions of specimen CUFC 104, sample 76888: diameter 0.65 mm, thickness 0.32 mm.

Remarks: The description of Bandy (1951) is followed herein. L. modesta is distinguished by its acute periphery, curved, flush, tangential sutures, and the slight uncoiling tendency in the final chambers. The apertural face has quite thick, rounded borders. L. matsumotoi Takayanagi has strongly curved sutures, and L. stephensoni Cushman has more chambers and does not tend to uncoil.

Lenticulina oblonga (Takayanagi)

Robulus oblongus TAKAYANAGI, 1960, p.115, pl.7, fig.8.

Robulus firmus TAKAYANAGI, 1960, p.114, pl.7, fig.4.

Lenticulina nuda (Reuss). GRAHAM AND CHURCH, 1963, p.35, pl.3, fig.10.

Dimensions of specimen CUFC 105, sample 76887: diameter 0.78 mm, thickness 0.32 mm.

Remarks: The description of Takayanagi (1960) is followed herein, although in the present study, the specimens may lack rounded rims on the apertural face. The present author questions whether R. firmus is a separate species, or lies within the range of variation of L. oblonga. R. firmus is supposed to be thicker, with one less chamber. A problem arises with the use by Takayanagi of the species name oblonga, as

Coryell and Rivero erected the species Robulus oblongus in 1940. Hence their species should have priority. It seems that a new name would be desirable for the present species, perhaps L. firma if R. firmus and R. oblongus are conspecific. L. oblonga (Takayanagi) is distinguished by the thick, blunt, clear keel, gently curved sutures which meet at a single point, with no umbo, and its tendency to uncoil. L. nuda (Reuss) is distinguished by having all the sutures meet at the periphery, hence Graham and Church (1963) were in error.

Lenticulina ovalis (Reuss)

Cristellaria ovalis REUSS, 1844, p.213 (fide Ellis and Messina, 1940 et seq).---REUSS, 1845, pl.8, fig.49, pl.12, fig.19, pl.13, figs.60-63 (fide Ellis and Messina, 1940 et seq).

Lenticulina ovalis (Reuss). POZARYSKA, 1957, p.126, pl.15, fig.4.---SLITER, 1968, p.66, pl.7, fig.12.

Dimensions of specimen CUFC 106, sample 76887: diameter 0.84 mm, thickness 0.48 mm.

Remarks: The description of Pozaryska (1957) is followed herein, with the additional note that there is often a thin, narrow keel which always merges into the periphery by the final few chambers. L. ovalis is characterized by the prominent proloculus or early portion of the test which appears hemispherical, and causes the test to be very thick, often as thick as it is large in diameter. The periphery on the bottom of the test would be very broadly rounded but for the keel, which is also a distinguishing feature when present, as is the very low number of chambers, 7 at a maximum. Robulus alexanderi Sandidge is very similar, but has more chambers, is thinner, and has a subacute periphery.

Lenticulina pseudosecans (Cushman)

Robulus pseudo-secans CUSHMAN, 1938b, p.32, pl.5, fig.3 (fide Ellis and Messina, 1940 et seq).

Lenticulina pseudo-secans (Cushman). TRUJILLO, 1960, p.314, pl.45, fig.5.

Lenticulina spissocostata Cushman. PERLMUTTER AND TODD, 1965, pl.1, fig.13.

Robulus spissocostatus Cushman. MELLO, 1969, p.53 (partim), pl.5, figs.8,9.

Dimensions of specimen CUFC 107, sample 76904: diameter 0.68 mm, thickness 0.36 mm.

Remarks: The description of Cushman (1938b) is followed herein. In the present specimens, the raised sutures are observed to thin gradually towards the periphery. L. pseudosecans is distinguished by the raised sutures, thin, wide keel, and the 7 or 8 chambers in the final whorl. Cristellaria navarroensis Plummer differs in having 10 or more chambers in the final whorl. The description of Mello (1969) for R. spissocostatus includes forms with as few as 6 chambers, and with well developed keels. These forms properly are referred to L. pseudosecans, as are the two figured specimens of Mello. For the same reason, the specimen figured in plate 1, figure 13 by Perlmutter and Todd (1965) as L. spissocostata belongs to L. pseudosecans.

Lenticulina revoluta (Israelsky)

Robulus revolutus ISRAELSKY, 1955, p.49, pl.15, figs.3-6.

Lenticulina revoluta (Israelsky). SLITER, 1968, p.67, pl.7, fig.11.

Dimensions of specimen CUFC 108, sample 76886: diameter 0.37 mm, thickness 0.20 mm.

Remarks: The description of Israelsky (1955) is followed herein, with the exception that the aperture is observed to be radiate, not oval. This feature was likely the result of broken specimens in Israelsky's study. L. revoluta is readily distinguished by the test which is keeled throughout, the arched chambers, and very strongly curved, oblique sutures meeting at the umbos.

Lenticulina rotulata (Lamarck)

Lenticulites ^rrotulata LAMARCK, 1804, p.188 (fide Ellis and Messina, 1940, et seq).---LAMARCK, 1806, pl.62(14), fig.11 (fide Ellis and Messina, 1940 et seq).

Lenticulina rotulata (Lamarck). TAKAYANAGI, 1960, p.103, pl.5, fig.29.

Test free, lenticular, planispiral, involute, biumbonate, umbos. large, clear, protruding somewhat from test, nearly central; nearly circular in side view, periphery acute, often with a wide, thin, clear keel that merges into the periphery by the final few chambers. Chambers 10 or more in the final whorl, wedge shaped, low and broad, increasing slowly in size as added. Sutures distinct, limbate, flush to very gently raised, nearly straight, and tangential. Wall calcareous, perforate, smooth. Apertural face gently convex, an inverted-V shape, with narrow, raised rims. Aperture radiate, at peripheral angle, without robuline slit.

Dimensions of specimen CUFC 109, sample 76902: diameter 1.54 mm, thickness 0.61 mm.

Remarks: L. rotulata is distinguished from Robulus stephensoni Cushman by the former's large umbos, from R. munsteri Roemer which tends to uncoil, and from most other species of Lenticulina by its acute periphery with ~~very~~ keel, and the straight, tangential sutures. It has more chambers than L. macrodisca (Reuss).

Lenticulina spissocostata (Cushman)

Robulus spisso-costatus CUSHMAN, 1938b, p.32, pl.5, fig.2 (fide Ellis and Messina, 1940 et seq).---MELLO, 1969, p.53 (partim).

Lenticulina spissocostata (Cushman). PERLMUTTER AND TODD, 1965, p.111, pl.6, figs.3,4.

Dimensions of specimen CUFC 110, sample 76888, diameter 1.38 mm, thickness 0.49 mm.

Remarks: The description of Cushman (1938b) is followed herein. L. spissocostata is distinguished from most species of Lenticulina by the large size and curved, raised sutures that thin towards the periphery. It is distinguished from L. pseudosecans (Cushman) by the former's subacute periphery and greater number of chambers. The reasons for placing specimens referred to the present species by Perlmutter and Todd (1965) and Mello (1969) in L. pseudosecans have already been discussed under that species.

Lenticulina subangulata (Reuss)

Cristellaria subangulata REUSS, 1863a, p.74, pl.8, fig.7 (fide Ellis and Messina, 1940 et seq.).

Lenticulina subangulata (Reuss). POZARYSKA, 1957, p.128, pl.18, fig.2.

Dimensions of specimen CUFC 111, sample 76876: diameter 0.67 mm, thickness 0.33 mm;

Remarks: The description of Pożaryska (1957) is followed herein, with the additional notes that the sutures are nearly straight and tangential, and that the keel is not a universal feature. A few specimens occur that are quite strongly uncoiling. L. subangulata is distinguished by the polygonal outline, 7 or so chambers, and tendency to uncoil.

Lenticulina velascoensis White

Lenticulina velascoensis WHITE, 1928a, p.199, pl.28, fig.8 (fide Ellis and Messina, 1940 et seq.)---HANZLIKOVÁ, 1972, p.68, pl.16, fig.11.

Dimensions of specimen CUFC 112, sample 76892: diameter 0.47 mm, thickness 0.16 mm.

Remarks: The description of White (1928a) is followed herein. L. velascoensis is distinguished by the depressed umbos, the strongly curved, oblique sutures, and thin keel throughout. The present

specimens may in fact not have depressed umbos, but rather have the umbos broken out in preservation. There is some possibility, therefore, that the specimens assigned herein to L. velascoensis may belong to L. revoluta (Israelsky).

Lenticulina williamsoni (Reuss)

Cristellaria williamsoni REUSS, 1862, p.327, pl.6, fig.4 (fide Ellis and Messina, 1940 et seq).

Robulus williamsoni (Reuss). CUSHMAN, 1946, p.54, pl.18, figs.2,3.

NOT Lenticulina sp. cf. L. williamsoni (Reuss). SLITER, 1968, p.68, pl.7, fig.16.

Test free, lenticular and thick, planispiral, involute, may have small umbos; periphery entire in side view, acute, with thin, fairly wide keel that merges into acute periphery by final few chambers. Chambers 5 to 8 in final whorl, wedge shaped, quite high as well as broad, increasing quite rapidly in size as added, with a pronounced tendency to uncoil. Sutures, distinct, limbate, typically gently depressed, but occasionally flush; curved and tangential. Wall calcareous, perforate, smooth. Apertural face triangular, gently convex, bordered by quite narrow lips. Aperture radiate, at peripheral angle, without robuline slit.

Dimensions of specimen CUFC 113, sample 76896: diameter 0.62 mm, thickness 0.32 mm.

Remarks: L. williamsoni is readily distinguished from most species by the low number of chambers, strongly keeled early portion, and gently depressed sutures. L. ovalis (Reuss) has a much thicker test. Specimens assigned to L. sp. cf. L. williamsoni by Sliter (1968) have a subacute periphery and sutures that overlap each other and are flush. Hence these forms cannot be referred to L. williamsoni.

Genus MARGINULINA d'Orbigny, 1826

Marginulina bullata Reuss

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Marginulina (Marginulina) bullata REUSS, 1845, p.29, pl.13, figs.34-38
(fide Ellis and Messina, 1940 et seq).

Marginulina bullata Reuss: SLITER, 1968, p.70, pl.8, figs.6,7.

Dimensions of specimen CUFC 114, sample 76870: length 0.43 mm,
diameter 0.16 mm.

Remarks: The description of Sliter (1968) is followed herein. As a general rule, the initial coil is substantially larger than in the figured specimens of Sliter. This species is readily distinguished by the well developed initial coil, subglobular chambers with strongly depressed, horizontal sutures, and eccentric elongate apertural neck.

Marginulina curvatura Cushman

Marginulina curvatura CUSHMAN, 1938b, p.34, pl.5, figs. 13, 14 (fide Ellis and Messina, 1940 et seq).---HANZLIKOVÁ, 1972, p.69, pl.16, fig.6.

NOT Marginulina sp. cf. M. curvatura Cushman. SLITER, 1968, p.70, pl.8, figs.8,9.

Dimensions of specimen CUFC 115, sample 76872: length 1.33 mm, width 0.46 mm, thickness 0.42 mm.

Remarks: The description of Cushman (1938b) is followed herein. The arcuate test, with small but distinct initial coil, increasingly inflated chambers, oblique sutures and terminal eccentric aperture without an elongate neck distinguish this species. The specimens figured by Sliter (1968) as M. sp. cf. M. curvatura have chambers that are much too strongly overlapping, and a weakly developed initial coil. They are thus referable to M. trunculata (Berthelin).

Marginulina directa Cushman

Marginulina austinana Cushman var. directa CUSHMAN, 1937a, p.93, pl.13, figs.5-8 (fide Ellis and Messina, 1940 et seq).

Vaginulinopsis directa (Cushman). SLITER, 1968, p.75, pl.9, fig.9.

Dimensions of specimen CUFC 116, sample 76870: length 0.61 mm, width 0.20 mm, thickness 0.15 mm.

Remarks: The description of Sliter (1968) is followed herein. This species is distinguished from M. austinana Cushman in which the initial coil is substantially larger in diameter than the width of the uncoiled portion of the test. The present species is characterized by the very straight, compressed test with flush sutures and reduced initial coil.

Marginulina jonesi (Reuss)

Cristellaria (Marginulina) jonesi REUSS, 1863a, p.61, pl.5, fig.19
(fide Ellis and Messina, 1940 et seq.).

Marginulina jonesi Reuss. POZARYSKA, 1957, pl.108, pl.12, fig.4.

Marginulinopsis jonesi (Reuss). TAPPAN, 1962, p.167, pl.42, figs.1-6.

Dimensions of specimen CUFC 117, sample 76886: length 1.09 mm, width 0.50 mm, thickness 0.38 mm.

Remarks: The description of Pozaryska (1957) is followed herein. The present specimens usually possess a thin, narrow keel that eventually merges into an acute periphery at the last chamber. The intersection of the costae with the keel produces a spinose lower periphery. The wide, compressed test, low number of chambers, gently depressed later sutures, and longitudinal costae that fade out on the final chamber distinguish M. jonesi.

Marginulina obliquinoda Bandy

Marginulina similis d'Orbigny var. obliquinodus BANDY, 1951, p.498, pl.73, fig.2.

Marginulina obliquinodus Bandy. TRUJILLO, 1960, p.325, pl.46, fig.12.

Dimensions of specimen CUFC 118, sample 76883: length 0.64 mm, diameter 0.24 mm.

Remarks: The description of Bandy (1951) is followed herein. M. obliquinoda is distinguished by the uncompressed, rapidly tapering, gently curved test with a small initial coil and flush sutures throughout that become quite strongly oblique in the later stages.

Marginulina reiseri (Tappan)

Marginulinopsis reiseri TAPPAN, 1960, p.293, pl.2, figs.1,2 (fide Ellis and Messina, 1940 et seq).---TAPPAN, 1962, p.167, pl.43, figs.1-4.

Dimensions of specimen CUFC 119, sample 76871: length 0.64 mm, width 0.21 mm, thickness 0.15 mm.

Remarks: The description of Tappan (1960) is followed herein. This species is distinguished from most species by the essentially straight and entire dorsal margin, the convex, lobulate ventral margin, the low, broad chambers and strongly oblique and depressed sutures. The initial coil is not as prominent or produced towards the ventral margin as^o in Tappan's type figures. Marginulina inaequalis Reuss is very similar but too rounded in section, and Vaginulina loeblichii McLean is almost parallel-sided, with flush sutures and no produced initial coil. The species is represented in the present study by a single specimen.

Marginulina trunculata (Berthelin)

Cristellaria trunculata BERTHELIN, 1880, p.53, pl.3, figs.26,27 (fide Ellis and Messina, 1940 et seq).

Cristellaria trunculata (pars) Berthelin. CHAPMAN, 1894, pp.650-651 (fide Ellis and Messina, 1940 et seq).

Marginulina trunculata (Berthelin). GRAHAM AND CHURCH, 1963, p.38, pl.4, figs.4,5.

Marginulina sp. cf. M. curvatura Cushman. SLITER, 1968, p.70, pl.8, figs.8,9.

Dimensions of specimen CUFC 120, sample 76873: length 0.47 mm, diameter 0.24 mm.

Remarks: The description of Berthelin (1880) is followed herein, with the additional note that the aperture is radiate. This is the only real distinction between this species and Lingulinopsis sequana Berthelin. M. trunculata is distinguished by the stout test with

reduced, close-coiled initial portion, and very strongly embracing final chambers, which leave preceding chambers visible only as low, broad bands. Occasionally one or two chambers are added that barely overlap the previous ones, but this is unusual, and the early, more typical stage is readily visible.

Genus NEOFLABELLINA Bartenstein, 1948

Neoflabellina reticulata (Reuss)

Flabellina reticulata REUSS, 1851b, p.30, pl.2, fig.22 (fide Ellis and Messina, 1940 et seq).

Palmula reticulata (Reuss). CUSHMAN, 1946, p.84, pl.31, figs.1-6.

Neoflabellina reticulata (Reuss). POZARYSKA, 1957, p.162, pl.26, fig.6, t.f.43.

Dimensions of specimen CUFC 121, sample 76872: length 0.85 mm, width 0.53 mm, thickness 0.17 mm.

Remarks: The description of Pożaryska (1957) is followed herein. The hexagonal ornamentation, arranged in rows along the low chambers, is distinctive of this species. Cushman's 1946 description refers to octagonal meshes, but the present specimens definitely exhibit hexagonal ornament.

Neoflabellina rugosa (d'Orbigny)

Flabellina rugosa d'ORBIGNY, 1840, p.23, pl.2, figs.4,5,7 (fide Ellis and Messina, 1940 et seq).

Palmula rugosa (d'Orbigny). CUSHMAN, 1946, p.83, pl.31, figs.9-17.

Neoflabellina rugosa (d'Orbigny). POZARYSKA, 1957, p.163, t.f.44.

Dimensions of specimen CUFC 122, sample 76903: length 0.57 mm, width 0.34 mm, thickness 0.13 mm.

Remarks: The description of Pożaryska (1957) is followed herein. This species is readily distinguished by its thin, raised sutures and tuberculate chambers.

Genus PLANULARIA Defrance, in de Blainville, 1826

Planularia dissona (Plummer)

Astacolus dissonus PLUMMER, 1931, p.145, pl.11, figs.17,18, pl.15, figs.2-7.---MELLO, 1969, p.58, pl.6, fig.6.

Planularia dissona (Plummer). CUSHMAN, 1946, p.57, pl.19, figs.11-18.

Dimensions of specimen CUFC 123, sample 76871: length 2.51 mm, width 1.56 mm, thickness 0.88 mm.

Remarks: The description of Plummer (1931) is followed herein. This species is distinguished by the very well developed initial coil that is circular in outline, and by the uncoiling chambers that reach back to the coil. Also characteristic are the raised umbos.

Planularia liebusi Brotzen

Planularia liebusi BROTZEN, 1936, p.60, pl.4, figs.4,6, t.f.18 (fide Ellis and Messina, 1940 et seq).---HANZLIKOVÁ, 1972, p.71, pl.16, figs.8,9.

Test free, elongate and gently arcuate, strongly compressed; outer margin entire in side view, acute with or without single keel, or may have initial double keel that becomes single, often with raised margin that is above the level of the inflated chambers; inner margin mildly lobulate. Chambers 5 or 6 in initial planispiral coil, which is small but produced towards inner margin, later becoming curvilinear, increasing quite rapidly in size as added, broad and usually low, becoming inflated, often quite strongly so. Sutures distinct, thickened, raised, oblique and gently curved, in depressed areas between chambers, running down inner margin on angles of test to join previous sutural ridges, producing bicarinate inner margin. Wall calcareous, perforate, ornamented by few to numerous costae that are gently arcuate but essentially longitudinal. Aperture radiate, at peripheral angle.

Dimensions of specimen CUFC 124, sample 76891: length 0.82 mm, width 0.38 mm, thickness 0.16 mm.

Remarks: P. liebusi is distinguished from the otherwise very similar P. striolata (Reuss) by the former's inflated chambers, raised sutures in depressed areas, and less strongly developed ornamentation.

Planularia striolata (Reuss)

Vaginulina striolata REUSS, 1863a, p.46, pl.3, fig.7 (fide Ellis and Messina, 1940 et seq).

Citharina kochii (Roemer) var. striolata (Reuss). FRIZZELL, 1954, p.94, pl.11, figs.10-12.

Test free, elongate, often gently arcuate, compressed; inner and outer margins truncate and angles carinate, outer margin entire, inner margin lobulate. Chambers initially in planispiral coil of 5 or so chambers, the coil usually small and not strongly produced, subsequent curvilinear chambers very low and broad. Sutures distinct, limbate, and flush to raised. Wall calcareous, perforate, ornamented by short longitudinal ribs between raised sutures, or by continuous curved costae that nearly parallel outer margin, if sutures flush. Aperture radiate, at peripheral angle.

Dimensions of specimen CUFC 125, sample 76892: length 0.47 mm, width 0.29 mm, thickness 0.14 mm.

Remarks: P. striolata is distinguished by its costate test with flush to raised sutures and uninflated chambers. In general, the coiled portion is also much less prominent than in P. liebusi Brotzen. }

Genus PSEUDONODOSARIA Boomgaart, 1949

Pseudonodosaria appressa (Loeblich and Tappan)

Pseudoglandulina sp. PLUMMER, 1931, p.158, pl.10, figs.16,17.

Rectoglandulina appressa LOEBLICH AND TAPPAN, 1955, p.4, pl.1, figs.1-4 (fide Ellis and Messina, 1940 et seq).---MELLO, 1969, p.62, pl.7, figs.1,2.

Dimensions of specimen CUFC 126, sample 76872: length 0.68 mm, diameter 0.35 mm.

Remarks: The description of Loeblich and Tappan (1955) is followed herein. P. appressa is distinguished by its subfusiform test with flush sutures and final chamber occupying 1/2 to 3/5 of the test.

Pseudonodosaria humilis (Roemer)

Nodosaria humilis ROEMER, 1841, p.95, pl.15, fig.6 (fide Ellis and Messina, 1940 et seq).

Rectoglandulina humilis (Roemer). TAPPAN, 1962, p.170, pl.44, figs.8-10.

Rectoglandulina sp. B. GRAHAM AND CHURCH, 1963, p.46, pl.5, fig.3.

Dimensions of specimen CUFC 127, sample 76870: length 0.61 mm,
diameter 0.45 mm.

Remarks: The description of Tappan (1962) is followed herein. P. humilis is readily distinguished by the rapidly tapering, nearly conical test, with greatest width near the top, gently depressed sutures, and a final chamber that is broader than high.

Pseudonodosaria manifesta (Reuss)

Glandulina manifesta REUSS, 1851b, p.22, pl.2, fig.4 (fide Ellis and Messina, 1940 et seq).

Pseudoglandulina manifesta (Reuss). CUSHMAN, 1946, p.76, pl.27, figs.20-26.

Pseudonodosaria manifesta (Reuss). SLITER, 1968, p.72, pl.8, fig.18.

Dimensions of specimen CUFC 128, sample 76872: length 0.66 mm,
diameter 0.31 mm.

Remarks: The description of Sliter (1968) is followed herein. P. manifesta is distinguished by its nearly parallel-sided test, more elongate chambers than P. humilis (Roemer), and greater number of chambers than P. parallela (Marsson).

Pseudonodosaria obesa (Loeblich and Tappan)

Rectoglandulina obesa LOEBLICH AND TAPPAN, 1955, p.5, pl.1, figs.5,6 (fide Ellis and Messina, 1940 et seq).

Rectoglandulina pygmaea (Reuss). TRUJILLO, 1960, p.326, pl.47, fig.1.

Pseudonodosaria obesa (Loeblich and Tappan). SLITER, 1968, p.72, pl.8, fig.17.

Dimensions of specimen CUFC 129, sample 76873: length 0.41 mm, diameter 0.27 mm.

Remarks: The description of Loeblich and Tappan (1955) is followed herein. P. obesa is distinguished by its strongly inflated test, with final chamber occupying approximately 3/5 of the test, and from P. appressa (Loeblich and Tappan), which is much more elongate. Glandulina pygmaea Reuss has a final chamber which occupies at least 4/5 of the test, hence the specimens referred to that species by Said and Kenawy (1936) and Trujillo (1960) should be referred to P. obesa.

Pseudonodosaria parallela (Marsson)

Glandulina parallela MARSSON, 1878, p.124, pl.1, fig.4 (fide Ellis and Messina, 1940 et seq).

Pseudoglandulina parallela (Marsson). POZARYSKA, 1957, p.94, pl.9, fig.5.

Dimensions of specimen CUFC 130, sample 76875: length 0.47 mm, diameter 0.28 mm.

Remarks: The description of Pożaryska (1957) is followed herein. P. parallela is readily distinguished by its parallel-sided, two-chambered test with flush suture.

Genus SARACENARIA Defrance, in de Blainville, 1824

Saracenaria navicula (d'Orbigny)

Cristellaria navicula d'ORBIGNY, 1840, p.27, pl.2, figs.19,20 (fide Ellis and Messina, 1940 et seq).

Lenticulina navicula (d'Orbigny). CUSHMAN, 1946, p.56, pl.18, fig.16.

Saracenaria navicula (d'Orbigny). SLITER, 1968, p.73, pl.9, fig.1.

Dimensions of specimen CUFC 131, sample 76895: length 0.58 mm, width 0.42 mm, thickness 0.33 mm.

Remarks: The description of Sliter (1968) is followed herein. A tendency to uncoiling is observed in some specimens, and the apertural face is unusual in that many specimens possess a very fine median slit (not a robuline slit) running from the radiate aperture to the initial part of the periphery. S. navicula is distinguished by its flush sutures, acute dorsal periphery, and broad but distinctly higher than broad apertural face. The margins of the apertural face are quite broadly rounded.

Saracenaria pseudonavicula Marie

Saracenaria pseudonavicula MARIE; 1941, p.110, pl.10, figs.113,114 (fide Ellis and Messina, 1940 et seq).

Saracenaria cf. pseudonavicula Marie. TAKAYANAGI, 1960, p.106, pl.6, fig.6.

Dimensions of specimen CUFC 132, sample 76874: diameter 0.35 mm, thickness 0.23 mm.

Remarks: The description of Marie (1941) is followed herein. S. pseudonavicula is distinguished by the wholly involute test, triangular apertural face, acute dorsal margin, and the rounded facial carinae.

Saracenaria saratogana Howe and Wallace

Saracenaria saratogana HOWE AND WALLACE, 1932, p.40 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.58, pl.28, figs.4-6.

Test free, elongate, initially planispiral, becoming uncoiling and rectilinear, triangular in section; dorsal periphery initially acute, often with thin keel, becoming rounded. Chambers fairly low, broad, gently arched, the final few chambers failing to reach back to coiled portion on ventral margin. Sutures distinct, limbate, gently curved and flush to gently depressed on sides of test, always gently depressed on ventral margin. Wall calcareous, perforate, smooth. Apertural face triangular, with rounded margins. Aperture radiate, at peripheral angle.

Dimensions of specimen CUFC 133, sample 76885: length 0.73 mm, width 0.43 mm, thickness 0.39 mm.

Remarks: This species resembles numerous specimens assigned to S. italica Defrance. Defrance's type figure and description are clearly inadequate, hence the validity of S. italica is in doubt. The description of Sliter (1968) of S. saratogana refers to a biserial initial portion and flush sutures, and is clearly at odds with the intent of Howe and Wallace (1932) who failed to provide an adequate description, but who illustrated forms with a planispiral initial portion and depressed sutures. S. saratogana is distinguished by the uncoiling test, triangular apertural face with rounded ventral margins, rounded dorsal margin, and gently depressed ventral sutures. S. dutroi Tappan is narrower, with higher chambers, and more angular margins.

Saracenaria triangularis (d'Orbigny)

Cristellaria triangularis d'ORBIGNY, 1840, p.27, pl.2, figs.21,22
(fide Ellis and Messina, 1940 et seq).

Saracenaria triangularis (d'Orbigny). HANZLIKOVÁ, 1972, p.72, pl.16, fig.10.

Test free, somewhat elongate, triangular in section, initially planispiral and strongly involute, tending to uncoil, often only weakly so, but may become strongly uncoiled and curvilinear; dorsal margin acute to keeled, keel often disappearing by later stages, ventral margin truncate, gently convex to gently concave in section, always bordered by narrow, acute carinae that originate on ventral angles of apertural face and run to the junction of the sutures of the coiled portion, and hence do not join periphery. Ventral margin may also have numerous fine longitudinal costae. Chambers 8 or more in the adult, increasing fairly rapidly in size as added, wedge-shaped in coiled portion, may become subrectangular in side view if uncoiling. Sutures distinct, limbate, gently curved, and flush to gently depressed on sides of test, always

depressed on ventral margin of test. Wall calcareous, perforate, smooth except for costae on ventral margin. Apertural face inflated, triangular, with rounded margins except for carinate ventral angles. Aperture radiate, at peripheral angle.

Dimensions of specimen CUFC 134, sample 76870: length 0.74 mm, width 0.43 mm, thickness 0.40 mm.

Remarks: S. triangularis is distinguished by the tendency to uncoil, acute to keeled dorsal margin, carinate ventral angles, and broadly triangular apertural face.

Saracenaria tripleura (Reuss)

Cristellaria tripleura REUSS, 1860, p.211, pl.9, fig.5 (fide Ellis and Messina, 1940 et seq).

Saracenaria aff. tripleura (Reuss). POZARYSKA, 1957, p.120, pl.10, fig.2.

Dimensions of specimen CUFC 135, sample 76871: length 0.47 mm, width 0.29 mm, thickness 0.25 mm.

Remarks: The description of Pożaryska (1957) is followed herein. Some specimens in the present study exhibit a rounded dorsal margin, and in addition the margins of the apertural face may be mildly inflated. S. tripleura is distinguished by the large, elongate triangular apertural face with rounded margins that is slightly removed from the coiled portion of the test, and by the low number of chambers.

Subfamily LINGULININAE Loeblich and Tappan, 1961

Genus LINGULINA d'Orbigny, 1826

Lingulina pygmaea Reuss

Lingulina pygmaea REUSS, 1874, p.90, pl.(II)20, fig.23 (fide Ellis and Messina, 1940 et seq).---GRAHAM AND CHURCH, 1963, p.37, pl.3, figs.24,25.

NOT Lingulina pygmaea Reuss. CUSHMAN, 1946, p.77, pl.27, fig.38.---SLITER, 1968, p.75, pl.9, fig.10.

Test free, elongate, compressed, uniserial and rectilinear; periphery indented in side view, margins rounded. Chambers numerous, as many as 10, low, broad, strongly arched, increasing very slowly in size as added, such that test is nearly parallel-sided, with chamber margins turned under to produce indented periphery. Sutures distinct, strongly arched, gently depressed. Wall calcareous, perforate, smooth. Aperture a terminal oval slit parallel to plane of compression of test, slightly produced.

Dimensions of specimen CUFC 136, sample 76872: length 0.47 mm, width 0.16 mm, thickness 0.05 mm.

Remarks: L. pygmaea is distinguished from L. furcillata Berthelin, which has nearly equant, barely arched chambers. For this reason, the forms assigned by Cushman (1946) to L. pygmaea should be assigned to L. furcillata. The forms assigned by Sliter (1968) to L. pygmaea have strongly embracing initial chambers with acute margins directed towards the base, producing a ragged or serrate periphery. Hence they do not belong to the present species.

Lingulina sp.
(Plate 4, Figs.1,2)

Test free, subcircular in outline, compressed; periphery entire, carinate, with short basal spine. Chambers 5, increasing quite rapidly in size as added, and strongly embracing, such that final chamber occupies 1/2 of test, previous chambers visible as narrow horizontal bands. Sutures distinct, horizontal, flush to very gently depressed. Wall calcareous, perforate, smooth. Aperture a terminal slit, parallel to plane of compression, divided by keel which is continuous around periphery.

Dimensions of specimen CUFC 137, sample 76872: length 0.36 mm, width 0.28 mm, thickness 0.17 mm.

Remarks: The subcircular outline, strongly embracing chambers, horizontal sutures and carinate periphery with basal spine are distinctive of this species.

Genus ELLIPSOCRISTELLARIA Silvestri, 1920

Ellipsocristellaria sp.

• Globulina sp. A. GRAHAM AND CHURCH, 1963, p.49, pl.5, fig.17.

Ellipsocristellaria sp.. SLITER, 1968, p.76, pl.9, fig.14.

Dimensions of specimen CUFC 138, sample 76871: length 0.42 mm, width 0.30 mm, thickness 0.28 mm.

Remarks: The description of Sliter (1968) is followed herein. The strongly embracing planispiral chambers, with only three visible, and slit-like aperture parallel to the plane of gentle compression are distinctive of this species.

Genus LINGULINOPSIS Reuss, 1860

Lingulinopsis sequana Berthelin

Lingulinopsis sequana BERTHELIN, 1880, p.63, pl.2, fig.19 (fide Ellis and Messina, 1940 et seq.).

Lingulinopsis sp.. SLITER, 1968, p.77, pl.9, fig.15.

Dimensions of specimen CUFC 139, sample 76875: length 0.46 mm, diameter 0.29 mm.

Remarks: The description of Sliter (1968) is followed herein. It differs from L. sequana sensu Berthelin only in possessing a greater number of uncoiling chambers, and thus a series of chambers visible as arcuate bands. The present author feels that the specimen figured and described by Berthelin (1880) was possibly an immature form. In all other aspects, the present forms agree well with Berthelin's type description. L. sequana is distinguished by the very gently compressed test, enrolled early portion and strongly embracing later chambers, and the elongate, slit-like aperture parallel to the plane of coiling.

Family POLYMORPHINIDAE d'Orbigny, 1839
 Subfamily POLYMORPHININAE d'Orbigny, 1839
 Genus GLOBULINA d'Orbigny, in de la Sagra, 1839

Globulina hispida Terquem

Globulina hispida TERQUEM, 1882, p.131, pl.13, fig.32 (fide Ellis and Messina, 1940 et seq).

Dimensions of specimen CUFC 140, sample 76881: length 0.57 mm, width 0.47 mm, thickness 0.39 mm.

Remarks: The description of Terquem (1882) is followed herein. The specimens in the present study may be quite elongate and compressed, and the base may be acute. The aperture is obscured by fistulose growths in the form of a large hispid cap with numerous short necks with collars and rounded apertural openings. The hispid test distinguishes G. hispida from other species of Globulina.

Globulina lacrima (Reuss)

Polymorphina (Globulina) lacrima REUSS, 1845, p.40, pl.12, fig.6, pl.13, fig.83 (fide Ellis and Messina, 1940 et seq).

Globulina lacrima (Reuss). SLITER, 1968, p.77, pl.9, fig.17, pl.10, fig.1.

Dimensions of specimen CUFC 141, sample 76871: length 0.29 mm, width 0.25 mm, thickness 0.23 mm.

Remarks: The description of Sliter (1968) is followed herein. G. lacrima is distinguished by the flush sutures, and particularly from G. subsphaerica (Berthelin) by the chambers extending nearly to the base, and resulting nearly symmetrical test in outline.

Globulina subsphaerica (Berthelin)

Polymorphina subsphaerica BERTHELIN, 1880, p.58, pl.4, fig.18 (fide Ellis and Messina, 1940 et seq).

Globulina lacrima Reuss var. subsphaerica (Berthelin). CUSHMAN, 1946, p.96, pl.40, fig.13.

Globulina lacrima (Reuss). SAID AND KENAWY, 1956, p.137, pl.3, figs.17,18.

Globulina subsphaerica (Berthelin). SLITER, 1968, p.78, pl.10, figs.2,3.

Globulina lacrima Reuss. MELLO, 1969, p.68, pl.7, figs.17,18.

Dimensions of specimen CUFC 142, sample 76874: length 0.62 mm, width 0.40 mm, thickness 0.37 mm.

Remarks: The description of Sliter (1968) is followed herein. G. subsphaerica is distinguished from G. lacrima (Reuss) by the former's more rapidly increasing chamber size and the greater removal of the chambers from the base, resulting in the test being produced to one side. The specimens assigned by Said and Kenawy (1956) and Mello (1969) to G. lacrima should thus be referred to G. subsphaerica.

Genus GUTTULINA d'Orbigny, in de la Sagra, 1839

Guttulina adhaerens (Olszewski)

Polymorphina adhaerens OLSZEWSKI, 1875, p.119, pl.1, fig.11 (fide Ellis and Messina, 1940 et seq).

Guttulina adhaerens (Olszewski). CUSHMAN, 1946, p.96, pl.40, figs.8-10.---HANZLIKOVÁ, 1972, p.73, pl.17, fig.13.

Dimensions of specimen CUFC 143, sample 76874: length 0.80 mm, width 0.67 mm, thickness 0.54 mm.

Remarks: The description of Cushman (1946) is followed herein. This species is quite variable in form, but is characterized and distinguished by the clavate chambers well removed from the base, and by the depressed sutures, which results in the test being essentially a quinqueloculine cluster of chambers.

Guttulina trigonula (Reuss)

Polymorphina trigonula REUSS, 1845, p.40, pl.13, fig.84 (fide Ellis and Messina, 1940 et seq).

Guttulina trigonula (Reuss). CUSHMAN, 1946, p.95, pl.40, figs.6,7.---HANZLIKOVÁ, 1972, p.73, pl.17, figs.11,12.

Dimensions of specimen CUFC 144, sample 76890: length 0.41 mm, width 0.41 mm, thickness 0.29 mm.

Remarks: The description of Cushman (1946) is followed herein. G. trigonula is distinguished by its nearly triangular shape both in side and apertural views, with rounded margins. Some specimens possess fistulose growths at the aperture.

Genus PYRULINA d'Orbigny, in de la Sagra, 1839

Pyrulina cylindroides (Roemer)

Polymorphina cylindroides ROEMER, 1838, p.385, pl.3, fig.26 (fide Ellis and Messina, 1940 et seq).

Pyrulina cylindroides (Roemer). CUSHMAN, 1946, p.97, pl.40, figs.18, 19.---MELLO, 1969, p.69, pl.8, fig.1.

Dimensions of specimen CUFC 145, sample 76892: length 0.40 mm, diameter 0.18 mm.

Remarks: The description of Cushman (1946) is followed herein. The fusiform to subfusiform test with flush, strongly oblique sutures and biserial appearance is distinctive of P. cylindroides. P. apiculata Marie has an apical spine or sharply pointed base, versus the subacute to subrounded base of P. cylindroides.

Subfamily RAMULININAE Brady, 1884

Genus RAMULINA Jones, in Wright, 1875.

The genus Ramulina is characterized by some confusion and uncertainty. Much of the difficulty arises from the fact that complete, intact specimens as such are seldom reported. An exception is the set of Brady's (1879) illustrations of R. globulifera. There is thus some question as to what the relationship is, if any, between globular and tubular forms. Thus the various species reported may in fact be form species, and the forms referred to these species may have been related in life. For example, one can visualize the globular R. globulifera Brady being connected by the tubular R. arkadelphiana Cushman.

Ramulina arkadelphiana Cushman

Ramulina arkadelphiana CUSHMAN, 1938b, p.43, pl.7, figs.12-14 (fide Ellis and Messina, 1940 et seq).

Ramulina sp.. YOUNG, 1951, p.62, pl.14, figs.9,10.

Dimensions of specimen CUFC 146, sample 76871: length 0.74 mm, width 0.61 mm.

Remarks: The description of Cushman (1938b) is followed herein.

R. arkadelphiana is distinguished by the thin, nearly constant-diameter branching tubes with slight swellings of the test where the branches meet. Branches may be very closely spaced or quite widely spaced, and the hispid ornament may be quite fine and dense, or coarse and sparse.

Ramulina bullardae Frizzell

Ramulina aculeata (d'Orbigny). WRIGHT, 1886, p.331, pl.27, fig.11 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.100 (partim), pl.43, figs.11,12.

Ramulina novaculeata BULLARD, 1953, p.346, pl.46, fig.26 (fide Ellis and Messina, 1940 et seq).

Ramulina bullardae FRIZZELL, 1954, p.149.

Ramulina sp. a. TAKAYANAGI, 1960, p.118, pl.7, figs.17,18.

Dimensions of specimen CUFC 147, sample 76903: length 0.52 mm, diameter 0.25 mm.

Remarks: The description of Bullard (1953) is followed herein. R. bullardae is distinguished by the subglobular to ellipsoidal chambers separated by strongly constricting sutures, and by the bent axis of the test. Chamber walls are hispid.

Ramulina globulifera Brady

Ramulina globulifera BRADY, 1879, p.272, pl.8, figs.32,33 (fide Ellis and Messina, 1940 et seq).---PLUMMER, 1931, p.174, pl.11, fig.15.---BARKER, 1960, p.158, pl.76, figs.22-28.

Ramulina globo-tubulosa CUSHMAN, 1938, p.44, pl.7, fig.16 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.79, pl.10, fig.9.

Dentalina aculeata d'Orbigny. CUSHMAN, 1946, p.67, pl.26, figs.17,18.

Lagena hispida Reuss. SAID AND KENAWY, 1956, p.136, pl.3, fig.9.

Dentalina(?) pseudoaculeata OLSSON, 1960, p.14, pl.3, figs.1,2.

Ramulina pseudoaculeata (Olsson). SLITER, 1968, p.79, pl.10, fig.8.

Dimensions of multi-tubular specimen CUFC 148, sample 76871:
diameter 0.36 mm; dimensions of bi-tubular specimen CUFC 149, sample
76873: diameter 0.39 mm.

Remarks: The description of Brady (1879) is followed herein. R. globulifera as defined by Brady is characterized by globular chambers with 2 or several tubular extensions, which in Brady's figures connect adjacent globular chambers. However, in the present study, the chambers are never connected in preservation. The hispid ornament may be fine and dense, or coarse and sparse. There is no consistent orientation of the tubular extensions, even in specimens with but two, where they may be colinear or at angles to each other. In the present study, long, straight, constant-diameter hispid tubes are thought to represent lengths of the tubes that originally connected globular chambers of R. globulifera, and hence are assigned to this species also.

Ramulina muricatina Loeblich and Tappan

Ramulina aculeata (d'Orbigny). CUSHMAN, 1946, p.100 (partim), pl.43, figs.14-16.

Ramulina muricatina LOEBLICH AND TAPPAN, 1949, p.261, pl.50, figs. 5,6 (fide Ellis and Messina, 1940 et seq).

Ramulina cf. R. muricatina Loeblich and Tappan. MELLO, 1969, p.69, pl.8, fig.3.

Dimensions of specimen CUFC 150, sample 76884: length 0.98 mm,
diameter 0.23 mm.

Remarks: The description of Loeblich and Tappan (1949) is followed herein. R. muricatina is characterized by the hispid, tubular test with its irregular swellings and bendings, without distinct chambers or branchings.

Family GLANDULINIDAE Reuss, 1860
 Subfamily OOLININAE Loeblich and Tappan, 1961
 Genus OOLINA d'Orbigny, 1839

Oolina apiculata Reuss

Oolina apiculata REUSS, 1851b, p.22, pl.2, fig.1 (fide Ellis and Messina, 1940 et seq).---TAKAYANAGI, 1960, p.102, pl.5, fig.25.

Lagena apiculata (Reuss). FRIZZELL, 1954, p.102, pl.14, figs.5,6.---POZARYSKA, 1957, p.40, pl.3, fig.9.---MELLO, 1969, p.66, pl.7, fig.11.

Oolina reussi SAID AND KENAWY, 1956, p.145, pl.7, fig.15.

NOT Lagena apiculata Reuss. SAID AND KENAWY, 1956, p.136, pl.3, fig.8.

NOT Oolina apiculata Reuss. TAPPAN, 1962, p.182, pl.47, fig.16.---SLITER, 1968, p.80, pl.10, fig.13.

Test free, unilocular, subglobular to pyriform, with greatest diameter below equator, and with basal spine. Wall calcareous, perforate, smooth. Aperture terminal, radiate, may be slightly produced.

Dimensions of specimen CUFC 151, sample 76904: length 0.53 mm, diameter 0.29 mm.

Remarks: This species is distinguished by the short to long apical spine, and radiate aperture. For this reason, specimens assigned to O. apiculata by Tappan (1962) and Sliter (1968) do not belong in this species, because the aperture is rounded in their specimens. The specimen figured as L. apiculata by Said and Kenawy (1956) lacks the apical spine, but is too elongate to assign to O. simplex Reuss.

Oolina delicata Sliter

Oolina delicata SLITER, 1968, p.80, pl.10, figs.21,22.

Dimensions of specimen CUFC 152, sample 76875: length 0.58 mm, diameter 0.25 mm.

Remarks: The description of Sliter (1968) is followed herein. O. delicata is distinguished by the elongate, subfusiform test. None of the present specimens has a basal spine, and one specimen has well developed costae that run the length of the test.

Oolina simplex Reuss

Oolina simplex Reuss, 1851b, p.22, pl.2, fig.2 (fide Ellis and Messina, 1940 et seq).---TAKAYANAGI, 1960, p.102, pl.5, fig.26.

Lagena globosa (Montagu). SCHIJFMA, 1946, p.54, pl.2, fig.16.

Lagena ? simplex (Reuss). POZARYSKA, 1957, p.52, pl.3, fig.8.

Oolina globulosa (Montagu). SLITER, 1968, p.80, pl.10, fig.14.

Dimensions of specimen CUFC 153, sample 76874: length 0.23 mm, diameter 0.20 mm.

Remarks: The description of Pożaryska (1957) is followed herein. The simple, smooth, subglobular test with radiate aperture distinguishes this species. Schijfma (1946) and Sliter (1968) were in error in assigning these forms to Lagena and Oolina globosa (Montagu) respectively (note the typographic error in Sliter), because L. globosa is characterized by a round aperture. O. simplex has a clearly radiate aperture, as revealed by Reuss' (1851b) type figures, and thus Sliter (1968) made a major error in stating that O. simplex has a rounded aperture.

Genus FISSURINA Reuss, 1850

Fissurina alata Reuss

Fissurina alata REUSS, 1851a, p.58, pl.3, fig.1 (fide Ellis and Messina, 1940 et seq).

Test free, unilocular, subcircular to pyriform in outline, compressed, sides gently convex; periphery acute with a thick, blunt, clear keel. Wall calcareous, perforate, with a thinner, smoother central portion on each side, marked by a distinct groove. Aperture terminal,

slit-like, parallel to plane of compression, apertural area marked by slight thickening of test.

Dimensions of specimen CUFC 154, sample 76887: length 0.46 mm, width 0.41 mm, thickness 0.25 mm.

Remarks: F. alata is distinguished from most other species by the simple, single keel, from F. marginata (Walker and Boys) by the former's thick, blunt keel, and from F. laticarinata Sliter, which has a strongly produced aperture.

Fissurina auriculata (Brady)

Lagena auriculata BRADY, 1881, p.61 (fide Ellis and Messina, 1940 et seq).---BRADY, 1884, pl.60, figs.29,31,33 (fide Ellis and Messina, 1940 et seq).

Fissurina auriculata (Brady). BARKER, 1960, p.126, pl.60, fig.29.

Test free, unilocular, subcircular in outline, gently compressed with sides strongly convex; periphery ornamented by two parallel keels that unite just before the base and again before the aperture, on both sides, such that two large loops are formed on the periphery, one on each side of the base. Wall calcareous, perforate, smooth. Aperture terminal, a large oval slit parallel to periphery, not produced at all, bordered by keel which splits having united on upper periphery before aperture.

Dimensions of specimen CUFC 155, sample 76873: length 0.17 mm, width 0.18 mm, thickness 0.13 mm.

Remarks: The paired keels that unite before the base and before the aperture, only to split again to border the aperture, are quite distinctive of this inflated species of Fissurina.

Fissurina fimbriata (Brady)

Lagena fimbriata BRADY, 1881, p.61 (fide Ellis and Messina, 1940 et seq).---BRADY, 1884, pl.60, figs.26-28 (fide Ellis and Messina, 1940 et seq).

Fissurina fimbriata (Brady). BARKER, 1960, p.126, pl.60, figs.26-28.

Test free, unilocular, subcircular in outline, compressed with sides strongly convex; periphery acute, with thin, narrow keel that tends to extend out and down from midpoint of periphery, both peripheral keels joined across base of test by a fairly wide fringe, composed of two distinctly separate flanges, forming a single loop, that are traversed by numerous parallel tubuli at right angles to edge of fringe. Wall calcareous, perforate, smooth. Aperture terminal, flush, a slit-like opening parallel to plane of compression.

Dimensions of specimen CUFC 156, sample 76881: length 0.24 mm, width 0.24 mm, thickness 0.17 mm.

Remarks: F. fimbriata is readily distinguished by the carinate margins, and the fringe that surrounds the base, traversed by parallel tubuli. The fringe often makes the base of the test look flat, such that the test is subtriangular in outline.

Fissurina laticarinata Sliter

Fissurina laticarinata SLITER, 1968, p.81, pl.11, fig.6.

Dimensions of specimen CUFC 157, sample 76870: length 0.54 mm, width 0.47 mm, thickness 0.28 mm.

Remarks: The description of Sliter (1968) is followed herein. F. laticarinata is distinguished from F. alata Reuss by the former's wide, thin hyaline keel, and from F. marginata (Walker and Boys), which has neither a very wide keel, nor a strong thickening of the keel where the aperture is connected to the chamber through the keel.

Fissurina marginata (Walker and Boys)

Serpula (Lagena) marginata WALKER AND BOYS, 1784, p.2, pl.1, fig.7
(fide Ellis and Messina, 1940 et seq).

Vermiculum marginatum MONTAGU, 1803, p.524 (fide Ellis and Messina, 1940 et seq).

Entosolenia marginata (Walker and Jacob). CUSHMAN, 1946; p.126, pl.52, fig.15.

Fissurina marginata (Walker and Boys). POZARYSKA, 1957, p.61, pl.5, fig.5, pl.6, fig.4.

Fissurina alata Reuss. HANZLIKOVA, 1972, p.75, pl.18, fig.4.

Dimensions of specimen CUFC 158, sample 76871: length 0.24 mm, width 0.19 mm, thickness 0.13 mm.

Remarks: The description of Pożaryska (1957) is followed herein. The present forms do not exhibit the long apertural neck of some of Pożaryska's figured specimens. F. marginata is distinguished by its quite strongly convex-sided test, with a single, thin, narrow keel.

Fissurina meyeriana (Chapman)

Lagena meyeriana CHAPMAN, 1894a, p.706, pl.34, fig.7 (fide Ellis and Messina, 1940 et seq).

Fissurina meyeriana (Chapman). SLITER, 1968, p.81, pl.11, figs.1,2.

Dimensions of specimen CUFC 159, sample 76882: length 0.24 mm, width 0.20 mm, thickness 0.12 mm.

Remarks: The description of Sliter (1968) is followed herein. The base is frequently provided with a short, blunt spine, and the sides may be strongly convex with fairly closely spaced keels. F. meyeriana is distinguished by its bicarinate periphery and flush aperture.

Fissurina sandiegoensis Sliter

Fissurina sandiegoensis SLITER, 1968, p.82, pl.11, figs.4,5.

Dimensions of specimen CUFC 160, sample 76876: length 0.28 mm, width 0.19 mm, thickness 0.14 mm.

Remarks: The description of Sliter (1968) is followed herein. F. sandiegoensis is readily distinguished by the single narrow keel and numerous fine longitudinal costae on the chamber. The aperture is produced on a fairly thick, long flanged neck in the present study.

Fissurina sequenziana (Fornasini)

Lagena seguenziana FORNASINI, 1886, p.351, pl.8, figs.1-8 (fide Ellis and Messina, 1940 et seq).

Fissurina seguenziana (Fornasini). POZARYSKA, 1957, p.63, pl.5, fig.9.

Test free, unilocular, thin, with convex sides, sub-elliptical in outline; periphery provided with a thick, truncate keel that is elevated with respect to the faces of the test, and which may have two very fine carinae developed on its margins. This keel variously continues to base of test, terminates abruptly well before the base, or develops a thin, clear single keel along middle of this thicker keel, at base of test. Wall calcareous, perforate, smooth. Aperture terminal, slit-like, in a produced and thickened portion of keel.

Dimensions of specimen CUFC 161, sample 76871: length 0.27 mm, width 0.19 mm, thickness 0.11 mm.

Fissurina semiconcentrica (Cushman)

Lagena orbignyana (Seguenzia) var. semiconcentrica CUSHMAN, 1933a, p.10, pl.1, fig.22 (fide Ellis and Messina, 1940 et seq).

Fissurina orbignyana concentrica (Sidebottom). POZARYSKA, 1957, p.62, pl.5, fig.8.

NOT Fissurina orbignyana semiconcentrica (Cushman). POZARYSKA, 1957, p.62, pl.4, fig.9.

Dimensions of specimen CUFC 162, sample 76874: length 0.28 mm, width 0.25 mm, thickness 0.20 mm.

Remarks: The description of Pożaryska (1957) for F. orbignyana concentrica is followed herein. F. semiconcentrica is characterized by smooth centers on the chamber faces, while F. concentrica is ornamented on the entire chamber surface. The specimen figured by Pożaryska as F. orbignyana concentrica is shown only in edge view, but appears to have concentric ridges only towards the periphery. Pożaryska's illustrations of F. orbignyana semiconcentrica show a form with ornamentation, albeit not concentric costae, on the entire chamber surface. Hence Pożaryska

appears to have confused the two subspecies. F. semiconcentrica is distinguished by the concentric costae near the periphery that cover only the outer part of the chamber surface. In some specimens, rather than a single main peripheral keel, there are two parallel keels. The aperture is produced on a neck which has a collar and flanges formed by extensions of the peripheral keel.

Superfamily BULIMINACEA Jones, 1875

Family TURRILINIDAE Cushman, 1927

Subfamily TURRILININAE Cushman, 1927

Genus PRAEBULIMINA Hofker, 1953

Praebulimina carseyae (Plummer)

Buliminella carseyae PLUMMER, 1931, p.179, pl.8, fig.9.

Praebulimina laevis (Beissel). MCGOWRAN, 1962, p.61, pl.2, fig.3, pl.15, fig.6.

Praebulimina carseyae (Plummer). SLITER, 1968, p.83, pl.11, fig.16.

Dimensions of specimen CUFC 163, sample 76871: length 0.56 mm, diameter 0.32 mm.

Remarks: The description of Sliter (1968) is followed herein. P. carseyae is distinguished from most species by the four chambers per whorl, and from P. cushmani (Sandidge) by the former's more elongate test with entire outline, the whorls not increasing so rapidly in size.

Praebulimina cushmani (Sandidge)

Buliminella cushmani SANDIDGE, 1932, p.280, pl.42, figs.18,19 (fide Ellis and Messina, 1940 et seq.).

Praebulimina cf. carseyae (Plummer). MCGOWRAN, 1962, p.62, pl.2, fig.4, pl.15, fig.7.

Praebulimina cushmani (Sandidge). SLITER, 1968, p.83, pl.11, fig.15.

Dimensions of specimen CUFC 164, sample 76872: length 0.33 mm, diameter 0.27 mm.

Remarks: The description of Sliter (1968) is followed herein. P. cushmani is distinguished from most species by its four chambers per whorl, and from P. carseyae (Plummer) by the former's robust, rapidly flaring test with strongly indented outline.

Præbulimina kickapooensis (Cole)

Bulimina kickapooensis COLE, 1938, p.45, pl.3, fig.5 (fide Ellis and Messina, 1940 et seq).---MELLO, 1969, p.75, pl.8, figs.14,15.

Præbulimina kickapooensis (Cole). SLITER, 1968, p.84, pl.11, figs.17, 18, NOT 19.

Dimensions of specimen CUFC 165, sample 76875: length 0.61 mm, diameter 0.27 mm.

Remarks: The description of Sliter (1968) is followed herein, although the present specimens are more parallel-sided than those figured by Sliter. The megalospheric form is characterized by larger size and a broadly rounded base, whereas the microspheric form is smaller, with a narrowly rounded to acute base. There are a number of specimens with the internal tooth structure preserved. P. kickapooensis is distinguished from most species by the elongate, triserial, nearly parallel-sided test, and from P. aspera (Cushman and Parker) by the former's much higher chambers.

Præbulimina navarroensis (Cushman and Parker)

Bulimina reussi Morrow var. navarroensis CUSHMAN AND PARKER, 1935, p.100, pl.15, fig.11 (fide Ellis and Messina, 1940 et seq).---MELLO, 1969, p.75, pl.9, fig.1.

Bulimina ovulum Reuss var. navarroensis Cushman and Parker. TAKAYANAGI, 1960, p.120, pl.7, fig.21.

Dimensions of specimen CUFC 166, sample 76887: length 0.28 mm, diameter 0.21 mm.

Remarks: The description of Mello (1969) is followed herein. P. navarroensis is distinguished by its triserial chamber arrangement, from

P. aspera (Cushman and Parker) by the former's flaring test with strongly depressed sutures, from P. kickapooensis (Cole) by the present species' equant chambers and stout, flaring test, and from the very similar P. reussi (Morrow) by the present species much shorter chambers, such that the final whorl comprises only one-half of the test instead of two-thirds or more as in P. reussi. This latter species also has a more triangular cross section.

Praebulimina reussi (Morrow)

Bulimina ovula d'Orbigny. REUSS, 1845, p.37, pl.8, fig.57, pl.13, fig.73 (fide Ellis and Messina, 1940 et seq).

Bulimina reussi MORROW, 1934, p.195 (fide Ellis and Messina, 1940 et seq).

Praebulimina ovulum (Reuss). BELFORD, 1960, p.64, pl.16, figs.7-9.

Praebulimina reussi (Morrow). HANZLIKOVA, 1972, p.77, pl.18, fig.16.

Dimensions of specimen CUFC 167, sample 76873: length 0.34 mm, diameter 0.24 mm.

Remarks: The description of Morrow (1934) is followed herein. The rapidly flaring, large, triserial test distinguishes this species from most others. P. reussi is distinguished from P. navarroensis (Cushman and Parker) by the former's more rapid increase in chamber size, such that the final whorl comprises at least two-thirds of the test length. In the present study, P. reussi typically, but not always, is triangular in section with rounded angles.

Genus PYRAMIDINA Brotzen, 1948

Pyramidina prolixa (Cushman and Parker)

Bulimina prolixa CUSHMAN AND PARKER, 1935, p.98, pl.15, fig.5 (fide Ellis and Messina, 1940 et seq).---MELLO, 1969, p.77, pl.9, fig.2.

Pyramidina prolixa (Cushman and Parker), HANZLIKOVA, 1972, p.78, pl.19, fig.1.

Dimensions of specimen CUFC 168, sample 76884: length 0.53 mm, diameter 0.29 mm.

Remarks: The description of Cushman and Parker (1935) is followed herein. P. proluxa is distinguished by its elongate, slowly tapering test with smooth surface.

Pyramidina triangularis (Cushman and Parker)

Bulimina triangularis CUSHMAN AND PARKER, 1935, p.97, pl.15, fig.6 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.65, pl.16, figs.10-12.

Pyramidina triangularis (Cushman and Parker). HANZLIKOVÁ, 1972, p.78, pl.18, figs. 20,21.

Dimensions of specimen CUFC 169, sample 76904: length 0.28 mm, diameter 0.20 mm.

Remarks: The description of Cushman and Parker (1935) is followed herein. P. triangularis is distinguished by its short, rapidly flaring test with faintly spinose initial portion, and faint costae. P. minima (Brotzen) is distinguished by its s-shaped rather than horizontal sutures, according to Hanzliková (1972). Unfortunately, Cushman and Parker did not describe the shape of the sutures of the present species, nor are the sutures clearly visible in the type figure. P. minima is characterized by a spinose initial portion without costae, and this may be a distinguishing feature. There is a possibility, however, that these two forms are conspecific.

Family BOLIVINITIDAE Cushman, 1927

Genus BOLIVINA d'Orbigny, 1839

Bolivina incrassata gigantea Wicher

Bolivina incrassata Reuss. CUSHMAN, 1946, p.127, pl.53, figs.8-11.---BANDY, 1951, p.510, pl.75, fig.5.

Bolivina incrassata Reuss forma gigantea WICHER, 1949, p.57 [Serbian], p.85 [English], pl.5, figs.2,3 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.88, pl.12, fig.15.

Dimensions of specimen CUFC 170, sample 76887: length 0.95 mm, width 0.25 mm, thickness 0.16 mm.

Remarks: The description of Cushman (1946) is followed herein. The distinction between B. incrassata Reuss and B. incrassata gigantea is not clear. It seems to have been based largely on the fact that very large forms were observed in the Maastrichtian, hence distinction between the two subspecies is now based on stratigraphic occurrence, not any real difference in morphology. The present author questions whether the two subspecies can be consistently, reliably distinguished, and also maintains that absolute size is not a valid criterion for distinction of species or subspecies. Reference to the type figure of B. incrassata of Reuss shows that this species is characterized by an acute to very narrowly rounded base, and quite strongly tapering test. B. incrassata gigantea as defined and figured by Wicher includes a microspheric form with acute base and quite rapidly tapering test, and a megalospheric form with a broadly rounded base and nearly parallel sides. Thus the present specimens all fall within the range of variation allowed by B. incrassata gigantea but exceed that allowed by B. incrassata. It may well be that Reuss' species is merely the microspheric form of the present so-called subspecies. B. incrassata crassa Vasilenko-Myatlyuk is distinguished by its much broader test, which is strongly elliptical in outline.

Genus BOLIVINOIDES Cushman, 1927

Bolivinoides compressa Reiss

Bolivinoides compressa REISS, 1954, p.156, pl.30, figs.1-3 (fide Ellis and Messina, 1940 et seq).

NOT Bolivinoides compressa OLSSON, 1960, p.30, pl.4, figs.20,21.

Test free, biserial, rhomboid to kite-shaped, strongly compressed; periphery acute and keeled. Chambers low, broad, arched, increasing

steadily in size as added. Sutures distinct, limbate, oblique, curved, and gently depressed. Wall calcareous, perforate, with two paramedian rows of lobes on each side of median suture; initial portion of test nodose. Aperture a narrow, high, interiomarginal arch.

Dimensions of specimen CUFC 171, sample 76871: length 0.25 mm, width 0.18 mm, thickness 0.10 mm.

Remarks: The strongly compressed test, with keeled periphery and two rows of paramedian nodes, distinguishes this species. Olsson's species of 1960 requires a new name, as B. compressa Reiss (1954) has priority.

Bolivinoides decorata australis Edgell

Bolivinoides decorata (Jones) subsp. australis EDGELL, 1954, p.71, pl.13, figs.4,6, pl.14, figs.5,6.

Bolivinoides australis Edgell. BARR, 1966, p.233, pl.34, fig.1, pl.35, figs.1-3.

Bolivinoides decorata (Jones) australis Edgell. MELLO, 1969, p.73, pl.8, fig.8.

Dimensions of specimen CUFC 172, sample 76880: length 0.58 mm, width 0.42 mm, thickness 0.20 mm.

Remarks: The description of Edgell (1954) is followed herein, with the additional notes that the chambers are low and broad, and the sutures nearly straight, oblique, and flush. B. decorata australis is distinguished by the short, stout ribs that are transverse to but do not cross the sutures, and by the initial portion of the test that is covered in pustules.

Bolivinoides decorata gigantea Hiltermann and Koch

Bolivinoides decorata (Jones) subsp. gigantea HILTERMANN AND KOCH, 1950 p.610, t.f.2(49-51, 55-57, 61-63), 3(49-51, 55-57, 61-63), 4(49-51, 55-57, 61-63), 5(50), 6 (fide Ellis and Messina, 1940 et seq).--EDGELL, 1954, p.72, pl.13, fig.4, pl.14, fig.4.

NOT Bolivinoides decoratus gigantea Hiltermann-Koch. HANZLIKOVÁ, 1972, p.81, pl.19, fig.14.

Dimensions of specimen CUFC 173, sample 76870: length 0.77 mm, width 0.50 mm, thickness 0.28 mm.

Remarks: The description of Edgell (1954) is followed herein, with the additional notes that the chambers are low and broad, and the sutures nearly straight, oblique, and flush. B. decorata gigantea is distinguished by the long continuous ribs that are transverse to, and cross, the sutures, and the smooth, thickened initial portion of the test. The specimen figured by Hanzliková (1972) as B. decorata gigantea has stout discontinuous ribs, as in B. decorata australis Edgell, but is much too elongate and narrow for that subspecies.

Bolivinooides draco draco (Marsson)

Bolivinooides draco MARSSON, 1878, p.157, pl.3, fig.25 (fide Ellis and Messina, 1940 et seq).

Bolivinooides draco draco (Marsson). EDGEELL, 1954, p.73, pl.13, figs.1-3, pl.14, figs.1-3.---SLITER, 1968, p.88, pl.12, fig.17.

Bolivinooides draco (Marsson). BARR, 1970, p.646, pl.99, figs.2,3.

Dimensions of specimen CUFC 174, sample 76870: length 0.56 mm, width 0.39 mm, thickness 0.22 mm.

Remarks: The description of Edgell (1954) is followed herein, with the additional notes that the chambers are low and broad, and the sutures nearly straight, oblique and flush. B. draco is readily distinguished by the acute margins, the median sulcus bordered by two longitudinal ribs, and the continuous and discontinuous ribs, which run perpendicular to the sutures and merge into the two parallel median ribs.

Genus LOXOSTOMOIDES Reiss, 1957

Loxostomoides sp.
(Plate 4, Figs.5,6)

Test free, elongate, with rounded base, initially biserial and compressed, with rounded margins, becoming uniserial and oval to

circular in section. Chambers very gently arched, no more than 1-1/2 times as broad as high in biserial stage, inflated, increasing fairly rapidly in size as added, but width of test usually not increasing significantly; uniserial portion with chambers as high as or higher than broad, strongly inflated, usually added slightly to one side of axis of test, alternating. Sutures distinct, quite strongly depressed, initially curved and oblique, later becoming straight and less strongly oblique. Wall calcareous, perforate, smooth. Aperture subterminal, eccentric, and very slightly produced towards axis of test, rounded, connected by simple internal tooth plate to previous aperture.

Dimensions of specimen CUFC 175, sample 76874: length 0.69 mm, width 0.20 mm, thickness 0.18 mm.

Remarks: The strongly inflated chambers, biserial to uniserial chamber arrangement, and subterminal rounded aperture distinguish this species.

Family EOUVIGERINIDAE Cushman, 1927

Genus EOUVIGERINA Cushman, 1926

Eouvigerina americana Cushman

Eouvigerina americana CUSHMAN, 1926b, p.4, pl.1, fig.1 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.63, pl.16, figs.3-6.

Dimensions of specimen CUFC 176, sample 76904: length 0.39 mm, width 0.15 mm, thickness 0.12 mm.

Remarks: The description of Cushman (1926b) is followed herein, with the exception that the present specimens never exhibit any tendency to triserial chamber arrangement. The biserial chamber arrangement is distinct, and does not even become twisted. The rhomboid aperture described by Cushman is likely an irregular rounded aperture. The ornamentation is hispid, and the keel is usually quite strongly developed. The cameral keels distinguish this species.

Eouvigerina gracilis Cushman

Eouvigerina gracilis CUSHMAN, 1926b, p.5, pl.1, fig.2 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.62, pl.16, figs.1,2.

Dimensions of specimen CUFC 177, sample 76871: length 0.39 mm, diameter 0.16 mm.

Remarks: The description of Cushman (1926b) is followed herein. E. gracilis is distinguished from E. americana Cushman by the former's hispid test without cameral keels, and from E. hispida Cushman which has no tendency to uniserial chamber arrangement, and which has a basal spine.

Genus STILOSTOMELLA Guppy, 1894

Stilostomella horridens (Cushman)

Ellipsonodosaria horridens CUSHMAN, 1936b, p.53, pl.9, figs.19-21 (fide Ellis and Messina, 1940 et seq).

Stilostomella horridens (Cushman). SAID AND KENAWY, 1956, p.146, pl.4, fig.38.

Dimensions of specimen CUFC 178, sample 76873: length 0.72 mm, diameter 0.18 mm.

Remarks: The description of Cushman (1936b) is followed herein. S. horridens is distinguished by the pyriform chambers ornamented only on the lower portion by short, sharp, downward directed spines.

Stilostomella pseudoscripta (Cushman)

Ellipsonodosaria pseudoscripta CUSHMAN, 1937b, p.103, pl.15, fig.14 (fide Ellis and Messina, 1940 et seq).

Siphonodosaria pseudoscripta (Cushman). GRAHAM AND CHURCH, 1963, p.56, pl.6, fig.13.

Stilostomella pseudoscripta (Cushman). HANZLIKOVÁ, 1972, p.84, pl.20, fig.3.

Dimensions of specimen CUFC 179, sample 76875: length 0.47 mm, diameter 0.09 mm.

Remarks: The description of Cushman (1937b) is followed herein. Ellipsonodosaria minuta Cushman is arcuate, and E. paleocenica Cushman

and Todd only becomes faintly hispid on the final few chambers. S. pseudoscripta is distinguished from S. horridens (Cushman) by the former's much smaller size and hispid ornamentation.

Family BULIMINIDAE Jones, 1875
Subfamily PAVONININAE Eimer and Fickert, 1899
Genus REUSSELLA Galloway, 1933

Reussella cimbrica (Troelsen)

Pseudouvigerina cimbrica Troelsen, 1945. BROTZEN, 1945, p.47, pl.1, figs.8,9, t.f. 8C (fide Ellis and Messina, 1940 et seq).

Reussella cimbrica (Brotzen). HANZLIKOVA, 1972, p.85, pl.19, fig.20.

Dimensions of specimen CUFC 180, sample 76893: length 0.39 mm, width 0.14 mm.

Remarks: The description of Brotzen (1945) is followed herein. This species is distinguished by its gently depressed sutures, concave sides, and margins provided with a thick rib.

Reussella szajnochae (Grzybowski)
(Plate 4, Figs.10,11)

Verneuilina szajnochae GRZYBOWSKI, 1896, p.287, pl.9, fig.19 (fide Ellis and Messina, 1940 et seq).

Reussella szajnochae (Grzybowski), subsp.. BELFORD, 1960, p.66, pl.16, figs.16-19, pl.17, figs.1-13.

Reussella aff. szajnochae (Grzybowski). MCGOWAN, 1962, p.74, pl.3, fig.9.

Reussella szajnochae (Grzybowski). GRAHAM AND CHURCH, 1963, p.53, pl.6, fig. 9.---HANZLIKOVA, 1972, p.85, pl.20, figs.9-11.

Pyramidina szajnochae (Grzybowski). SLITER, 1968, p.87, pl.12, fig.13.

Dimensions of angular specimen CUFC 181, sample 76874: length 0.51 mm, width 0.34 mm; dimensions of rounded specimen CUFC 182, sample 76903: length 0.43 mm, width 0.30 mm.

Remarks: The description of Grzybowski (1896) is followed herein. This rather distinct species occurs in two forms in the present study.

The first and stratigraphically younger form occurs in samples 76868, and 76870-75, which represents the uppermost section of the Korojon Calcarenite in the present study. This form is quite regular, with the sides rather solid appearing and gently concave, with the angles serrate but otherwise entire, well developed, and not twisted. In transverse section, the test is distinctly triangular, with acute angles. It corresponds most closely with the figured specimens of Grzybowski (1896) and McGowran (1962). The second, stratigraphically older, form is found exclusively in the calcilutite at the base of the Korojon Calcarenite (see Appendix IIIn) this calcilutite being the Toolonga Calcilutite. This form has a twisted test in the final stages, with much more indented angles in side view, and a more nearly circular section. It corresponds most closely to the figured specimens of Belford (196Q), Graham and Church (1963), and Hanzliková (1972).

Family UVIGERINIDAE Haeckel, 1894

Genus PSEUDOUVIGERINA Cushman, 1927

Pseudouvigerina cristata (Marsson)

Uvigerina cristata MARSSON, 1878, p.150, pl.3, fig.20 (fide Ellis and Messina, 1940 et seq).

Pseudouvigerina cristata (Marsson). LOEBLICH AND TAPPAN, 1964, p.C568, fig.448(1-3).---HANZLIKOVÁ, 1972, p.86, pl.19, figs.18,19.

Test free, elongate and quite rapidly tapering, triserial and triangular in section, with truncate angles each bordered by two parallel serrate keels. Chambers gently arched, increasing slowly in size as added. Sutures distinct, gently depressed, and arched. Wall calcareous, perforate, irregularly pustulose. Aperture terminal, sub-elliptical, with phialine lip and projecting simple tooth plate.

Dimensions of specimen CUFC 183, sample 76871: length 0.35 mm, width 0.21 mm.

Remarks: The pustulose walls and truncate angles with parallel serrate keels are distinctive of this species.

Pseudouvigerina sp.
(Plate 4, Figs.12,13)

Test free, 1-1/2 times as long as broad, increasing but little in thickness after initial whorl, base rounded, apertural end acute; periphery lobulate in side view, initially broadly rounded in section, becoming narrowly rounded to subacute in final few chambers. Chambers triserial, inflated, initially subglobular, becoming more elongate and angular in section, increasing regularly in size as added and removed quite strongly from previous whorls. Sutures distinct, depressed; gently curved. Wall calcareous, perforate, initial whorl and lower half of subsequent chambers provided with quite coarse spines. Aperture terminal, elliptical, on fairly short neck with phialine lip.

Dimensions of specimen CUFC 184, sample 76892: length 0.28 mm, diameter 0.21 mm.

Remarks: The fairly stout test with spinose lower portion, inflated chambers, and apertural neck with phialine lip distinguish this species.

Superfamily	DISCORBACEA Ehrenberg, 1838
Family	DISCORBIDAE Ehrenberg, 1838
Subfamily	DISCORBINAE Ehrenberg, 1838
Genus	CONORBINA Brotzen, 1936

Conorbina sigmoidalis (Schijfsma)

Discorbis sigmoidalis SCHIJFSMA, 1946, p.83, pl.4, fig.12.

Rosalina aff. sigmoidalis (Schijfsma). MCGOWRAN, 1962, p.184, pl.7, fig.4, pl.15, fig.3.

Dimensions of specimen CUFC 185, sample 76885: diameter 0.27 mm, thickness 0.14 mm.

Remarks: The description of McGowran (1962) is followed herein. It differs somewhat from the description of Schijfsma (1946) in that it describes the equatorial periphery as lobulate and the axial periphery as acute, with a thin hyaline keel. All chambers, rather than the final few, are inflated on the umbilical side, and the aperture is bordered above by a very fine lip. C. sigmoidalis is distinguished from C. supracretacea (Schijfsma) by the former's much lower number of chambers in the final whorl, the more nearly biconvex test, and the quite strongly inflated chambers on the umbilical side with lobulate periphery.

Conorbina supracretacea (Schijfsma)

Discorbis supracretacea SCHIJFSMA, 1946, p.83, pl.4, fig.10.

Rosalina cf. supracretacea (Schijfsma). MCGOWRAN, 1962, p.185, pl.7, fig.5, pl.15, fig.4.

Rotorbinella supracretacea (Schijfsma). HANZLIKOVÁ, 1972, p.87, pl.20, fig.13.

Dimensions of specimen CUFC 186, sample 76884: diameter 0.44 mm, thickness 0.28 mm.

Remarks: The description of Schijfsma (1946) is followed herein, with the additional note that the aperture is bordered above by a fine lip. C. supracretacea is distinguished from C. sigmoidalis (Schijfsma) by the former species' entire, circular equatorial periphery, the more clearly plano-convex test, and greater number of chambers in the final whorl. It is quite similar to Eponides concinna Brotzen, but E. concinna is typically more convex on the umbilical side than on the spiral side. Additionally, the spiral side and hence periphery of C. supracretacea is slightly turned onto the umbilical side, whereas the reverse is true for E. concinna.

Genus EPISTOMINELLA Husezima and Maruhasi, 1944

Epistominella sp.
(Plate 4, Figs.7-9)

Coleites sp. nov.. McGOWRAN, 1962, p.193, pl.8, fig.3, pl.15, fig.1.

Test free, low trochospiral, inequally biconvex and nearly lenticular; spiral side gently convex, evolute, umbilical side more strongly convex and involute, with obscured umbilicus; equatorial periphery nearly entire, axial periphery acute, with thin, fairly wide keel. Chambers 6 or 7 in final whorl, increasing regularly and quite rapidly in size as added; on spiral side crescentic, obscure, on umbilical side inflated, triangular in outline. Sutures on spiral side obscure, limbate, and elevated, curved and oblique; on umbilical side quite distinct, recurved and depressed. Wall calcareous, coarsely perforate on spiral side, less so on umbilical side; on spiral side coarsely and irregularly reticulate, with final few chambers not ornamented, on umbilical side reticulations initially obscure chambers and sutures, as well as umbilicus, eventually confined to sutural depressions and becoming finer, final chambers and sutures not ornamented. Aperture a very narrow slit, with thin flap, parallel to periphery and located on umbilical side near peripheral keel.

Dimensions of specimen CUFC 187, sample 76870: diameter 0.59 mm, thickness 0.23 mm.

Remarks: The chamber arrangement and shape, aperture, and reticulate ornamentation with its distinctive distribution characterize this species.

Subfamily BAGGININAE Cushman, 1927

Genus VALVULINERIA Cushman, 1926

Valvulineria infrequens Morrow

Valvulineria infrequens MORROW, 1934, p.197, pl.30, fig.3 (fide Ellis and Messina, 1940 et seq).---GRAHAM AND CHURCH, 1963, p.60, pl.7, figs.6,7.

Dimensions of specimen CUFC 188, sample 76872: diameter 0.25 mm, thickness 0.09 mm.

Remarks: The description of Morrow (1934) is followed herein, with the additional note that as many as eight chambers may be present in the final whorl. V. infrequens is distinguished by its slowly increasing chamber size, almost equally biconvex test, and chambers that are not very much broader than high on the umbilical side.

Valvulineria lenticula (Reuss)

Rotalina lenticula REUSS, 1845, p.35, pl.12, fig.17 (fide Ellis and Messina, 1940 et seq).

Gyroidina depressa (Alth). PLUMMER, 1931, p.190, pl.13, fig.3.---MELLO, 1969, p.85, pl.10, fig.2.

Valvulineria cretacea (Carsey). BANDY, 1951, p.504, pl.74, fig.1.

Valvulineria lenticula (Reuss). HARRIS AND McNULTY, 1956, p.865, pl.97, figs.1-5.---BELFORD, 1960, p.75, pl.20, figs.3-10.

Gyroidina cretacea (Carsey). SLITER, 1968, p.117, pl.21, figs.7,8.

Dimensions of specimen CUFC 189, sample 76875: diameter 0.30 mm, thickness 0.21 mm.

Remarks: The description of Harris and McNulty (1956) is followed herein. In addition, the reader is referred to that article for an excellent discussion of the status of Rotalina depressa Alth and Rotalia cretacea Carsey, which were placed in synonymy with V. lenticula. V. lenticula is distinguished by its somewhat plano-convex test, the umbilical side being more strongly convex, by its quite broadly rounded periphery, and the quite prominent apertural face.

Valvulineria nonionoides Bandy

Valvulineria cf. V. umbilicatula (d'Orbigny). CUSHMAN, 1946, p.139 (partim), pl.52, fig.9.

Valvulineria nonionoides BANDY, 1951, p.504, pl.74, fig.5.

Gyroidina nonionoides (Bandy). SLITER, 1968, p.117, pl.21, fig.60.

Dimensions of specimen CUFC 190, sample 76893: diameter 0.41 mm, thickness 0.20 mm.

Remarks: The description of Bandy (1951) is followed herein, with the additional notes that the spiral side is more strongly convex than in Bandy's specimens, and the chambers are subrectangular in plan. This species is readily distinguished by its low number of subrectangular chambers, broadly rounded periphery, and irregular umbilical flap or plug.

Valvulineria undulata Belford

Valvulineria undulata BELFORD, 1960, p.76, pl.20, figs.19-24.

Dimensions of specimen CUFC 191, sample 76899: diameter 0.28 mm, thickness 0.14 mm.

Remarks: The description of Belford (1960) is followed herein. V. undulata is distinguished from the very similar V. lenticula (Reuss) by the former's less strongly convex umbilical side, by its lower number of chambers (6 or 7, versus the typical 8 or more of V. lenticula which may have but 7), and by the sutures, which are reflexed on the spiral side, and sinuate versus gently arched on the umbilical side.

Family GLABRATELLIDAE Loeblich and Tappan, 1964

Genus HERONALLENIA Chapman and Parr, 1931

Heronallenia minuta (Sliter)

Heronallenia sp.. McGOWRAN, 1962, p.188, pl.8, fig.2.

Pseudopatellinella minuta SLITER, 1968, p.127, pl.24, fig.7.

Dimensions of specimen CUFC 192, sample 76887: diameter 0.29 mm, thickness 0.10 mm.

Remarks: The description of McGowran (1962) is followed herein. Although the description of Sliter (1968) is the type description, it contains some significant errors. The umbilical side is distinctly concave, the axial periphery is rounded, and more than the final 4 or 5 chambers are visible on the umbilical side. These features are clearly visible not only in the present study, but in the type figures of Sliter

as well. In addition, the present specimens have limbate, thickened, and raised sutures on the spiral side. These sutures, combined with the petaloid spiral side chambers and quite low convex spiral side, distinguish H. minuta from Heronallenia sp. of the present study.

Heronallenia sp.
(Plate 5, Figs.1-3)

Test free, not too low trochospiral, concavo-convex; spiral side strongly convex, evolute, umbilical side strongly concave, involute; equatorial periphery lobulate, axial periphery rounded. Chambers 3 to 5 in final whorl, inflated, increasing rapidly in size as added; on spiral side crescentic, with globular proloculus; on umbilical side crescentic, with two large interiomarginal re-entrants with a lobe between them. Sutures distinct, on spiral side strongly depressed and oblique, on umbilical side gently depressed. Wall calcareous, perforate, initially pustulose on spiral side, becoming smooth. Aperture interiomarginal, extraumbilical, a high arch in the re-entrant nearest the periphery, bordering deep umbilicus.

Dimensions of specimen CUFC 193, sample 76871: diameter 0.32 mm, thickness 0.23 mm.

Remarks: This species is distinguished from H. minuta (Sliter) by the present species' spiral side, which is much more strongly convex, has crescentic chambers, and depressed sutures. It also has fewer chambers in the final whorl. It is not equivalent to Heronallenia sp. of McGowan (1962).

Family EPISTOMARIIDAE Hofker, 1954

Genus NUTTALLINELLA Belford, 1959

Nuttallinella coronula (Belford)

Nuttallina coronula BELFORD, 1958, p.97, pl.19, figs.1-14, t.f.4 (fide Ellis and Messina, 1940 et seq).

Nuttallinella coronula (Belford). BELFORD, 1960, p.84, pl.23, figs.7-12.---McGOWRAN, 1962, p.197.

Dimensions of specimen CUFC 194, sample 76904: diameter 0.41 mm, thickness 0.17 mm.

Remarks: The description of Belford (1958) is followed herein. The plano-convex to biconvex test with wide, thin keel, depressed umbilical sutures, and well developed apertural lip are distinctive of this species.

Superfamily GLOBIGERINACEA Carpenter, Parker and Jones, 1862

Family HETEROHELICIDAE Cushman, 1927

Subfamily HETEROHELICINAE Cushman, 1927

Genus HETEROHELIX Ehrenberg, 1843

Heterohelix globulosa (Ehrenberg)

Textularia globulosa EHRENBURG, 1840, p.135, pl.4, figs.2 β ,4 β ,5 β ,7 β ,8 β (fide Ellis and Messina, 1940 et seq).

Gumbelina reussi CUSHMAN, 1938, pp.7,11, pl.2, figs.6-9 (fide Ellis and Messina, 1940 et seq).

Gumbelina globulosa (Ehrenberg). CUSHMAN, 1946, p.105, pl.45, figs.9-15.

Heterohelix striata (Ehrenberg). SCHIJFSMA, 1946, p.74, pl.4, fig.6.

Gumbelina sp.. YOUNG, 1951, p.63, pl.14, fig.11.

Heterohelix globulosa (Ehrenberg). SLITER, 1968, p.94, pl.14, figs.1-3.

Dimensions of specimen CUFC 195, sample 76888: length 0.28 mm, width 0.20 mm, thickness 0.13 mm.

Remarks: The description of Sliter (1968) is followed herein. H. globulosa is distinguished by its regularly tapering test with globular chambers and very fine costae. H. moremani (Cushman) is otherwise similar but abnormally elongate, H. striata (Ehrenberg) has much more prominent costae, and H. navarroensis Loeblich has subquadrate chambers.

Although most authors distinguish the species H. reussi (Cushman) on the presence in that species of triangular pits between chambers along the median suture, the present author does not, because the illustrations of that species by Cushman (1938) include, in figures 6 and 7, specimens which clearly lack the triangular depressions. Hence the forms with more loosely appressed chambers are herein considered to lie within the range of variation of H. globulosa. The present study includes specimens with distinct depressions, but often the recognition of this feature is difficult or of questionable certainty. No attempt is made herein to present a synonymy of H. reussi. The reader is referred to some of the more important papers on Upper Cretaceous planktonic foraminifera, such as Pessagno (1967), Douglas (1969) and Douglas and Rankin (1969), for descriptions and synonymies of H. reussi.

A number of very large specimens occur in the present study with the final few pairs of chambers increasing very little in size as added, such that the test becomes nearly parallel-sided. They resemble Gumbelina punctulata Cushman, but may in fact be an alternate generation of H. globulosa. They cannot consistently be distinguished with confidence from the typical H. globulosa.

Heterohelix pulchra (Brotzen)

Gumbelina pulchra BROTZEN, 1936, p.121, pl.9, figs.2,3 (fide Ellis and Messina, 1940 et seq).

Gumbelina globulosa (Ehrenberg). MCGUGAN, 1964, p.942, pl.150, fig.20.

Heterohelix globulosa (Ehrenberg). PERLMUTTER AND TODD, 1965, p.113, pl.2, figs.9,13.

Heterohelix pulchra (Brotzen). PESSAGNO, 1967, p.262, pl.87, fig.4.
---DOUGLAS, 1969, p.158, pl.11, figs.3,14.

Dimensions of specimen CUFC 196, sample 76881: length 0.29 mm, width 0.24 mm, thickness 0.11 mm.

Remarks: The description of Douglas (1969) is followed herein. The reader is referred to Douglas' excellent discussion of the species Gumbelina planata Cushman and G. pseudotessera Cushman, both of which are placed in synonymy with H. pulchra. H. pulchra is distinguished by its compressed test, often with strongly reniform chambers and curved sutures, and distinct lateral flanges at the aperture, which flanges may extend in a faint ring around the upper surface of the penultimate chamber. For this reason, the forms assigned by McGugan (1964) and Perlmutter and Todd (1965) to H. globulosa (Ehrenberg) are herein assigned to H. pulchra. G. glabrans Cushman is distinguished by its more rounded chambers in outline, more strongly compressed test, and much higher, narrower aperture. In view of the lack of an edge view, or adequate description and distinction from H. pulchra, the forms assigned to H. glabrans by McGowran (1962) are left in that species, although they may in fact belong to H. pulchra.

Genus GUBLERINA Kikoïne, 1948

Gublerina cuvillieri Kikoïne

Gublerina cuvillieri KIKOÏNE, 1948, p.26, pl.2, fig.10 (fide Ellis and Messina, 1940 et seq).---DE KLASZ, 1953, p.246, pl.8, fig.1 (fide Ellis and Messina, 1940 et seq).---HANZLIKOVÁ, 1972, p.93, pl.24, figs.13,14.

Gublerina ornatissima (Cushman and Church). MCGOWRAN, 1962, p.167, pl.6, fig.7, pl.15, fig.9.

Dimensions of specimen CUFC 197, sample 76871: length 0.75 mm, width 0.50 mm, thickness 0.16 mm.

Remarks: The description of Kikoïne (1948) is followed herein, with the additional note that the chambers are frequently ornamented. De Klasz (1953) referred to irregular pustulose ornament on the lower portion of the test. The present specimens frequently have quite coarse, irregular longitudinal ridges on the chambers, usually becoming

increasingly confined to the equatorial region of the chambers, and eventually leaving the chambers smooth. Ventilabrella ornatissima Cushman and Church becomes parallel-sided and multiserial, hence McGowran (1962) was in error. The forms assigned to G. cuvillieri are readily distinguished by the regularly tapering, biserial test, with the two series separated by nonseptate flanges. Presence or absence of ornamentation is not considered diagnostic, but the ornamentation, when present, is distinctly discontinuous.

Gublerina sp. A
(Plate 5, Figs. 4-7)

Test free, elongate, biserial, initially quite rapidly tapering, but usually becoming nearly parallel-sided; periphery often initially carinate. Chambers initially subglobular, later considerably broader than high, and quadrate to subreniform, added in two series that are in contact but not appressed. Sutures distinct, limbate to thin, depressed, gently curved and nearly horizontal. Wall calcareous, perforate, usually ornamented by numerous fairly coarse continuous costae that are initially longitudinal, but increasingly curve obliquely from the periphery of the test towards the median suture. Aperture a fairly high interiomarginal arch, with well developed lateral flanges.

Dimensions of costate specimen CUFC 198, sample 76886: length 0.42 mm, width 0.30 mm, thickness 0.13 mm; dimensions of non-costate specimen CUFC 199, sample 76891: length 0.27 mm, width 0.20 mm, thickness 0.09 mm.

Remarks: This species is readily distinguished by the subquadrate chambers, continuous costae that become oblique, and loosely appressed series. The absence of a nonseptate flange may indicate that these forms are not in fact Gublerina, but some form of Heterohelix, reminiscent in chamber shape and apertural characteristics of H. pulchra

(Brotzen). The costae may be absent from some specimens, but the early marginal carinae and the lack of strong chamber divergence are characteristic.

Cublerina sp. B
(Plate 5, Figs.8,9)

Test free, elongate, quite irregular in outline, biserial rarely becoming multiserial; periphery lobulate, rounded. Chambers initially somewhat broader than high, increasing slowly in size as added for first four or five whorls, at which point next chambers is twice as large, producing discontinuity in outline of test, after which chambers increase regularly in size as added, usually becoming reniform. A narrow nonseptate flange is inserted between the two series beginning at the point of rapid increase in chamber size, this flange occasionally replaced by a third series of reniform chambers. Sutures distinct, depressed, straight, becoming curved where chambers are reniform. Wall calcareous, perforate, finely striate. Aperture a fairly high interior-marginal arch, with a fairly high flange that may embrace entire upper margin of test.

Dimensions of specimen CUFC 200, sample 76870: length 0.49 mm, width 0.33 mm, thickness 0.12 mm.

Remarks: This species is distinguished by its finely striate test, reniform chambers, and great increase in chamber size after four or five whorls.

Genus PSEUDOTEXTULARIA Rzehak, 1891

Pseudotextularia elegans (Rzehak)

Cuneolina elegans RZEHAKE, 1891, p.4 (fide Ellis and Messina, 1940 et seq).

Gümbelina plummerae Loetterle. CUSHMAN, 1946, p.101, pl.45, figs.1-3.

Pseudotextularia elegans (Rzehak). PESSAGNO, 1967, p.268, pl.75, figs.12-17, pl.85, figs.10,11, pl.88, figs.14-16, pl.89, figs.10,11, pl.97, fig.18, pl.98, figs.19,20.---SLITER, 1968, p.98, pl.14, figs.13-15.

Heterohelix striata (Ehrenberg). GRAHAM AND CHURCH, 1963, p.62, pl.7, fig.12.

Dimensions of specimen CUFC 201, sample 76887: length 0.55 mm, width 0.32 mm, thickness 0.38 mm.

Remarks: The description of Sliter (1968) is followed herein, with the additional note that the aperture may be a quite high arch. The chambers of the form assigned to H. striata by Graham and Church (1963) are clearly thicker than broad, and hence are assigned herein to P. elegans. P. elegans is readily distinguished from most species by the thicker than broad chambers, fine but distinct costae, from P. deformis (Kikoine) which has coarser costae and nearly flat chamber roofs in edge view, and from P. intermedia de Klash which has small chambers added at the crown of the test outside the plane of biserial chambers. According to Smith (1978), who restricted the genus Pseudotextularia Rzehak to biserial growth forms, that species would not belong to Pseudotextularia. Smith maintained that forms with a multiserial terminal stage that is circular to subcircular in apertural view should be referred to Racemiguembelina Gallitelli. It may well be that P. intermedia is transitional from P. elegans to R. fructicosa (Egger).

Genus RACEMIGUEMBELINA Montanaro Gallitelli, 1957

Racemiguembelina fructicosa (Egger)

Gümbelina fructicosa EGGER, 1900, p.35, pl.14, figs.8,9,24-26 (fide Ellis and Messina, 1940 et seq.).

Pseudotextularia varians Rzehak. CUSHMAN, 1946, p.110, pl.47, figs.4-9.

Racemiguembelina fructicosa (Egger). LOEBLICH AND TAPPAN, 1964, p.C656, fig.525(8).---PESSAGNO, 1967, p.270, pl.90, figs.14, 15.---SLITER, 1968, p.98, pl.14, fig.16.---MARTIN, 1972, p.82, pl.4, fig.3.---WRIGHT AND APTHORPE, 1976, pl.1, fig.4.

Pseudotextularia fructicosa (Egger). HANZLIKOVÁ, 1972, p.96, pl.24, fig.9.

Test free, conical, initially biserial, finally multiserial. Chambers added in biserial fashion, much thicker than broad, for all but final whorl, which consists of a ring of globular chambers around upper margin of test. Sutures distinct, depressed, straight. Wall calcareous, perforate, with continuous, quite coarse, longitudinal costae. Aperture in biserial stage a wide, quite high interiomarginal arch, bordered above by a lip; in multiserial final whorl all chambers open into large "umbilical" region, and may be connected by a thin coverplate with infra-laminal accessory apertures.

Dimensions of specimen CUFC 202, sample 76870: length 0.58 mm, diameter 0.44 mm.

Remarks: The present specimens are unusual in that the test is biserial except for the final whorl, with thick, Pseudotextularia-like chambers rather than the globular chambers referred to by Loeblich and Tappan (1964). In fact, this may be a form transitional from P. elegans (Rzehak) to R. fructicosa. Sliter (1968) referred to the aperture "at [the] base of [the] terminal chamber" (*ibid.*, p.98), but in fact there is no distinctly terminal chamber, and the aperture is multiple. The reader is referred to Martin (1972) for an excellent description and illustration of the apertural form of R. fructicosa.

Family PLANOMALINIDAE Bolli, Loeblich and Tappan, 1957

Genus GLOBIGERINELLOIDES Cushman and Ten Dam, 1948

Globigerinelloides alvarezi (Eternod Olvera)

Planomalina alvarezi ETERNOD OLVERA, 1959, p.91, pl.4, figs.5-7 (*fide* Sliter, 1968).

Globigerinella aspera (Ehrenberg). BELFORD, 1960, p.91, pl.25, figs.4-6.---GRAHAM AND CHURCH, 1963, p.64, pl.7, fig.17.

"Globigerinella" japonica TAKAYANAGI, 1960, p.131 (partim), pl.9,
fig.12, t.f.22 a-c.

Globigerinelloides alvarezi (Eternod Olvera). SLITER, 1968, p.98,
pl.15, figs.1,2.

Dimensions of specimen CUFC 203, sample 76881: diameter 0.25 mm,
thickness 0.12 mm.

Remarks: The description of Sliter (1968) is followed herein. The description of Eternod Olvera (1959) is not contained in the Catalogue of Foraminifera, and the present author was unable to locate the original article. G. alvarezi is distinguished by its 7 to 8 chambers in the final whorl, and nearly circular outline, from other species in the present study. Belford (1960) and Graham and Church (1963) were in error in assigning 7 chambered forms to Globigerinella aspera (Ehrenberg), which has 6 hispid chambers. Takayanagi (1960) grouped these forms plus forms assigned herein to Globigerinelloides volutus (White) in "Globigerinella" japonica. Globigerinelloides alvarezi is distinguished from most other species of this genus with 7 to 9 chambers by its combination of globular chambers and quite wide umbilicus. It may be synonymous with Planomalina caseyi Bolli, Loeblich and Tappan, which has 7 to 9 chambers rather than 7 or 8, but the present author cannot comment further without reference to the original description and figures of Eternod Olvera for P. alvarezi.

Globigerinelloides multispina (Lalicker)

Biglobigerinella multispina LALICKER, 1948, p.624, pl.92, figs.1-3
(fide Ellis and Messina, 1940 et seq).

Biglobigerinella biforaminata (Hofker). OLSSON, 1960, p.44, pl.8,
figs.7,8.---MELLO, 1969, p.95 (partim), pl.2, figs.4,5.

Globigerinelloides messinae (Brönnimann). OLSSON, 1964, p.174 (partim),
pl.7, figs.6-8.---SLITER, 1968, p.99 (partim), pl.15, fig.5.

Globigerina (Biglobigerinella) biforaminata Hofker. PERLMUTTER AND
TODD, 1965, p.118, pl.5, fig.3.

Globigerinelloides multispina (Lalicker). PESSAGNO, 1967, p.276, pl.70, figs.1,2, pl.82, figs.10,11, pl.91, figs.1,2.---HANZLIKOVÁ, 1972, p.99, pl.25, figs.2-4.

Dimensions of thick-chambered specimen CUFC 204, sample 76881: diameter 0.25 mm, thickness 0.16 mm; dimensions of biapertural specimen CUFC 205, sample 76872: diameter 0.29 mm, thickness 0.16 mm; dimensions of bicameral specimen CUFC 206, sample 76893: diameter 0.21 mm, thickness 0.17 mm.

Remarks: The description of Lalicker (1948) is followed herein, with the additional notes that there are 5 or 6 chambers, or chambers plus pairs of chambers, in the final whorl, and the final stage may be a single globular and biapertural chamber, or a very thick and biapertural chamber, rather than a pair of uniapertural chambers. By far the most common form in the present study has a biapertural globular final chamber. This biserial or biapertural final stage is herein regarded as of specific, not generic, significance. It is an ontogenetic development, as some broken biapertural specimens reveal a uniapertural stage resembling G. volutus (White), from which the present species is indistinguishable in juveniles. It may be desirable to place G. multispina in synonymy with G. volutus.

Globigerinelloides subcarinatus (Brönnimann)

Globigerinella messinae subcarinata BRÖNNIMANN, 1952, p.44, pl.1, figs.10,11, t.f.21.

Globigerinelloides subcarinatus (Brönnimann). PESSAGNO, 1967, p.278, pl.62, figs.12,13.

Dimensions of specimen CUFC 207, sample 76870: diameter 0.31 mm, thickness 0.11 mm.

Remarks: The description of Brönnimann (1952) is followed herein, with the additional notes that there may be but 4-1/2 chambers in the final whorl, and the apertural lip is actually quite wide and thin. The

much-compressed test with subcarinate periphery readily distinguishes this species.

Globigerinelloides volutus (White)

Globigerina voluta WHITE, 1928a, p.197, pl.28, fig.5 (fide Ellis and Messina, 1940 et seq.).

Globigerinella aspera (Ehrenberg). SCHIJFSMA, 1946, p.94, pl.6, fig.8.
---BANDY, 1951, p.508, pl.75, fig.3.---McGUGAN, 1957, p.343.

"Globigerinella" japonica TAKAYANAGI, 1960, p.131 (partim), t.f.22d,e.

Globigerinelloides messinae (Brönnimann). OLSSON, 1964, p.174
(partim).---SLITER, 1968, p.99 (partim), pl.15, fig.3.

Globigerina (Biglobigerinella) biforaminata Hofker. PERLMUTTER AND TODD, 1965, p.118 (partim), pl.5, fig.2.

Globigerinelloides volutus (White). PESSAGNO, 1967, p.278, pl.62, figs.9-11, pl.100, fig.9.

Globigerinelloides multispinata Lalicker. DOUGLAS, 1969, p.161, pl.9, fig.6.

Biglobigerinella biforaminata (Hofker). MELLO, 1969, p.95 (partim), pl.2, fig.3.

Globigerinelloides aspera (Ehrenberg). HANZLIKOVÁ, 1972, p.98, pl.25, fig.1.

Dimensions of 4-chambered specimen CUFC 208, sample 76886:
diameter 0.27 mm, thickness 0.13 mm; dimensions of 5-chambered specimen CUFC 209, sample 76874: diameter 0.31 mm, thickness 0.15 mm; dimensions of 6-chambered specimen CUFC 210, sample 76876: diameter 0.29 mm, thickness 0.13 mm.

Remarks: The description of White (1928a) is followed herein, with the additional note that the wall is usually finely hispid. Assigned to this species are forms with 5 to 6, or rarely 4, globular chambers in a partially evolute planispiral coil. These forms have been assigned by several authors to G. messinae (Brönnimann), but reference to Brönnimann's (1952) description and figures of Globigerinella messinae messinae shows that that species has a compressed test with a quite

narrow and high aperture. In fact, Brönnimann took care to distinguish that species from Globigerinelloides volutus, which has globular chambers and a much lower aperture. Thus Olsson (1964) and Sliter (1968) were in error in using the species messinae for these forms. Uniapertural specimens assigned to species biforaminata Hofker or multispina Lalicker, which Douglas (1969) incorrectly called multispinata, are herein referred to G. volutus.

Several authors have referred these forms to Phanerostomum asperum Ehrenberg. Ehrenberg failed to give a description of these forms, but it appears from his illustrations that the sutures are limbate and raised, as in Globotruncana Cushman. Pessagno (1967) and Sliter (1968) both argued that the species asperum was inadequately described and illustrated, and the present author agrees that Globigerinelloides asperus (or aspera) should no longer be regarded as a valid species. In addition, all reports of G. asperus refer to 6 chambers in the final whorl, never 5, whereas White (1928a) described G. volutus as having 5 or more chambers to the final whorl. Thus G. volutus more adequately embraces the range of variation of the present population.

G. volutus is distinguished from G. prairiehillensis Pessagno which has a much more rapid increase in chamber size, and well developed relict apertural flaps.

Family	ROTALIPORIDAE Sigal, 1958
Subfamily	HEDBERGELLINAE Loeblich and Tappan, 1961
Genus	HEDBERGELLA Brönnimann and Brown, 1958

Hedbergella planispira (Tappan)

Globigerina planispira TAPPAN, 1940, p.122, pl.19, fig.12 (fide Ellis and Messina, 1940 et seq).

Hedbergella planispira (Tappan). MICHAEL, 1972, p.211, pl.2, figs.10-12.

Dimensions of specimen CUFC 211, sample 76903: diameter 0.28 mm, thickness 0.13 mm.

Remarks: The description of Tappan (1940) is followed herein, with the exception that the aperture is not strictly umbilical, but is clearly extraumbilical-umbilical in nature. H. planispira is distinguished from several species of Hedbergella by its low spire, from H. amabilis Loeblich and Tappan which has clavate chambers, H. holmdelensis Olsson which is still higher spired, and Globotruncana cretacea (Hedbergella) delrioensis Carsey which has rugose early chambers and a final chamber which is strongly umbilically produced. It may occasionally be confused with Globigerinelloides volutus (White) if the spire is particularly low and the aperture strongly extraumbilical.

Genus PRAEGLOBOTRUNCANA Bermudez, 1952

Praeglobotruncana havanensis (Voorwijk)

Globotruncana havanensis VOORWIJK, 1937, p.195, pl.1, figs.25,26,29 (fide Ellis and Messina, 1940 et seq.)---HANZLIKOVÁ, 1972, p.105, pl.29, figs.2-5.

Globotruncana citae BOLLI, 1951, p.197, pl.35, figs.4-6.

Globotruncanella havanensis (Voorwijk). PESSAGNO, 1967, p.373, pl.84, figs.1-3.

Praeglobotruncana citae (Bolli). POSTUMA, 1971, pp.70,71, 7 figs.

Dimensions of specimen CUFC 212, sample 76873: diameter 0.29 mm, thickness 0.13 mm.

Remarks: The description of Postuma (1971) is followed herein, although Globotruncana citae Bolli is herein placed in synonymy with P. havanensis (Voorwijk). There is some controversy concerning the generic assignment of this species. Because no specimens are found with tegilla, they are herein assigned to Praeglobotruncana on the basis of having an extraumbilical-umbilical aperture bordered above by a quite wide lip, succeeding lips being preserved. The photographic

illustration of specimens with preserved tegilla would persuade the present author to assign this species to Globotruncanella Reiss. P. havanensis is distinguished by its 4 or 5 imbricate chambers in the final whorl, concave umbilical side, bluntly angled periphery without strong keel, and quite spinose early chambers.

Family GLOBOTRUNCANIDAE Brotzen, 1942

Genus GLOBOTRUNCANA Cushman, 1927

Globotruncana arca (Cushman)

Pulvinulina arca CUSHMAN, 1926c, p.23, pl.3, fig.1 (fide Ellis and Messina, 1940 et seq).

Globotruncana arca (Cushman). PESSAGNO, 1967, p.321, pl.79, figs.5-8, pl.90, figs.6-8, pl.96, figs.7,8,17.---DOUGLAS, 1969, p.176, pl.9, figs.1-3, pl.10, figs.4-7.---HANZLIKOVÁ, 1972, p.102, pl.26, figs.11-13, pl.27, fig.1.

Globotruncana lapparenti subsp.. BELFORD, 1960, p.98, pl.29, figs.1-4.

Globotruncana tricarinata (Quereau). OLSSON, 1964, p.171 (partim), pl.5, fig.5.---HANZLIKOVÁ, 1972, p.112, pl.27, fig.1, pl.31, fig.4.

Dimensions of specimen CUFC 213, sample 76893: diameter 0.52 mm, thickness 0.26 mm.

Remarks: The description of Pessagno (1967) is followed herein, with the additional note from Postuma (1971, p.18) that the sutures on the spiral side are less strongly beaded in the final stages. The reader is also referred to Pessagno's (1967) excellent synonymy. G. arca is distinguished by its markedly convex spiral side with umbilically inturned carinal band, which is usually quite wide, but may be narrow. G. churchi Martin has the inner whorls of the spiral side elevated to produce a shoulder, and G. mariei Banner and Blow has a less truncate periphery with much weaker umbilical keel. It may in fact be conspecific with G. arca.

Globotruncana bulloides Vogler

Globotruncana linnei (d'Orbigny) subsp. bulloides VOGLER, 1941, p.287, pl.23, figs.32-39 (fide Ellis and Messina, 1940 et seq).

Globotruncana marginata (Reuss). CUSHMAN, 1946, p.150, pl.62, figs.1, 2.---BELFORD, 1960, p.100, pl.30, figs.1-7.---SLITER, 1968, p.104, pl.17, figs.5,6.---DOUGLAS, 1969, p.182, pl.8, figs.4, 5.

Rosalinella marginata (Reuss). SCHIJFSA, 1946, p.97, pl.7, fig.10.

Globotruncana lapparenti tricarinata (Quereau). SAID AND KENAWY, 1956, p.150, pl.5, fig.20.

Globotruncana globigerinoides Brotzen. BELFORD, 1960, p.99, pl.29, figs.12-14.

Globotruncana caniculata (Reuss). MCGUGAN, 1964, p.948, pl.152, fig.9.

Globotruncana bulloides Vogler. PESSAGNO, 1967, p.324, pl.64, figs.15-17, pl.67, figs.1-3, pl.73, figs.9,10, pl.75, figs.4-8, pl.97, figs.14,15.---POSTUMA, 1971, pp.20,21, 7 figs.

Globotruncana tricarinata (Quereau). SLITER, 1968, p.107, pl.19, fig.1.

Dimensions of globigerine specimen CUFC 214, sample 76903: diameter 0.57 mm, thickness 0.27 mm; dimensions of linneiana-like specimen CUFC 215, sample 76895: diameter 0.55 mm, thickness 0.23 mm; dimensions of arca-like specimen CUFC 216, sample 76904: diameter 0.55 mm, thickness 0.26 mm.

Remarks: The description of Postuma (1971) is followed herein, with reference to the synonymy of Pessagno (1967). A brief synonymy of G. marginata (Reuss) is provided herein. Douglas (1969) placed G. bulloides in synonymy with G. marginata. An excellent discussion of the problem caused by Vogler's (1941) description and type figure produced from thin section is found in Pessagno.

Rosalina marginata Reuss (1845) is not illustrated in edge view, nor is there sufficient detail in the illustration to allow Pessagno to distinguish G. bulloides from Marginotruncana marginata on the basis of apertural characteristics. G. bulloides is recognized by its quite wide carinal band and quite strongly inflated chambers on the spiral side.

In the present study, a considerable range of variation is observed. The spiral side is flat to markedly convex, as in G. arca (Cushman), from which it is then distinguished only with difficulty by the degree of chamber inflation. The chambers may be strongly to only weakly inflated on both sides of the test, and the peripheral keels may be weakly developed on an otherwise rounded periphery, or may be prominent, thick, and becoming less strongly beaded on a strongly truncate periphery. The final chamber may be quite strongly developed umbilically, with an umbilical keel or rim, such that its distinction from G. ventricosa White is rendered difficult. The problem, as in most species which are represented by large numbers of specimens and exhibiting a great range of variation, is not the recognition of the typical forms, such as G. bulloides, G. arca, G. globigerinoides Brotzen and G. tricarinata (Quereau), all of which are in theory distinct, but the consistent distinction between them. Where such a distinction is not possible, the present author believes that the large range of variation is representative of the natural state for the single species. G. globigerinoides is characterized by two very weakly developed keels symmetrically disposed on a rounded periphery, and thus is not distinguishable in the present study.

Globotruncana contusa (Cushman)

(Plate 7, Figs.4-6)

Pulvinulina arca Cushman var. contusa CUSHMAN, 1926c, p.23 (fide Ellis and Messina, 1940 et seq).

Globotruncana contusa (Cushman). PESSAGNO, 1967, p.330, pl.75, figs.18-20, pl.77, figs.1-9, pl.78, figs.6-11, pl.92, figs.10-12, pl.96, figs.11,13-16. POSTUMA, 1971, pp.30,31, 7 figs.

Dimensions of specimen CUFC 217, sample 76870 diameter 0.58 mm, thickness 0.42 mm.

Remarks: The description of Postuma (1971) is followed herein. G. contusa is readily distinguished by its very high convex spiral side,

which gives the test a conical shape, often as high as or higher than it is broad in diameter, and the crescentic, concave chambers on the spiral side. The present specimens are much higher-spined than both G. arca (Cushman) and G. fornicata Plummer, but not as high as "typical" G. contusa. They may in fact be G. scutilla (author unknown), a species unknown to the present author except for a reference in van Hinte (1976) to a form, ranging from the Late Campanian to Mid Maastrichtian, transitional from G. fornicata to G. contusa. According to Dr. F. Gradstein (pers. comm., 1979), the present forms are referable to G. scutilla, but the present author has not been able to find the author, type description, or type figures for that species.

Globotruncana elevata (Brotzen)

Rotalia elevata BROTZEN, 1934, p.66, pl.3, fig.c (fide Ellis and Messina, 1940 et seq.).

Globotruncana (Globotruncana) lugeoni Tilev. EDGELL, 1957, p.113, pl.2, figs.7-9.

Globotruncana elevata (Brotzen). PESSAGNO, 1967, p.336, pl.78, figs.12-14, pl.80, figs.1-6, pl.81, figs.9-14, pl.93, figs.1-5,8, t.f.44.—POSTUMA, 1971, pp.34,35, 7 figs.

Dimensions of specimen CUFC 218, sample 76870: diameter 0.45 mm, thickness 0.29 mm.

Remarks: The description of Postuma (1971) is followed herein, and the reader is referred to the excellent synonymy of Pessagno (1967). G. elevata is distinguished by its single keel, extremely convex umbilical side, gently convex inner whorls with flat to gently concave final whorl on the spiral side, and petaloid chambers on the spiral side. G. ganserri Bolli has a flat to concave spiral side with rugose early chambers on the umbilical side, and G. stuartiformis Dalbiez has triangular chambers on the spiral side, which is also slightly more convex than in G. elevata.

Globotruncana fornicata Plummer

Globotruncana fornicata PLUMMER, 1931, p.130, pl.13, figs.4-6.---
 PESSAGNO, 1967, p.338, pl.63, figs.1-9, pl.80, figs.7-9,
 pl.96, figs.3,4.---HANZLIKOVÁ, 1972, p.106, pl.28, figs.6,7.

Dimensions of specimen CUFC 219, sample 76904: diameter 0.42 mm,
 thickness 0.25 mm.

Remarks: The description and synonymy of Pessagno (1967) are followed herein, with the additional note from Postuma (1971, p.38) that the carinal band is inturned umbilically. The crescentic and often crenulate chambers on the spiral side of the moderately spiroconvex test distinguish G. fornicata from all other species.

Globotruncana lapparenti Brotzen

Globotruncana lapparenti BROTZEN, 1936, pp.175,176 (fide Ellis and Messina, 1940 et seq).---PESSAGNO, 1967, p.344, pl.71, figs.6-13, pl.97, figs.8,9.

Globotruncana lapparenti Brotzen subsp. lapparenti Brotzen. BOLLI, 1945, p.230, pl.9, fig.11, t.f.1(15-16) (fide Ellis and Messina, 1940 et seq).

Globotruncana linneiana (d'Orbigny). TRUJILLO, 1960, p.342, pl.49, fig.8.---HANZLIKOVÁ, 1972, p.107, pl.29, figs.6,7.

Dimensions of specimen CUFC 220, sample 76896: diameter 0.59 mm,
 thickness 0.31 mm.

Remarks: The description of Pessagno (1967) is followed herein, with the additional note that the keels are closely spaced. The present specimens are only mildly spiroconvex. G. lapparenti is distinguished by its very low convex spiral side and closely spaced double keels. The otherwise similar G. linneiana (d'Orbigny) has widely spaced double keels. For this reason, the forms assigned by Trujillo (1960) and Hanzliková (1972) to G. linneiana are herein considered to belong to G. lapparenti. G. ventricosa White also has closely spaced keels on a low spiroconvex test, but is much more strongly umbilicoconvex, especially the final chamber.

Globotruncana linneiana (d'Orbigny)

Rosalina linneiana d'ORBIGNY, 1839, p.101, pl.5, figs.10-12 (fide Ellis and Messina, 1940 et seq).

Globotruncana lapparenti lapparenti Brotzen. BOLLI, 1951, p.190, t.f.1a.---BELFORD, 1960, p.96, pl.27, figs.6-12.

Globotruncana lapparenti tricarinata (Quereau). BOLLI, 1951, p.190, t.f. 1b.---BELFORD, 1960, p.97, pl.28, figs.1-6.

Globotruncana linneiana (d'Orbigny). PESSAGNO, 1967, p.346, pl.72, figs.1-4, 7-9, pl.97, figs.11-13.---DOUGLAS, 1969, p.181, pl.3, fig.1.

Globotruncana lapparenti Bolli. POSTUMA, 1971, pp.48,49, 7 figs.

Globotruncana pseudolinneiana (Pessagno). HANZLIKOVA, 1972, p.109, pl.29, figs.8,9.

Dimensions of uninflated specimen CUFC 221, sample 76879: diameter 0.49 mm, thickness 0.25 mm; dimensions of bulloides-like specimen CUFC 222, sample 76881: diameter 0.46 mm, thickness 0.17 mm.

Remarks: The description of Pessagno (1967) is followed herein.

G. linneiana is distinguished by its flat to very low convex spiral side, widely spaced double keels, and vertical carinal band. Douglas (1969) questioned the validity of G. tricarinata (Quereau), which may in fact be G. ventricosa White, or in the present author's opinion, G. linneiana. The specimens of the present study occasionally possess very gently inflated chambers on the spiral side, which renders their distinction from G. bulloides Vogler uncertain.

Globotruncana ventricosa White

Globotruncana canaliculata (Reuss) var. ventricosa WHITE, 1928b, p.284, pl.38, fig.5 (fide Ellis and Messina, 1940 et seq).

Globotruncana sp.. MCGUGAN, 1957, pl.34, fig.16.

Globotruncana ventricosa White. PESSAGNO, 1967, p.362, pl.75, figs.21-26, pl.79, figs.9-14, pl.95, figs.10,11, pl.99, fig.2.---DOUGLAS, 1969, p.188, pl.2, figs.1,3.

Dimensions of specimen CUFC 223, sample 76900: diameter 1.06 mm, thickness 0.43 mm.

Remarks: The description and synonymy of Pessagno (1967) are followed herein. G. ventricosa is distinguished by its nearly flat spiral side, the quite widely spaced double keels not as widely spaced as in G. linneiana (d'Orbigny), and the final chambers, which are strongly inflated ventrally, forming a strong umbilical shoulder.

Genus RUGOGLOBIGERINA Brönnimann, 1952

Rugoglobigerina hexacamerata Brönnimann

Rugoglobigerina reicheli hexacamerata BRÖNNIMANN, 1952, p.23, pl.2, figs.10-12, t.f.8.

Rugoglobigerina hexacamerata Brönniman. PESSAGNO, 1967, p.364, pl.74, fig.4, pl.91, figs.5-7.

Dimensions of specimen CUFC 224, sample 76884: diameter 0.47 mm, thickness 0.24 mm.

Remarks: The description of Brönnimann (1952) is followed herein, with the additional note that the umbilicus is covered by tegilla with intra- and infralaminar accessory apertures. R. hexacamerata is distinguished by the flat to gently excavated spiral side, restricted sutures, six chambers to the final whorl, and spinose rather than rugose early chambers on the final whorl.

Rugoglobigerina macrocephala Brönnimann

Rugoglobigerina macrocephala macrocephala BRÖNNIMANN, 1952, p.25, pl.2, figs.1-3, t.f.9.

Rugoglobigerina macrocephala ornata BRÖNNIMANN, 1952, p.27, pl.2, figs.4-6, t.f.10.

Rugoglobigerina macrocephala Brönnimann. OLSSON, 1964, p.172, pl.6, fig.9.

Hedbergella bornholmensis DOUGLAS AND RANKIN, 1969, p.193, t.f.6.---
HANZLIKOVÁ, 1972, p.100, pl.25, figs.5-7.

Dimensions of specimen CUFC 225, sample 76871: diameter 0.34 mm, thickness 0.22 mm.

Remarks: The description of Brönnimann (1952) is followed herein, with the additional note that the umbilicus is covered by tegilla with

intra- and infralaminar accessory apertures. The degree to which the meridional pattern of rugosities is developed is not regarded by the present author as being of taxonomic significance, hence the two subspecies macrocephala Bronnimann and ornata Bronnimann, are not recognized herein. For the same reason that several forms assigned by other workers to Hedbergella monmouthensis (Olsson) are reassigned in this paper to R. rugosa (Plummer) (see discussion of this under R. rugosa), the forms assigned by Douglas and Rankin (1969) and Hanzlikova (1972) to H. bornholmensis Douglas and Rankin are herein regarded as juveniles of R. macrocephala. In juveniles, the aperture assumes a slightly extra-umbilical position, usually bordered by a smooth lip, where tegilla are not preserved. R. macrocephala is distinguished by the meridionally arranged rugosities, and by the much enlarged final chamber, such that there are but 4, or rarely 5, chambers to the outer whorl. The final chamber is commonly much broader (measured tangent to the equatorial periphery) than high (measured perpendicular to the equatorial periphery).

Rugoglobigerina rugosa (Plummer)
(Plate 6, Figs.1-12, Plate 7, Figs.1-3)

Globigerina rugosa PLUMMER, 1927, p.38, pl.2, fig.10 (fide Ellis and Messina, 1940 et seq.)---PLUMMER, 1931, p.194.

Globigerina cretacea d'Orbigny. YOUNG, 1951, p.65, pl.14, figs.1-3.---McGUGAN, 1957, p.343, pl.34, fig.11.

Rugoglobigerina rugosa pennyi BRONNIMANN, 1952, p.34, pl.4, figs.1-3, t.f.14.

Rugoglobigerina rugosa rugosa (Plummer). BRONNIMANN, 1952, p.28, t.f.11-13.---OLSSON, 1960, pl.10, figs.16-18.

Rugoglobigerina rugosa (Plummer). EDGEELL, 1957, p.115, pl.4, figs.10-12.---McGOWRAN, 1962, p.116.---LOEBLICH AND TAPPAN, 1964, p.C663, fig.530(3).---OLSSON, 1964, p.173, pl.7, figs.2-5.---PESSAGNO, 1967, p.366, pl.75, figs.2,3, pl.101, figs.8,9.---SLITER, 1968, p.108, pl.19, fig.2.---DOUGLAS, 1969, p.175, pl.6, figs.1,2.---POSTUMA, 1971, pp.90,91, 7 figs.

- Rugoglobigerina (Rugoglobigerina) bulbosa BELFORD, 1960, p.94, pl.26, figs.1-10, t.f.7(1-8).
- Rugoglobigerina (Rugoglobigerina) pilula BELFORD, 1960, p.92, pl.25, figs.7-13, t.f.6(1-6).
- Rugoglobigerina (Rugoglobigerina) plana BELFORD, 1960, p.95, pl.27, figs.1-5, t.f.8(1-6).
- Rugoglobigerina reicheli pustulata Brönnimann. OLSSON, 1960, p.50, pl.10, figs.13-15.
- Rugoglobigerina cf. rugosa (Plummer). TAKAYANAGI, 1960, p.134; pl.10, fig.2.---MELLO, 1969, p.94, pl.2, fig.6.
- Globigerina (Rugoglobigerina) rugosa Plummer. PERLMUTTER AND TODD, 1965, p.118, pl.5, fig.4.
- Globotruncanella monmouthensis (Olsson). PESSAGNO, 1967, p.374, pl.61, figs.1-3.
- Hedbergella monmouthensis (Olsson). SLITER, 1968, p.101, pl.15, fig.4. ---DOUGLAS, 1969, p.167, pl.9, fig.4.---HANZLIKOVA, 1972, p.101, pl.26, figs.3,4,6.
- Rugoglobigerina pilula Belford. DOUGLAS, 1969, p.175, pl.6, figs.8,9. ---HANZLIKOVA, 1972, p.115, pl.33, fig.4.---WRIGHT AND APHORPE, 1976, pl.2, fig.10.
- Hedbergella planispira (Tappan). HANZLIKOVA, 1972, p.101, pl.25, fig.15, pl.26, figs.1,2.
- Rugoglobigerina macrocephala Brönnimann. HANZLIKOVA, 1972, p.114, pl.33, figs.10,11.
- Rugoglobigerina pennyi Brönnimann. HANZLIKOVA, 1972, p.114, pl.33, figs.1-3.
- Rugoglobigerina pustulata Brönnimann. HANZLIKOVA, 1972, p.115, pl.33, fig.7.
- Rugoglobigerina rotundata Brönnimann. HANZLIKOVA, 1972, p.115, pl.33, figs.8,9.
- Rugoglobigerina cf. pustulata (Brönnimann). WRIGHT AND APHORPE, 1976, pl.2, fig.11.

Test free, low trochospiral, 2 to 3 whorls to test, biconvex; spiral side flat, with inner whorls level with final whorl, to strongly convex, with final whorl on completely different level from inner whorls; equatorial periphery strongly lobulate, axial periphery rounded. Chambers most commonly 5 or 6 in final whorl, but frequently 7,

especially in strongly spiroconvex specimens, increasing steadily but not too rapidly in size as added, except final chamber which may be much reduced, smooth, and produced towards umbilicus, often produced towards umbilicus even if not reduced in size. Sutures distinct, depressed, strongly so on umbilical side, radial and straight, except on spiral side, where they may be gently curved. Wall calcareous, perforate, ornamented by rugosities arranged in meridional ridges or rows running from midpoint of periphery. Primary aperture a large interiomarginal arch opening into umbilicus, covered by tegilla with intra- and infralaminar accessory apertures.

Dimensions of high-spined specimen CUFC 226, sample 76887: diameter 0.46 mm, thickness 0.31 mm; dimensions of adult low-spined specimen CUFC 227, sample 76873: diameter 0.34 mm, thickness 0.19 mm; dimensions of juvenile low-spined specimen CUFC 228, without tegilla, sample 76873: diameter 0.26 mm, thickness 0.16 mm; dimensions of juvenile low-spined specimen CUFC 229, with tegilla, sample 76886: diameter 0.24 mm, thickness 0.13 mm; dimensions of medium-spined specimen CUFC 230, sample 76871: diameter 0.40 mm, thickness 0.25 mm.

Remarks: The confusion that surrounds this species warrants, in the present author's opinion, a full description and synonymy. The present author is in agreement with the assessment of Pessagno (1967) that R. rugosa pennyi Brönnimann and R. reicheli pustulata Brönnimann are not valid subspecies. From the present study, it is clear that the two subspecies, R. rugosa rugosa and R. rugosa pennyi, cannot reliably be distinguished. Numerous authors have assigned forms to R. macrocephala Brönnimann that do not have a sufficiently enlarged final chamber. They are herein referred to R. rugosa. The three species of Belford (1960), R. bulbosa, R. pilula, and R. plana, are herein regarded as representing immature specimens, or at least, ones in which the

characteristic large test size of R. rugosa, with attendant large umbilicus, has not been attained. In the present study, R. rugosa occurs only very rarely in the 60 mesh fraction of the 10 samples of calcilutite thought to be equivalent to the Toolonga Calcilutite. Thus there has been no development, for whatever reason, of the "typical" R. rugosa with large umbilicus. It is likely that these immature, or at least, small forms of R. rugosa were the basis Belford used in erecting his three species. They are not regarded herein as valid species.

"Hedbergella" or "Globotruncanella monmouthensis" has been reported and illustrated by a large number of authors (see synonymy). These forms have extraumbilical-umbilical apertures, 5 chambers, and rugose walls. Reference to Olsson (1960) shows that the aperture of true H. monmouthensis is clearly extraumbilical. Very abundant small forms occur in the present study with 5 chambers to the outer whorl, rugose walls, and an extraumbilical-umbilical aperture with fine bordering lip. This apertural characteristic is suggestive of Hedbergella Bronnimann and Brown. However, a number of these forms occur with preserved tegilla rather than a lip, which is thus thought to be the broken remnant of tegilla. For this reason, the present author took a number of specimens of the large, typical R. rugosa with wide umbilicus and clearly umbilical primary aperture, and broke them down, one chamber at a time, reversing, as it were, the growth process or ontogeny. Eventually, small 5-chambered forms were obtained with an extraumbilical aperture. Thus the forms included in this paper's synonymy under the species monmouthensis Olsson (which is still regarded by the present author as a valid and separate species) are regarded as juvenile specimens of R. rugosa.

R. rotundata Bronnimann is readily distinguished by its very robust

test, more closely appressed chambers with less strongly depressed sutures, and much smaller umbilicus in fully developed specimens.

Superfamily ORBITOIDACEA Schwager, 1876

Family EPONIDIDAE Hofker, 1951

Genus EPONIDES de Montfort, 1808

Eponides biconvexa Marie

Eponides biconvexa MARIE, 1941, p.224, pl.34, fig.324 (fide Ellis and Messina, 1940 et seq).

Dimensions of specimen CUFC 231, sample 76881: diameter 0.27 mm, thickness 0.15 mm.

Remarks: The description of Marie (1941) is followed herein. E. biconvexa is distinguished from most species by its nearly equally bi-convex test, flush sutures, well developed triangular apertural face, and low number of chambers, and from E. beisseli Schijfsma by the former's straight radial sutures on the spiral side, and its gently curved, mildly oblique sutures on the umbilical side.

Eponides birdi Trujillo

Eponides birdi TRUJILLO, 1960, p.332, pl.48, fig.7.

Eponides sp. cf. E. birdi Trujillo. GRAHAM AND CHURCH, 1963, p.57, pl.6, fig.18.

Dimensions of specimen CUFC 232, sample 76902: diameter 0.28 mm, thickness 0.17 mm.

Remarks: The description of Trujillo (1960) is followed herein. E. birdi is distinguished from E. concinna Brotzen by the former's more strongly convex umbilical side and fewer chambers, and from E. biconvexa Marie by its slightly tangential rather than radial sutures on the spiral side. The apertural face may be quite prominent. Gyroidinoides trujilloi Sliter has far too many chambers.

Eponides concinna Brotzen

Eponides concinna BROTZEN, 1936, p.167, pl.12, fig.4 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.83, pl.23, figs.1-6.

Test free, low trochospiral, biconvex, umbilical side the more strongly convex; equatorial periphery mildly lobulate in latest stages, axial periphery narrowly rounded, with a thick, blunt, imperforate keel. Chambers 8 in final whorl, increasing slowly in size as added; on spiral side subrectangular to crescentic, with all but final whorl covered in a smooth, clear boss; on umbilical side final 2 or 3 chambers mildly inflated, with triangular projections over umbilicus which is quite narrow and steep-sided. Sutures distinct, on spiral side limbate, flush, and mildly oblique; on umbilical side initially flush, limbate, straight and radial, later becoming depressed, curved. Wall calcareous, coarsely perforate on umbilical side, imperforate on spiral side due to boss, smooth. Aperture a low interiomarginal slit running from umbilicus under chamber projections to a point near the periphery, bordered above by a weakly developed lip.

Dimensions of specimen CUFC 233, sample 76904: diameter 0.52 mm, thickness 0.28 mm.

Remarks: E. concinna is distinguished by its subequally biconvex test on which the umbilical side is the more strongly convex, the relatively high number of chambers, the gently inflated final chambers, and its very low apertural face.

Eponides diversus Belford

Eponides diversus BELFORD, 1960, p.82, pl.22, figs.16-26.

Nuttallides diversus (Belford). HANZLIKOVÁ, 1972, p.87, pl.21, fig.1.

Dimensions of specimen CUFC 234, sample 76903: diameter 0.46 mm, thickness 0.27 mm.

Remarks: The description of Belford (1960) is followed herein, with the additional notes that the sutures are very gently depressed on

the umbilical side, and the aperture is bordered above by a very well developed lip that terminates where the apertural face is reflexed near the periphery. E. diversus is distinguished by its very thick test, few chambers, which are almost as high as broad on the umbilical side, and reflexed apertural face with prominent lip. The final whorl on the spiral side is nearly concave.

Family CIBICIDIDAE Cushman, 1927
Subfamily PLANULININAE Bermúdez, 1952
Genus PLANULINA d'Orbigny, 1826

Planulina sp.
(Plate 7, Figs. 11-13)

• Test free, very low trochospiral, nearly planispiral, lenticular, one side but slightly more strongly convex, both sides apparently evolute, all but final whorl obscured by thickened irregular boss of calcite; equatorial periphery entire, axial periphery acute, with quite wide, thick keel. Chambers 6 in final whorl, increasing fairly rapidly in size as added. Sutures distinct, limbate, thick, raised and strongly curved. Wall calcareous, finely perforate, smooth. Aperture indeterminate.

Dimensions of specimen CUFC 235, sample 76894: diameter 0.28 mm, thickness 0.11 mm.

Remarks: This distinct form does not correspond closely to any species found by the present author in the literature. It is represented in the present study by a single specimen with a broken final chamber.

Subfamily CIBICIDINAE Cushman, 1927
Genus CIBICIDES de Montfort, 1808

Cibicides beaumontianus (d'Orbigny)

Truncatulina beaumontiana d'ORBIGNY, 1840, p.35, pl.3, figs.17-19 (fide Ellis and Messina, 1940 et seq.).

Cibicides beaumontianus (d'Orbigny). CUSHMAN, 1946, p.160, pl.65, fig.12.

Karrerria aff. beaumontiana (d'Orbigny). McGOWRAN, 1962, p.270, pl.13, fig.2, pl.20, fig.10, t.f.10A.

Dimensions of specimen CUFC 236, sample 76881: diameter 1.12 mm, thickness 0.42 mm.

Remarks: The description of Cushman (1946) is followed herein. The spiral side may be quite irregular; depending upon the substrate for this attached foraminifer, and the chambers are very obscure on the spiral side. C. beaumontianus is distinguished from most species by the carinate, lobulate periphery, irregular outline and chamber addition, and from C. ribbingi Brotzen by the former's greater number of chambers, 7 or more, in the final whorl.

Cibicides excavatus Brotzen

Cibicides excavata BROTZEN, 1936, p.189, pl.13, figs.7,8 (fide Ellis and Messina, 1940 et seq).---SCHIJFSMA, 1946, p.100, pl.6, fig.7.

Karrerria sp. nov.. McGOWRAN, 1962, p.271, pl.13, fig.1, pl.20, fig.11, t.f. 10B.

Cibicides excavatus Brotzen. HANZLIKOVA, 1972, p.117, pl.34, figs.2,3.

Dimensions of specimen CUFC 237, sample 76882: diameter 0.76 mm, thickness 0.38 mm.

Remarks: The description of Schijfsma (1946) is followed herein. C. excavatus is readily distinguished by its low number of chambers, typically 6, in the final whorl, its rounded periphery, and strongly inflated chambers.

Cibicides ribbingi Brotzen

Cibicides ribbingi BROTZEN, 1936, p.186, pl.13, figs.5,6, t.f.67,68 (fide Ellis and Messina, 1940 et seq).---HANZLIKOVA, 1972, p.116, pl.34, fig.4.

Cibicides ribbingi Brotzen. SCHIJFSMA, 1946, p.101, pl.6, fig.6.

Cibicides megaloperforatus SAID AND KENAWY, 1956, p.155, pl.7, fig.13.

Dimensions of specimen CUFC 238, sample 76881: diameter 0.85 mm, thickness 0.49 mm.

Remarks: The description of Schijfsma (1946) is followed herein.

C. ribbingi is distinguished from most species by its very irregular test with carinate and lobulate periphery, and irregularly concave to flat spiral side, and from C. beaumontianus (d'Orbigny) by the former's lower number of chambers, 4 or 5, in the final whorl.

Cibicides succedens Brotzen
(Plate 8, Figs. 1-9)

Cibicides minimalis SCHIJFSMA, 1946, p.104, pl.7, fig.11.

Cibicides vultziana (d'Orbigny). SCHIJFSMA, 1946, p.102, pl.5, fig.6.---McGUGAN, 1957, p.344, pl.32, fig.23.

Cibicides vultziana (d'Orbigny) var. plana. SCHIJFSMA, 1946, p.104, pl.5, fig.7.

Cibicides succedens BROTZEN, 1948, p.80, pl.12, fig.1, t.f.21.---OLSSON, 1960, p.53, pl.12, figs.10-12.

Cibicides aff. vultziana (d'Orbigny). McGOWRAN, 1962, p.250, pl.9, fig.5, pl.19, fig.9.

Cibicides bembix (Marsson). McGOWRAN, 1962, p.253, pl.10, fig.7, pl.19, fig.1.

Gavelinopsis bembix (Marsson). HANZLIKOVÁ, 1972, p.86, pl.20, fig.12.

Test attached, low trochospiral, varying from slightly concavo-convex through the typical plano-convex to unequally biconvex, the umbilical side always the more strongly convex; spiral side evolute, all but final whorl obscured by large central disc of clear shell material, umbilical side partially evolute, with large raised umbo of clear shell material; equatorial periphery initially entire, becoming mildly to quite strongly lobulate, axial periphery initially acute to rounded, becoming narrowly rounded to quite broadly rounded in final stages. Chambers numerous, 9 to 12 in final whorl, increasing slowly in size as added and becoming inflated in final few chambers, which may be mildly to strongly produced towards spiral side. Sutures distinct; on spiral

side initially limbate and flush, later narrow and gently to quite strongly depressed, and curved; on umbilical side initially limbate and flush, later narrow and depressed, and quite strongly curved. Wall calcareous, coarsely perforate on spiral side, much less so on umbilical side, with imperforate periphery, smooth. Aperture a low equatorial interiomarginal slit, extending quite far along spiral suture, as much as 8 chambers or more, with a thickened rim.

Dimensions of high umbilicoconvex (bembix-like) specimen CUFC 239, sample 76876: diameter 1.07 mm, thickness 0.40 mm; dimensions of low umbilicoconvex (voltzianus-like) specimen CUFC 240, sample 76871: diameter 0.89 mm, thickness 0.40 mm; dimensions of inflated (ripleyensis-like) specimen CUFC 241, sample 76878: diameter 1.23 mm, thickness 0.55 mm.

Remarks: This is a common and highly variable species in the present study. Forms assigned by other authors to C. bembix (Marsson) and C. voltzianus (d'Orbigny) are all within the range of variation of C. succedens. Rotalina voltziana, according to the type description of d'Orbigny (1840), has a convex spiral side and nearly flat umbilical side, and this is evident in the type figure. Thus the present forms do not belong to that species. C. bembix is also somewhat problematic, as the type figure of Marsson is very poor, but it seems to be characterized by a quite distinct keel, such that the axial profile of the umbilical side is reflexed, not convex throughout. C. ripleensis Sandidge is also very similar to the forms in the present study that are quite low on the umbilical side, with quite strongly inflated chambers that are produced towards the spiral side. The only difference is that the plug on the spiral side of C. ripleensis is spiral shaped. It may be conspecific with C. succedens.

Cibicides sp.
(Plate 8, Figs. 10-12)

Test attached, low trochospiral, planoconvex to mildly concavoconvex; spiral side flat to concave, evolute, all but final few chambers covered by a smooth imperforate layer of shell material, umbilical side nearly wholly involute, with a small central umbo of clear shell material; equatorial periphery initially entire, becoming gently lobulate, axial periphery initially acute with a thick, blunt, clear imperforate keel, becoming subacute to narrowly rounded and without a keel. Chambers numerous, 9 or 10 in final whorl, increasing slowly in size as added; on spiral side rhomboid, higher than broad, on umbilical side wedge shaped, becoming increasingly inflated as added. Sutures distinct; on spiral side nearly radial and straight, flush becoming depressed, on umbilical side curved, initially limbate, very gently depressed, later narrow and quite strongly depressed. Wall calcareous, perforate, smooth. Aperture a very low equatorial interiomarginal slit, extending only a short distance onto both sides of test, with a very small bordering lip on umbilical side.

Dimensions of specimen CUFC 242, sample 76874: diameter 0.50 mm, thickness 0.24 mm.

Remarks: The high conical test with many chambers and early keel readily distinguishes this species from C. beaumontianus (d'Orbigny), C. excavatus Brotzen and C. ribbingi Brotzen. The present species is easily distinguished from C. succedens Brotzen by the former's narrow, higher than broad chambers on the spiral side, on which all but the final few chambers are covered by a clear boss. The aperture of the present species also fails to extend along the spiral suture, which is obscured.

Family PLANORBULINIDAE Schwager, 1877

Genus PLANORBULINA d'Orbigny, 1826

Planorbulina sp.
(Plate 7, Figs. 7-10)

Test attached, typically planoconvex to discoid, but often umbilical side enrolled about itself partially or completely, such that a hollow tube is formed with the spiral side outermost; spiral side flat to gently convex, umbilical side flat to enrolled, non-umbilicate; equatorial periphery strongly lobulate, axial periphery sub-truncate to narrowly rounded. Chambers numerous, ellipsoidal, inflated, especially on spiral side; initially in a regular low trochoid coil, later irregularly coiled, such that test is nearly circular in plan view, and increasing slowly in size as added. Sutures distinct, depressed, straight to curved. Wall calcareous, on spiral side coarsely punctate, on umbilical side coarsely perforate, smooth. Apertures interomarginal, directed nearly radially towards center of test on umbilical side, two or more per chamber, consisting of two or more narrow arches with short hemicylindrical necks and flaring openings, usually located at the sutures of adjoining two chambers; apertures preserved as further chambers and apertures are added.

Dimensions of discoid specimen CUFC 243, sample 76875: diameter 0.82 mm, thickness 0.30 mm; dimensions of enrolled specimen CUFC 244, sample 6880: length 0.57 mm, diameter 0.33 mm.

Remarks: This species is distinguished from P. pacifica Sliter, the only other species of Planorbulina known to the present author from the Upper Cretaceous, by the presence in the former of two or more apertures per chamber.

Family	HOMOTREMATIDAE Cushman, 1927
Subfamily	VICTORIELLINAE Chapman and Crespin, 1930
Genus	CARPENTERIA Gray, 1858

Carpenteria globosa (Belford)

Haerella globosa BELFORD, 1960, p.116, pl.35, figs.13-20.

Dimensions of specimen CUFC 245, sample 76888: diameter 0.46 mm, thickness 0.56 mm.

Remarks: The description of Belford (1960) is followed herein. This species is distinguished by its conical test, four chambers in the outer whorl, and wide, oval, apical aperture, and theoretically from Maerella conica Belford by the former's much higher conical test. It may well be that this species is merely irregular, like Cibicides ribbingi Brotzen, and that the two forms distinguished by Belford are conspecific. There are insufficient specimens in the present study to allow further comment.

Superfamily CASSIDULINACEA d'Orbigny, 1839
Family PLEUROSOMELLIDAE Reuss, 1860
Subfamily PLEUROSOMELLINAE Reuss, 1860
Genus PLEUROSOMELLA Reuss, 1860

Pleurostomella subnodosa Reuss

Pleurostomella subnodosa REUSS, 1860, p.204, pl.8, fig.2 (fide Ellis and Messina, 1940 et seq).---CUSHMAN, 1946, p.132, pl.55, figs.1-9.---TAKAYANAGI, 1960, p.120, pl.8, fig.1.

NOT Pleurostomella subnodosa Reuss. SLITER, 1968, p.110, pl.19, fig.10.

Dimensions of specimen CUFC 246, sample 76872: length 0.87 mm, diameter 0.29 mm.

Remarks: The description of Cushman (1946) is followed herein, with the exception that the internal tooth is not seen. The present specimens most closely resemble those of figures 3 and 7 of Cushman's plate 55, that is, the aperture is nearly terminal, and subcircular, with only the hint of a hood. Forms assigned by Sliter (1968) to P. subnodosa do not belong to this species as they have 2 small basal teeth, as in Bandyella greatvalleyensis (Trujillo). Bandyella is initially triserial, and Pleurostomella biserial. However, where sutures are indistinct, this distinction may not be clear.

Genus ELLIPSOGLANDULINA A. Silvestri, 1900

Ellipsoglandulina sp.
(Plate 9, Figs.1,2)

Test free, elongate, uniserial, flaring quite rapidly from rounded base, circular in section. Chambers 5 in adult test, mildly to quite strongly inflated, increasing quite rapidly in size as added; initially very strongly embracing, such that chambers are visible only as narrow bands, later only closely appressed, higher than broad. Sutures distinct, initially nearly flush, later more strongly depressed, horizontal. Wall calcareous, perforate, smooth. Aperture a terminal V-shaped to crescentic slit, with an internal tooth projecting from concave side of aperture, and joined to triangular extension of chamber.

Dimensions of specimen CUFC 247, sample 76871: length 0.98 mm, diameter 0.46 mm.

Remarks: This species is distinct from any known to the present author in the literature, primarily because of the apertural characteristics.

Genus ELLIPSOIDEA Heron-Allen and Earland, 1910

Ellipsoidella binaria Belford

Ellipsoidella binaria BELFORD, 1960, p.71, pl.19, figs.14-22.

Dimensions of specimen CUFC 248, sample 76904: length 0.92 mm, diameter 0.31 mm.

Remarks: The description of Belford (1960) is followed herein. E. binaria is distinguished from E. solida (Brotzen) by the former's T- or anchor-shaped aperture, and quite robust test.

Ellipsoidella solida (Brotzen)

Nodosarella solida BROTZEN, 1936, p.140, pl.9, fig.11 (fide Ellis and Messina, 1940 et seq.).

Ellipsoidella sp. cf. E. solida (Brotzen). BELFORD, 1960, p.73, pl.19, figs. 10-12.

Test free, elongate, gently flaring from narrowly to broadly rounded base, circular in section. Chambers numerous, initially biserial, rapidly becoming uniserial but not rectilinear, mildly inflated, slightly higher than broad. Sutures distinct, initially flush and oblique, increasingly depressed and more nearly horizontal as formed. Wall calcareous, perforate, smooth. Aperture terminal, a narrow slit parallel to plane of biseriality, with slight overhanging hood or lip, connected to preceding aperture by a slender tube, successive apertures oriented at 180° to each other.

Dimensions of specimen CUFC 249, sample 76888: length 0.90 mm, diameter 0.19 mm.

Remarks: E. solida is distinguished from Nodosarella gracillima Cushman which has a strongly eccentric, subelliptical aperture.

Subfamily WHEELERELLINAE Petters, 1954

Genus BANDYELLA Loeblich and Tappan, 1962

Bandyella greatvalleyensis (Trujillo)

Pleurostomella greatvalleyensis TRUJILLO, 1960, p.345, pl.50, fig.5.

Bandyella greatvalleyensis (Trujillo). HANZLIKOVA, 1972, p.119, pl.35, fig.1.

Dimensions of specimen CUFC 250, sample 76880: length 0.80 mm, width 0.25 mm, thickness 0.20 mm.

Remarks: The description of Trujillo (1960) is followed herein, with the additional notes that the sutures are quite strongly oblique throughout, and the aperture is connected to previous apertures by an internal tooth structure, and successive apertures are oriented at 180° to each other. The uniserial chambers are initially cuneate, but subsequently are less strongly appressed, such that in side view there are 4 sides, not 3, to each chamber. The anchor-shaped aperture distinguishes this species from most others, and it is distinguished from

Ellipsoidella binaria Belford by the former's initial triserial stage and much more offset uniserial chambers, which in E. binaria are essentially rectilinear.

Family CAUCASINIDAE N. K. Bykova, 1959
 Subfamily FURSENKOININAE Loeblich and Tappan, 1961
 Genus CORYPHOSTOMA Loeblich and Tappan, 1962

Coryphostoma plaita (Carsey)

Bolivina plaita CARSEY, 1926, p.26, pl.4, fig.2 (fide Ellis and Messina, 1940 et seq).

Loxostoma plaitum (Carsey). PLUMMER, 1931, p.182, pl.10, figs.5-7.

Coryphostoma plaita (Carsey). HANZLIKOVA, 1972, p.120, pl.35, fig.5.

Dimensions of specimen CUFC 251, sample 76884: length 0.50 mm, width 0.13 mm, thickness 0.09 mm.

Remarks: The description of Carsey (1926) is followed herein. This species is distinguished by its strongly oblique, depressed, straight sutures and consequent plaited appearance of the biserial test. It is represented by a single specimen in the present study.

Family LOXOSTOMIDAE Loeblich and Tappan, 1962
 Genus LOXOSTOMUM Ehrenberg, 1854

Loxostomum eleyi (Cushman)

Bolivinita eleyi CUSHMAN, 1927, p.91, pl.12, fig.11 (fide Ellis and Messina, 1940 et seq).

Bolivinitella eleyi (Cushman). SCHIJFSMA, 1946, p.72; pl.6, fig.10.

Loxostomum eleyi (Cushman). HANZLIKOVA, 1972, p.121, pl.35, fig.8.

Dimensions of specimen CUFC 252, sample 76891: length 0.62 mm, width 0.27 mm, thickness 0.09 mm.

Remarks: The description of Schijfsma (1946) is followed herein, with the additional note that the chambers are arched throughout. The present specimens are quite variable, with three forms distinguished. The first is the most common, with an elongate, quite slender test and

highly arched, overlapping chambers. The second is similar, but is strongly concave on both faces, with the rather convoluted angles located on convex, rather than truncate or concave margins. The third form is the largest, with much broader, lower chambers than the other two forms. The strongly arched, limbate and flush sutures, carinate angles, and terminal ovate aperture distinguish this species.

Family NONIONIDAE Schultze, 1854
Subfamily CHILOSTOMELLINAE Brady, 1881
Genus QUADRIMORPHINA Finlay, 1939

Quadrimorphina allomorphinoides (Reuss)

Valvulina allomorphinoides REUSS, 1860, p.223, pl.11, fig.6 (fide Ellis and Messina, 1940 et seq.).

Valvulineria allomorphinoides (Reuss). CUSHMAN, 1946, p.138; pl.57, figs.6,7.

Quadrimorphina allomorphinoides (Reuss). SLITER, 1968, p.114, pl.20, fig.7.

Dimensions of specimen CUFC 253, sample 76904: diameter 0.42 mm, thickness 0.28 mm.

Remarks: The description of Sliter (1968) is followed herein, with the additional note that the equatorial periphery is essentially entire. This feature, along with the proportionately much larger final chamber that occupies half or more of the final whorl, and relatively thicker test, distinguishes this species from Q. camerata (Brotzen).

Quadrimorphina camerata (Brotzen)

Valvulineria camerata BROTZEN, 1936, p.155, pl.10, fig.2, t.f.57 (fide Ellis and Messina, 1940 et seq.).

Valvulineria allomorphinoides (Reuss). BANDY, 1951, p.503, pl.74, fig.4.

Valvulineria sp.. GRAHAM AND CHURCH, 1963, p.60, pl.7, fig.8.

Quadrimorphina camerata (Brotzen). SLITER, 1968, p.114, pl.20, fig.9.

Dimensions of specimen CUFC 254, sample 76904: diameter 0.39 mm, thickness 0.20 mm.

Remarks: The description of Sliter (1968) is followed herein. Q. camerata is distinguished from Q. allomorphinoides (Reuss) by the former's quite strongly indented periphery and proportionately much smaller final chamber, which occupies less than half of the test length.

Quadrिमorphina conica (Cushman and Todd)

Allomorphina trochoides (Reuss). CUSHMAN, 1946, p.145, pl.60, fig.7.

Allomorphina conica CUSHMAN AND TODD, 1949, p.62, pl.11, fig.8 (fide Ellis and Messina, 1940 et seq.).

Dimensions of specimen CUFC 255, sample 76893: length 0.38 mm, diameter 0.33 mm.

Remarks: The description of Cushman (1946) is followed herein, with the additional note that the aperture is bordered above by a quite well developed narrow lip. Q. conica is distinguished by its quite high trochospiral test, with three subglobular chambers in the final whorl.

Quadrिमorphina minuta (Cushman)

Allomorphina minuta CUSHMAN, 1936c, p.72, pl.13, fig.3.---CUSHMAN, 1946, p.145, pl.60, fig.6.

Dimensions of specimen CUFC 256, sample 76886, diameter 0.22 mm, thickness 0.12 mm.

Remarks: The description of Cushman (1936c) is followed herein. Q. minuta is distinguished from Q. allomorphinoides (Reuss) and Q. camerata (Brotzen) by its strongly compressed, low-spired test with only 3 chambers in the final whorl, and from Allomorphina navarroana Cushman by the present species' strongly compressed test.

Quadrिमorphina sp. A
(Plate 9, Figs.3,4)

Test free, 1-1/2 times as high as broad, trochospiral; base narrowly rounded, apertural end broadly rounded, ovate in section. Chambers initially small, indistinct, trochospiral or possibly tri-

serial, increasing very little in size as added in two whorls, followed by a final whorl of three chambers that are very much larger, occupying well over $3/4$ of length of test, and strongly embracing, $1-1/2$ to 2 times higher than broad, and not much inflated. Sutures initially very indistinct, eventually distinct, very gently depressed, curved and strongly oblique to axis of test. Wall calcareous, perforate, smooth. Aperture an interiomarginal slit, running from lower edge of final chamber to a point just beyond upper extremity of first chamber of final whorl, without a lip, but inner margin of final chamber infolded slightly.

Dimensions of specimen CUFC 257, sample 76870: length 0.49 mm, diameter 0.30 mm.

Remarks: The high trochospiral test, with strongly embracing, high final whorl readily distinguishes this species.

Quadrimorphina sp. B
(Plate 9, Figs.7-9)

Test free, low trochospiral, biconvex; spiral side evolute and quite flat, all chambers visible but early whorls indistinct, umbilical side flat except for inflated final chamber, involute with final chamber extending across umbilical region; equatorial periphery indented, axial periphery rounded. Chambers 5 in final whorl, increasing quite rapidly in size as added, only final chamber much inflated, on umbilical side. Sutures somewhat indistinct, only gently depressed; on spiral side radial, and gently curved, on umbilical side radial and straight. Wall calcareous, perforate, smooth. Aperture a low interiomarginal slit extending from covered umbilicus to equatorial periphery, bordered by a very narrow lip.

Dimensions of specimen CUFC 258, sample 76870: diameter 0.60 mm, thickness 0.25 mm.

Remarks: This species is distinguished from Q. camerata (Brotzen) by the former's much more strongly compressed test, with inflated final chamber, and larger test size.

Quadrिमorphina sp. C
(Plate 9, Figs.5,6)

Test free, 2 to 3 times as long as broad, strongly compressed; periphery entire and rounded. Chambers initially low trochospiral, later 2 per whorl; on spiral side indistinct, on umbilical side gently inflated. Sutures indistinct on spiral side, on umbilical side a single suture, transverse to length of test. Wall calcareous, perforate, smooth. Aperture a low interiomarginal arch, occupying over half of test width, bordered above by a fine, fairly wide lip.

Dimensions of specimen CUFC 259, sample 76870: length 0.39 mm, diameter 0.17 mm.

Remarks: This species with but 2 chambers in the outer whorl is rare, and not like any reported species known to the present author.

Subfamily NONIONINAE Schultze, 1854

Genus NONIONELLA Cushman, 1926

Nonionella cretacea Cushman

Nonionella cretacea CUSHMAN, 1931, p.42, pl.7, fig.2 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.115, pl.21, fig.1.

Dimensions of specimen CUFC 260, sample 76871: length 0.29 mm, width 0.20 mm, thickness 0.11 mm.

Remarks: The description of Cushman (1931) is followed herein. N. cretacea is distinguished from N. austinana Cushman by the former's greater number of chambers, and from N. robusta Plummer by the present species' much higher test, which is as much as two times higher than broad.

Genus PULLENIA Parker and Jones, in Carpenter,
Parker and Jones, 1862

Pullenia americana Cushman

Pullenia americana CUSHMAN, 1936c, p.76, pl.13, figs.4,5 (fide Ellis and Messina, 1940 et seq).---OLSSON, 1960, p.42, pl.7, figs.17,18.

Dimensions of specimen CUFC 261, sample 76881: diameter 0.37 mm, thickness 0.22 mm.

Remarks: The description of Cushman (1936c) is followed herein.

P. americana is distinguished by the 5 or 6 chambers in the outer whorl, quite strongly compressed test, mildly lobulate equatorial periphery, and chambers which do not increase as rapidly in thickness as in P. jarvisi Cushman.

Pullenia cretacea Cushman

Pullenia cretacea CUSHMAN, 1936c, p.75, pl.13, fig.8 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.115, pl.21, fig.2.

Pullenia jarvisi Cushman. SAID AND KENAWY, 1956, p.156, pl.7, fig.28.

Dimensions of specimen CUFC 262, sample 76893: diameter 0.38 mm, thickness 0.28 mm.

Remarks: The description of Cushman (1936c) is followed herein.

P. cretacea is distinguished by its 5 chambers in the outer whorl, its uninflated chambers, nearly entire equatorial periphery, and very broadly rounded axial periphery. Thus the specimen figured as P. jarvisi Cushman by Said and Kenawy (1956) clearly belongs, on the basis of its broadly rounded axial periphery and uninflated chambers, to P. cretacea. P. coryelli White is very similar, but is subglobular, not compressed.

Pullenia jarvisi Cushman

Pullenia jarvisi CUSHMAN, 1936c, p.77, pl.13, fig.6 (fide Ellis and Messina, 1940 et seq).---SLITER, 1968, p.115, pl.21, fig.3.

Dimensions of specimen CUFC 263, sample 76903: diameter 0.40 mm, thickness 0.28 mm.

Remarks: The description of Cushman (1936c) is followed herein. P. jarvisi is distinguished by its 5 chambers in the outer whorl, its somewhat compressed test, and quite strongly lobulate equatorial periphery.

Pullenia reussi Cushman and Todd

Pullenia reussi CUSHMAN AND TODD, 1943, p.4, pl.1, figs.10-13 (fide Ellis and Messina, 1940 et seq).---BELFORD, 1960, p.90, pl.24, figs.19-21.

Dimensions of specimen CUFC 264, sample 76892: diameter 0.44 mm, thickness 0.36 mm.

Remarks: The description of Cushman and Todd (1943) is followed herein. P. reussi is distinguished from most species by its subglobular test, with flush to only gently depressed sutures, and from P. coryelli White by the former's fewer (4 to 4-1/2 versus 5) chambers.

Genus SPIROTECTA Belford, 1961

Spirotecta pellicula Belford

Spirotecta pellicula BELFORD, 1961, p.81, pl.3, figs.1-8.---McGOWRAN, 1962, p.105.

Dimensions of specimen CUFC 265, sample 76886: diameter 0.44 mm, thickness 0.21 mm.

Remarks: The description of Belford (1961) is followed herein. S. pellicula is readily distinguished by its trochospiral, bi-involute, inequally biconvex test with lobulate periphery and 5 chambers in the outer whorl.

Family ALABAMINIDAE Hofker, 1951

Genus ALABAMINA Toulmin, 1941

Alabamina dorsoplana (Brotzen)

Eponides dorsoplana BROTZEN, 1940, p.31, t.f.8:2 (fide Ellis and Messina, 1940 et seq).

Alabamina australis australis BELFORD, 1960, p.84, pl.23, figs.13-20, t.f.4,5(1-4).

Alabamina dorsoplana (Brotzen). McGOWRAN, 1962, p.101, pl.3, fig.12
 ---SLITER, 1968, p.116, pl.21, fig.5.

Globorotalites tappanae SLITER, 1968, p.120, pl.22, figs.2,3.

Dimensions of specimen CUFC 266, sample 76874: diameter 0.32 mm,
 thickness 0.25 mm.

Remarks: The description of McGowran (1962) is followed herein.
A. dorsoplana is readily distinguished by its 5 or 6 chambers in the
 final whorl, planoconvex test with rounded axial periphery and high
 peripheral angle, very gently depressed sutures, and quite high interior-
 marginal aperture with reflexed apertural face. Thus Globorotalites
tappanae Sliter is herein placed in synonymy with the present species.
 The present author also questions the assignment by Sliter (1968) of
 forms with a quite low convex umbilical side and fairly strongly convex
 spiral side to A. dorsoplana. For the present, the present writer
 assumes that those forms may fall within the range of variation of A.
dorsoplana.

Family OSANGULARIIDAE Loeblich and Tappan, 1964

Genus GLOBOROTALITES Brotzen, 1942

Globorotalites conicus (Carsey)

Truncatulina refulgens Montfort var. conica CARSEY, 1926, p.46, pl.4,
 fig.15 (fide Ellis and Messina, 1940 et seq).

Globorotalites conicus (Carsey). BELFORD, 1960, p.100, pl.30, figs.8-
 13.---TANAGI, 1960, p.126, pl.8, fig.14.

Globorotalites michelinianus (d'Orbigny). SLITER, 1968, p.119, pl.22,
 fig.1.---HANZLIKOVÁ, 1972, p.128, pl.37, figs.7,8.

Dimensions of specimen CUFC 267, sample 76876: diameter 0.50 mm,
 thickness 0.34 mm.

Remarks: The description of Sliter (1968) is followed herein, with
 the exception that the sutures on the spiral side are gently elevated,
 increasingly so as formed. This form has been referred to the species
micheliniana d'Orbigny under several genera by a number of authors,

several of whom are found in the synonymy of Takayanagi (1960).

According to the type description and figures of d'Orbigny (1840), the sutures on the umbilical side of Rotalina micheliniana meet at a point, without prominent pseudoumbilicus. Thus, forms with a prominent pseudoumbilicus, strongly planoconvex test with an acute, carinate, entire periphery, and 6 to 7 chambers in the final whorl are assigned to G. conicus. The form assigned to Gyroidina micheliniana by Schijfsma (1946) properly belongs to that species, as there is no prominent pseudoumbilicus.

Globorotalites multiseptus (Brotzen)

Globorotalia multiseptus BROTZEN, 1936, p.161, pl.11, figs.6,7, t.f.59-61 (fide Ellis and Messina, 1940 et seq).

Globorotalites multiseptus (Brotzen). HANZLIKOVÁ, 1972, p.128, pl.37, figs.4,5.

Test free, low trochospiral, planoconvex; spiral side evolute, flat to mildly convex, umbilical side involute, quite strongly convex, without prominent umbilicus; equatorial periphery nearly entire but very mildly lobulate, axial periphery acute, carinate, with flange connecting outer edge of apertural face with initial portion of final whorl. Chambers 8 or more in final whorl, increasing slowly in size as added, mildly inflated on umbilical side. Sutures distinct; on spiral side limbate, strongly oblique and gently raised, on umbilical side curved, radial, and increasingly but only gently depressed as formed. Wall calcareous, perforate, smooth. Aperture a low interiomarginal slit at base of apertural face, bordered above by a narrow lip.

Dimensions of specimen CUFC 268, sample 76884: diameter 0.69 mm, thickness 0.39 mm.

Remarks: G. multiseptus is distinguished from G. conicus (Carsey) by the former's higher number of chambers in the final whorl, and absence of a prominent pseudoumbilicus, and from G. umbilicatus

(Loetterle) by the present species' larger size, less strongly lobulate periphery, and lack of an open umbilical region.

Globorotalites umbilicatus (Loetterle)

Globorotalia umbilicata LOETTERLE, 1937, p.43, pl.6, fig.9 (fide Ellis and Messina, 1940 et seq.).

Globorotalites umbilicatus (Loetterle). BELFORD, 1960, p.101, pl.30, figs.14-17

Dimensions of specimen CUFC '269, sample 76884: diameter 0.26 mm, thickness 0.12 mm.

Remarks: The description of Loetterle (1937) is followed herein, with the additional notes that the spiral side may be gently convex, and the periphery is acute and quite strongly lobulate. This species is distinguished by its small size, high number of chambers in the final whorl, low convex umbilical side with open umbilicus, and lobulate periphery.

Genus GYROIDINOIDES Brotzen, 1942

Gyroidinoides bandyi (Trujillo)

Eponides bandyi TRUJILLO, 1960, p.332, pl.48, fig.3.

Gyroidinoides bandyi (Trujillo). SLITER, 1968, p.120, pl.22, fig.5.

Dimensions of specimen CUFC 270, sample 76904: diameter 0.47 mm, thickness 0.28 mm.

Remarks: The description of Trujillo (1960) is followed herein. G. bandyi is distinguished from G. girardanus (Reuss) and G. globosus (Hagenow) by its biconvex test with sharply rounded periphery and projecting inner whorls on the spiral side, and from G. nodus (Belford) by the present species' sigmoid rather than straight sutures on the umbilical side, radial rather than oblique sutures on the spiral side, much lower apertural face, and more prominent spiral suture.

Gyroidinoides girardanus (Reuss)

Rotalina girardana REUSS, 1851a, p.73, pl.5, fig.34 (fide Ellis and Messina, 1940 et seq).

Gyroidina girardana (Reuss). CUSHMAN, 1946, p.140, pl.58, fig.9.

Gyroidinoides girardanus (Reuss). HANZLIKOVÁ, 1972, p.128, pl.37, fig.10.

Dimensions of specimen CUFC 271, sample 76871: diameter 0.44 mm, thickness 0.34 mm.

Remarks: The description of Cushman (1946) is followed herein. G. girardanus is readily distinguished by its acute periphery, high peripheral angle, chambers that project quite sharply towards the spiral side, and the prominent spiral suture.

Gyroidinoides globosus (Hagenow)

Nonionina globosa HAGENOW, 1842, p.574 (fide Ellis and Messina, 1940 et seq).

Gyroidina umbilicata d'Orbigny. MCGUGAN, 1957, p.342, pl.33, fig.4.

Gyroidina globosa (Hagenow). BELFORD, 1960, p.78, pl.21, figs.4-9.

Gyroidina sp. cf. G. girardana (Reuss). BELFORD, 1960, p.78, pl.21, figs.10-15.

Gyroidinoides aff. globosa (Hagenow). MCGOWRAN, 1962, p.244, pl.11, fig.5, pl.21, figs.7,8.

Dimensions of specimen CUFC 272, sample 76875: diameter 1.06 mm, thickness 0.82 mm.

Remarks: The description of McGowran (1962) is followed herein, with the additional notes that there is a quite well developed apertural lip, and all but the final whorl on the spiral side is covered by a large, smooth, clear boss. The aperture may extend along the spiral suture. G. globosus is distinguished by its well rounded periphery and deep umbilicus.

Gyroidinoides nodus (Belford)

Gyroidina noda BELFORD, 1960, p.79, pl.21, figs.16-27.

Dimensions of specimen CUFC 273, sample 76870: diameter 0.50 mm, thickness 0.34 mm.

Remarks: The description of Belford (1960) is followed herein, with the additional note that the axial periphery may be quite angular at the final few chambers. G. nodus is distinguished from most species by its low number of chambers, prominent raised central area on the spiral side, and nearly acute periphery. Its distinction from G. bandyi (Trujillo) has already been discussed under that species.

Gyroidinoides (?) sp.
(Plate 9, Figs.10-12)

Test free, low trochospiral, nearly planoconvex; spiral side flattened, with raised central area, evolute, umbilical side low convex, involute, with narrow umbilicus; equatorial periphery quite strongly lobulate, axial periphery fairly broadly rounded. Chambers 7 or 8 in final whorl, increasing slowly in size as added, inflated on both spiral and umbilical sides. Sutures distinct, depressed; on spiral side quite strongly oblique, on umbilical side nearly radial, initially sigmoid, later simply curved. Wall calcareous, perforate, smooth except for raised central area on spiral side, which is spinose. Aperture a very low interiomarginal slit, at the base of a narrow apertural face, running from near the umbilicus to a point near periphery.

Dimensions of specimen CUFC 274, sample 76889: diameter 0.31 mm, thickness 0.17 mm.

Remarks: This species is distinguished by its low convex umbilical side, rounded axial periphery, and spinose, raised central area on the spiral side.

Family	ANOMALINIDAE Cushman, 1927
Subfamily	ANOMALININAE Cushman, 1927
Genus	ANOMALINOIDES Brotzen, 1942

Anomalinoides rubiginosa (Cushman)

Anomalina rubiginosa CUSHMAN, 1926a, p.607, pl.21, fig.6 (fide Ellis and Massins, 1940 et seq.)---PERLMUTTER AND TODD, 1965, p.119, pl.6, figs.19-21.

Anomalina grosserugosa (Gumbel). PLUMMER, 1931, p.201, pl.14, fig.9.

Anomalinoides sp. nov.. McGOWRAN, 1962, p.235, pl.11, fig.8, pl.20, fig.8, t.f.8A.

NOT Gavelinella rubiginosa (Cushman). HANZLIKOVÁ, 1972, p.132, pl.38, figs.7,8.

Dimensions of specimen CUFC 275, sample 76871: diameter 1.13 mm, thickness 0.62 mm.

Remarks: The description of McGowran (1962) is followed herein. There seems to be some confusion in both Cushman papers, 1926a and 1946, concerning the dorsal and ventral sides, and the location of the aperture. For these reasons, those descriptions are not followed. Plummer (1931) failed to note the nature of the plug on the spiral side, and so her description is not followed herein. A. rubiginosa is characterized by large size in the adult, broadly rounded periphery, strongly inflated final chambers on the ventral or umbilical side, and an aperture that runs from a short distance on the ventral side under a lip, and thence across the periphery along the spiral suture under a very large, irregular plug of shell material that covers all but the final whorl. The specimens assigned to this species by Hanzliková (1972) have the aperture on the ventral side, with a very large, clear spiral boss. Thus they are herein referred to Gavelinella cayeuxi (de Lapparent).

Genus ANGULOGAVELINELLA Hofker, 1957

Angulogavelinella sp. A
(Plate 10, Figs.1-3)

Test free, low trochospiral, concavo-convex to planoconvex; spiral side wholly evolute, convex to occasionally flat, umbilical side involute, with quite broad, open umbilical region bordered by triangular projections of chambers, usually concave, but occasionally gently convex; equatorial periphery entire to very mildly lobulate, axial periphery acute with clear, imperforate keel. Chambers 7 to 9 in final

whorl, increasing fairly rapidly in size as added; on spiral side crescentic, on umbilical side strongly arched, becoming increasingly inflated as added. Sutures distinct; on spiral side nearly oblique, strongly curved, limbate, raised and very thick, in initial stages thicker than chambers are high, such that initial chambers are indistinct, later becoming proportionately much thinner; on umbilical side strongly curved, increasingly depressed as added. Wall calcareous, perforate, smooth. Aperture a low interiomarginal slit, running from the umbilicus to a point quite near the periphery, with an accessory slit running at an acute angle from that point up the apertural face, bordered on both sides by a small lip.

Dimensions of specimen CUFC 276, sample 76893: diameter 0.64 mm, thickness 0.22 mm.

Remarks: This species is readily distinguished from most others by its aperture and strongly curved, thick, raised sutures on the spiral side. It is distinguished from Angulogavelinella sp. B by the present species' typically concavo-convex form, and in planoconvex specimens, by the much more open, shallow umbilicus and much more prominent spiral-side sutures than on Angulogavelinella sp. B.

Angulogavelinella sp. B
(Plate 10, Figs.4-6)

Test free, low trochospiral, planoconvex to concavo-convex; spiral side wholly evolute, usually flat but occasionally gently convex, umbilical side involute, with a fairly narrow, steep-sided umbilicus, bordered by irregular projections of chambers, usually gently convex, but may be concave; equatorial periphery nearly entire to lobulate, axial periphery acute, with clear, imperforate keel. Chambers 8 to 10 in final whorl, increasing fairly rapidly in size as added; on spiral side crescentic, on umbilical side strongly arched, increasingly

inflated as added. Sutures distinct; on spiral side nearly oblique, strongly curved, limbate, thickened and gently raised, in initial stages thicker than chambers are high, such that initial chambers are indistinct, later becoming proportionately much thinner; on umbilical side strongly curved, increasingly depressed as formed. Wall calcareous, perforate, smooth. Aperture a low interiomarginal slit, running from umbilicus to a point near the periphery, with an accessory slit running at an acute angle up the apertural face, bordered on both sides by a small lip.

Dimensions of specimen CUFC 277, sample 76895: diameter 0.45 mm, thickness 0.15 mm.

Remarks: Angulogavelinella sp. B is distinguished from Angulogavelinella sp. A by the present species' typically planoconvex form, much less prominent sutures on the spiral side, and narrower, more steep-sided umbilicus.

Genus GAVELINELLA Brotzen, 1942

Gavelinella canalicula (Belford)

Anomalinoides canaliculus BELFORD, 1960, p.103, pl.31, figs.1-15, t.f.10(1-6).

Anomalinoides undulatus BELFORD, 1960, p.106, pl.32, figs.1-11, t.f.11(1-6).

Dimensions of specimen CUFC 278, sample 76896: diameter 0.48 mm, thickness 0.24 mm.

Remarks: The description of Belford (1960) for G. canalicula is followed herein, with the additional note that the differences for G. undulata (Belford) fall within the range of variation of G. canalicula. The species name canalicula is herein chosen for these two conspecific forms. G. canalicula is distinguished by its thick test, acute early periphery with thick, clear keel, and by its two prominent bosses,

surrounded by spiral grooves, on the umbilical side containing the low apertural slit that does not cross the periphery.

Gavelinella cayeuxi (de Lapparent)

Rotalina cayeuxi DE LAPPARENT, 1918, p.89, pl.9, figs.1-4, 6-9, t.f.25, 26 (fide Ellis and Messina, 1940 et seq).

Pseudovalvulineria aff. cayeuxi (de Lapparent). McGOWRAN, 1962, p.218, pl.9, fig.3, pl.18, figs.12,13.

Gavelinella rubiginosa (Cushman). HANZLIKOVÁ, 1972, p.132, pl.38, figs.7,8.

Dimensions of specimen CUFC 279, sample 76873: diameter 0.81 mm, thickness 0.40 mm.

Remarks: The description of McGowran (1962) is followed herein.

G. cayeuxi is readily distinguished by its very thick test with broadly rounded periphery, large clear boss on the spiral side, through which previous chambers are visible, and the partially involute, flattened umbilical side which has a spiral suture with a truncate, imperforate border.

Gavelinella eriksdalensis (Brotzen)

Cibicides (Cibicidoides) eriksdalensis BROTZEN, 1936, p.193, pl.14, fig.5, t.f. 69 (fide Ellis and Messina, 1940 et seq).

Anomalinoides eriksdalensis (Brotzen). BELFORD, 1960, p.108, pl.34, figs.1-11.

?Cibicides voltziana (d'Orbigny). McGUGAN, 1964, p.946, pl.152, fig.1.

Gavelinella eriksdalensis (Brotzen). SLITER, 1968, p.123, pl.23, fig.6.

Dimensions of specimen CUFC 280, sample 76904: diameter 0.59 mm, thickness 0.27 mm.

Remarks: The description of Sliter (1968) is followed herein, with the exception that the central portion of the umbilical side may have a complex, irregular thickening of the test rather than a simple spiral boss. G. eriksdalensis is distinguished from most species by its lenticular, compressed test with narrowly rounded periphery, and from

G. stellula (Belford) by the present species' wider umbilical region and thickened but not raised sutures on the umbilical side.

Gavelinella erugata (Belford)

Valvulineria erugata BELFORD, 1960, p.76, pl.20, figs.11-18.

Pseudovalvulineria aff. bettenstaedti (Hofker). MCGOWRAN, 1962, p.215, pl.9, fig.2, pl.18, fig.10.

Dimensions of specimen CUFC 281, sample 76896: diameter 0.27 mm, thickness 0.11 mm.

Remarks: The description of Belford (1960) is followed herein, with the additional notes that the inner whorls may project slightly on the spiral side, and the sutures on the umbilical side are initially limbate, flush, and thickened, before becoming narrow and gently depressed. G. erugata is distinguished by its small size, umbilical flap, and flat spiral side. Angulogavelinella bettenstaedti Hofker has a small accessory slit nearly perpendicular to the main interiomarginal aperture. Thus McGowran (1962) was in error in assigning the present forms to that species.

Gavelinella henbesti (Plummer)

Anomalina henbesti PLUMMER, 1936, p.290, pl.5, figs.7-10 (fide Ellis and Messina, 1940 et seq.).

Anomalinoides henbesti (Plummer). MCGOWRAN, 1962, p.229, pl.12, fig.7.

Gavelinella henbesti (Plummer). SLITER, 1968, p.123, pl.23, fig.2.

Dimensions of specimen CUFC 282, sample 76886: diameter 0.66 mm, thickness 0.27 mm.

Remarks: The description of McGowran (1962) is followed herein. G. henbesti is distinguished from most species by its quite thick test, and sutures that are initially limbate, but not unusually thickened or raised. G. pinguis (Jennings), which is very similar, has a broadly rounded rather than narrowly rounded periphery. In practice, the distinction is often very difficult.

Gavelinella pinguis (Jennings)

Anomalina pinguis JENNINGS, 1936, p.37, pl.5, fig.1 (fide Ellis and Messina, 1940 et seq.).

Anomalinoides aff. pinguis (Jennings). MCGOWRAN, 1962, p.228, pl.12, fig.1, pl.20, fig.9.

Anomalinoides pinguis (Jennings). GRAHAM AND CHURCH, 1963, p.65, pl.8, fig.2.

Dimensions of specimen CUFC 283, sample 76882: diameter 0.74 mm, thickness 0.34 mm.

Remarks: The description of McGowran (1962) is followed herein. G. pinguis is distinguished by its nearly bi-involute test and broadly rounded periphery. In principle, it may be distinguished from Anomalinoides nobilis Brotzen only by the ranges of the two species, the latter's being Paleocene, the present species' being Late Cretaceous.

Gavelinella sandidgei (Brotzen)

Cibicides sandidgei BROTZEN, 1936, p.191, pl.14, figs.2-4 (fide Ellis and Messina, 1940 et seq.).

Gavelinella sandidgei (Brotzen). SLITER, 1968, p.124, pl.23, figs.7,8.

Dimensions of specimen CUFC 284, sample 76872: diameter 0.25 mm, thickness 0.11 mm.

Remarks: The description and excellent synonymy of Sliter (1968) are followed herein. G. sandidgei is distinguished from other species of Gavelinella by its small planoconvex to more typically concavo-convex test with acute periphery. It is occasionally difficult to distinguish this species from juvenile specimens of Cibicides succedens Brotzen.

Gavelinella stellula Belford

Gavelinella stellula BELFORD, 1960, p.110, pl.33, figs.11-18.

Dimensions of specimen CUFC 285, sample 76903: diameter 0.53 mm, thickness 0.28 mm.

Remarks: The description of Belford (1960) is followed herein. G. stellula is distinguished from most species by its biconvex test with

very narrowly rounded periphery, and from G. eriksdalensis (Brotzen) by the present species' much more strongly thickened and raised sutures on the umbilical side, which also has a much smaller umbilical region.

Gavelinella sp.
(Plate 10, Figs. 7-9)

?Gavelinella sp. B.. GRAHAM AND CHURCH, 1963, p.70, pl.8, fig.19.

Test free, low trochospiral, planoconvex; spiral side flat, wholly evolute, all but final whorl covered by a smooth imperforate layer of calcite, umbilical side quite strongly convex, involute, with narrow umbilicus; ~~equatorial periphery~~ nearly entire, only mildly lobulate in later stages, axial periphery narrowly rounded, with high peripheral angle. Chambers 12 or more in final whorl, increasing slowly in size as added, on umbilical side becoming very mildly inflated. Sutures distinct; on spiral side very thick, limbate, and raised throughout, curved, connecting central layer of shell material with imperforate periphery, such that chambers initially on final whorl are either not discernible, or occur as very small perforations of the clear raised material, later becoming very narrow, curved, perforate depressions; on umbilical side initially limbate and flush, later depressed, gently curved throughout. Wall calcareous, perforate except as previously noted, smooth. Aperture a low interiomarginal slit, running from the umbilicus across periphery, and along the spiral suture for a few chambers, with a narrow bordering lip at the periphery only.

Dimensions of specimen CUFC 286, sample 76870: diameter 0.53 mm, thickness 0.26 mm.

Remarks: This species is distinguished by its unusual spiral side, which is flat and characterized by raised imperforate sutures, periphery, and central area.

Stensioina sp.
(Plate 10, Figs. 10-12)

Test free, low trochospiral, planoconvex to unequally biconvex; spiral side flat to very gently convex, evolute, umbilical side more strongly convex, partially evolute, with a narrow umbilicus or spiral boss; equatorial periphery nearly entire, becoming very mildly lobulate, axial periphery acute with ragged, blunt keel. Chambers 12 or more in final whorl, increasing slowly in size as added; on spiral side obscured by coarse irregular pustules, on umbilical side mildly inflated, increasingly so as added. Sutures on spiral side obscure, curved, marked by irregular, thick ridges of same height as pustules; on umbilical side initially limbate, thick and flush, becoming gently depressed. Wall calcareous, imperforate around umbilicus and at periphery, and entirely obscured on spiral side except for final chamber, which is perforate. Aperture a low interiomarginal slit, running from the periphery to the umbilicus, where it is covered by subtriangular extensions of chambers, and bordered above by a narrow lip.

Dimensions of specimen CUPC 287, sample 76880: diameter 0.62 mm, thickness 0.24 mm.

Remarks: This species is distinguished from S. truncata Belford by the former's planoconvex test with acute periphery, and from other species of Stensioina by its dense covering of pustules on the spiral side, which has quite irregular sutural ridges.

CHAPTER 4. FORAMINIFERAL BIOSTRATIGRAPHY.

4.1. INTRODUCTION: GENERATION OF DATA.

Thirty-six samples, 76868 and 76870 to 76904 inclusive, were deemed suitable for study because of their Late Cretaceous age, determined initially by the presence in all but 76897, 76898, and 76901 of specimens belonging to the Upper Cretaceous genus Globotruncana.

All foraminifera picked from the representative split for each of the >35, >60, and >120 mesh fractions in each of the thirty-six samples were identified. The total number of specimens was recorded for each species present in the representative split of each mesh fraction. Work sheets were then drawn up, one for each species, with columns for each of the three mesh fractions as well as the "whole" sample (the combination of the three mesh fractions), and a row for each of the thirty-six samples. For each mesh fraction, the total number of specimens was recorded. If the species was detected in the mesh fraction, but not the split, its presence was recorded with a P. Each mesh fraction was characterized by a "split factor" which was the reciprocal of the fraction of the mesh fraction used to obtain the representative association of foraminifera. For example, if a mesh fraction was split to 1/16 of its size to obtain an association of 300 or more foraminifera, its split factor was 16. For each mesh fraction of a given sample, the number of specimens was multiplied by the split factor to obtain a theoretical or working number of specimens of that species for the entire mesh fraction. The totals for the three mesh fractions were then added together to produce a number of specimens present in the whole sample. If a species was recorded in a mesh fraction as present (P), it was given a numerical value of '0', and made no contribution to the total number of specimens for the sample. If the species was never detected in any of the three representative splits, but was detected in the

remaining material, it was recorded as present (P) in the whole sample, but assigned a numerical value of '0'.

The result of this process was that for each species, its presence or absence in each of the thirty-six samples was known, and if it had occurred in any or all of the representative splits, its theoretical numerical abundance in the whole sample was calculated. This theoretical numerical abundance would of course only correspond by chance to the actual numerical abundance. The working of the sediment microsplitter is such that operator bias is eliminated, but the total number of specimens of a species in some amount of sediment passed through the microsplitter would almost never be divided exactly in two during one such pass. The numbers obtained in examining the representative association are only approximate, or representative of the actual situation in the sample. However, if one had taken a sample of the same weight from a few mm over, one would expect the actual numbers of specimens for each species, and the relative abundances, to be different by some amount. The assumption on which the subsequent sections of this chapter are based is that the relative abundances would be different but not significantly so. It is clear that the working or theoretical abundances are just that when one considers the case of a species recorded as present (P), and given a numerical value of '0'. It cannot be present at zero actual abundance.

For each sample, the total number of benthonic and total number of planktonic specimens for each representative split were recorded separately. These numbers were then treated in the same fashion as the numbers for each species, such that for each sample a theoretical or working total number of specimens was obtained for each of the benthonic and planktonic modes of life or components.

3

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The theoretical total number of specimens for each species was then divided by the theoretical total number of benthonic or planktonic specimens, then multiplied by 100, to obtain a theoretical percent abundance of the appropriate component for each species.

It was deemed desirable to separate the planktonic and benthonic components because they are affected by different factors at the time of their existence. This would eliminate perturbations in the percent abundance that could be caused by a change in the planktonic:benthonic ratio without any change in the actual nature of the benthonic associations involved. Separation of the two components thus eliminated some of the "background noise" and made for clearer and more easily understood comparisons between samples. This greatly aided the detailed local correlation, which is described in section 4.3.

4.2. FORAMINIFERAL CRITERIA FOR RECOGNITION OF STRATIGRAPHIC UNITS AT C-Y CREEK.

4.2.1. INTRODUCTION.

One of the major aims of the present study was to determine whether or not some foraminiferal criterion or set of criteria could be established to distinguish the Korojon Calcarenite from the Toolonga Calcilutite. As discussed in the section on the geological setting of the present study, the recognition of these two formations at C-Y Creek is a matter of some controversy.

Hooper (field notes, 1976) was able to recognize two predominantly calcareous units at C-Y Creek, as well as the much different Gearle Siltstone. These two calcareous units he referred to as the Korojon Calcarenite and Toolonga Calcilutite. Reference to the sample lithologies, in Appendix I, reveals that the samples are calcarenite, calcilutite, or mudstone, the latter being the Gearle Siltstone. All samples described as calcarenite by the present author were referred to

by Hooper as Korojon Calcarenite, and the samples described in Appendix I as calcilutite were referred to as Toolonga Calcilutite by Hooper.

On the basis of lithology, the samples seemed to be readily assigned to one of the three Upper Cretaceous formations at C-Y Creek, but reference to the literature reveals that this is not so simple a matter as it appears. What was desired was to devise some means, independent of lithology, to distinguish the three rock units from each other, particularly the Korojon Calcarenite and Toolonga Calcilutite.

It was decided that the criteria should be few in number, rapid and simple in application, and based on something other than presence or absence of species. While the presence of a species can be diagnostic, its absence cannot. Absence may mean that a particular species was not present in sufficient numbers to be included in the sample.

A species, to serve as a criterion for recognition or distinction of two formations when it is absent from the one formation, must be present in all samples of the other formation, and in such an abundance as to be unlikely to be absent from any samples of that second formation.

In the present study, the only species which fulfill this condition occur in the Gearle Siltstone. The reader may discern them by referring to those species which occur only in the Gearle Siltstone (see Appendix III), and referring to Fig.4, to see which of those species occur in high numerical abundance in the Gearle. They are not listed herein, because there is no real need for a foraminiferal criterion to distinguish the lithologically distinct Gearle Siltstone. In addition, there are too few samples of the Gearle Siltstone to establish reliable criteria for the Gearle in general.

If a species is present in two formations, it may serve as a criterion for distinction between the two formations if it is present in

Sample No.	Sample Weight(g)	No. Planktonic Specimens
76877	10.12	54
76896	14.76	69
76897	25.27	3
76898	25.10	1
76899	15.22	4
76900	16.80	11
76901	23.37	0

Table 1. Statistically Insignificant Planktonic Components.

Sample No.	Percent Arenaceous Specimens	Percent Cibicides succedens	Percent Rugoglobigerina rubra
76868	16.6	22.5	74.2
76870	30.9	16.3	59.3
76871	18.5	20.6	57.1
76872	21.3	20.1	69.1
76873	19.3	24.7	78.8
76874	22.6	27.3	69.2
76875	33.3	19.2	76.8
76876	21.7	29.9	70.4
76877	5.1	43.5	59.3
76878	16.7	20.3	72.0
76879	7.6	24.7	77.6
76880	15.0	23.6	77.4
76881	14.9	29.6	79.1
76882	11.0	23.6	65.0
76883	14.4	14.8	84.1
76884	21.4	16.2	66.8
76885	28.7	19.0	78.7
76886	32.4	16.9	71.7
76887	17.1	14.0	75.6
76888	19.2	P	23.1
76889	21.5	0.01	12.4
76890	19.5	22.9	62.8
76891	12.7	25.4	76.1
76892	27.2	16.5	62.8
76893	20.4	13.3	61.7
76894	34.4	1.4	15.0
76895	42.0	-	19.7
76896	50.9	-	39.1

Table 2. Numerical Data for Foraminiferal Criteria

Sample No.	Percent Arenaceous Specimens	Percent <u>Cibicides succedens</u>	Percent <u>Rugoglobigerina rugosa</u>
76897	100.0	-	67.7
76898	95.6	-	-
76899	56.9	-	25.0
76900	56.9	-	9.1
76901	99.2	-	-
76902	32.9	-	42.4
76903	15.3	-	5.6
76904	14.5	-	8.2

Table 2 (cont.). Numerical Data for Foraminiferal Criteria.

all samples of one formation, and in a significantly higher percent abundance than for all samples of the other formation in which it occurs.

Other taxonomic ranks, such as superfamilies, and foraminiferal categories, such as wall structure, can also be used, but the same principles apply.

There is some difficulty in applying these criteria where the number of foraminifera per gram of sediment is very low, because a statistically significant number of foraminifera cannot be obtained without processing very large amounts of sediment. Table 1 presents the sample numbers, sample weights, and number of planktonic foraminifera, where this situation occurs in the present study.

Sample 76877 is unusual in that its low planktonic foraminiferal count (54) is almost certainly due to the fact that the sample did not disaggregate appreciably, and not due to an actual low abundance of planktonic foraminifera.

4.2.2. CRITERIA.

The foraminiferal criteria devised for the recognition, distinction, and characterization of the three formations, the Gearle Siltstone, Toolonga Calcilutite, and Korojon Calcarenite, will now be described and discussed. Numerical data used for these criteria are presented in Table 2.

1) Arenaceous Specimens.

The percent arenaceous specimens in the benthonic component is a simple criterion which serves to distinguish the Gearle Siltstone from the two calcareous units, although the colour, texture, and lamination of the Gearle readily perform the same function. The three samples identified in the field as Gearle Siltstone, 76897, 76898, and 76901, all have a percent abundance of arenaceous specimens greater than 95,

whereas the remaining thirty-three samples range from 5.1 to 56.9. This single criterion readily distinguishes the Gearle Siltstone from the two calcareous units, but does not serve to distinguish the Toolonga Calcilutite from the Korojon Calcarenite.

ii) Cibicides succedens Brotzen.

The percent abundance of Cibicides succedens in the benthonic component is the single most useful criterion for distinguishing the Korojon Calcarenite from the Toolonga Calcilutite. C. succedens occurs in all samples of the Korojon Calcarenite, and in three samples of the Toolonga Calcilutite. Its minimum percent abundance in samples identified in hand specimen as Korojon is 13.3, in sample 76893, and it ranges to a maximum of 43.5 in 76877. This sample was hard, and did not disaggregate appreciably, which probably favoured the liberation of robust forms like C. succedens. Sample 76876, which is probably more reliable, had the next highest percent abundance of C. succedens, 29.9. In the three samples 76888, 76889, and 76894, identified as Toolonga Calcilutite in which C. succedens was found, its maximum percent abundance is 1.4, in 76894. A percent abundance of 5.0 may be considered the arbitrary division point between the formations.

On the basis of this criterion, samples 76868, 76870-887, and 76890-893 are identified as Korojon Calcarenite, and 76888-889, 76894-896, 76899-900, and 76902-904 are identified as Toolonga Calcilutite. This corresponds exactly to the assignment of these samples to the formations both in the field and in hand specimen examination.

iii) Rugoglobigerina rugosa (Plummer).

The percent abundance of Rugoglobigerina rugosa in the planktonic component is a very effective criterion for distinguishing the Korojon Calcarenite from the Toolonga Calcilutite. This species is present in all samples of the two formations, and in quite significant abundances.

Its minimum percent abundance in samples identified in hand specimen as Korojon Calcarenite is 57.1, in sample 76871, and its maximum is 84.1, in 76883. However, in samples assigned to the Toolonga Calcilute, its maximum percent abundance is 42.4, in sample 76902, and its minimum is 5.6, in 76903. A percent abundance of R. rugosa of 50 is tentatively set as the division between the Korojon and Toolonga. Study of a much greater number of samples would be required to verify or discount this figure of 50% as a reliable criterion to distinguish the two formations. Nevertheless, if the samples are assigned to the Korojon on the basis of greater than 50% abundance of R. rugosa in the planktonic component, and to the Toolonga on the basis of less than 50%, it is seen that this assignment of samples corresponds exactly to that determined on the basis of Cibicides succedens.

It is the present author's opinion that further criteria, even should they exist, are not necessary, as both C. succedens and R. rugosa serve so well to distinguish the Korojon Calcarenite from the Toolonga Calcilutite. Should examination of more samples render these criteria invalid, much more sophisticated numerical techniques would probably be required to establish new criteria, assuming that the two formations indeed can be distinguished on the basis of their foraminiferal faunas. However, this author sets forth both of these criteria as means of distinguishing the Korojon Calcarenite from the Toolonga Calcilutite, even where direct observations of sample lithology may not be possible, or are uncertain.

4.3. DETAILED LOCAL CORRELATION AND CHARACTERISTICS OF FORAMINIFERAL FAUNAS THROUGH THE SECTION.

4.3.1. INTRODUCTION: METHOD OF CORRELATION.

Because the stratigraphic section at C-Y Creek is not continuously exposed, at best only partial sections could be collected, along with

isolated samples. The vertical relationships between samples are therefore known in some cases, and in others are not. This information is found in Appendix I, where vertical or stratigraphic relationships between samples are recorded where known.

It was desired to place all thirty-six samples in proper stratigraphic sequence, and then to describe major changes in the foraminiferal fauna that occur through the section.

The detailed local correlation was based on the assumption that the foraminiferal fauna changed in composition through the section, and that trends or important changes could be detected. These trends would be established for partial sections and groups of samples of known stratigraphic relationship. Isolated samples or groups of samples could then be placed in proper stratigraphic sequence by comparing their foraminiferal faunas with the faunas of samples of known stratigraphic order.

Two types of criteria were used. The first was percent abundance of the various species considered, and the second was the first and/or last occurrence of species of limited stratigraphic distribution. No attempt will be made herein to detail the criteria used for each correlation. Appendix I contains the information to place broad constraints on the samples, by grouping some of them in known sequence. Notes will be given for each formation on changes in the foraminiferal fauna which served to arrange the groups in proper sequence, and these should serve as a guide to the reasoning used to reconstruct the stratigraphic section at C-Y Creek. Details used for the precise correlation are found in the percent abundance curves produced as Figures 4 to 8.

The planktonic and benthonic components were considered independently, and the results compared. Occasionally they conflicted, and the reader may observe a few of these conflicts in Figures 4 to 8. The

conflicts were such that at most a sample would move up or down one position in the sequence. The placement of samples in such cases was somewhat arbitrary, made in favour of the placement which seemed to have the greatest weight of evidence in its favour.

Species for the characterization of the samples were chosen for their numerical importance, the criterion usually being a minimum percent abundance of 2.0 in at least one sample, but ideally in several samples. This minimum was chosen for two reasons. The first is that some device was desired to cut the number of species considered down to a manageable number, with percent abundances that would be quite readily visible on a graph of reasonable scale. The second reason is that the percent abundances calculated using the procedure outlined in section 4.1 are imprecise. This means that only percent abundances on the order of a few percent (and perhaps even higher) can be considered reliable enough to characterize and distinguish samples.

The percent abundances of the selected species were plotted in a cumulative fashion, in a set sequence, for each sample of a given formation. Those samples of known stratigraphic order were so arranged, and then these sections and the isolated samples were compared until a sequence was obtained with a satisfactory amount of supporting evidence.

Once the stratigraphic sequence was determined to the present author's satisfaction, the graphs found as Figures 4 to 8 were prepared. Because there was insufficient control to allow the determination of the vertical distance between each pair of adjacent samples, they were spaced at equal distances on the vertical scale of the graphs, with no implications for the actual vertical distances between samples. The cumulative percent abundances were then plotted on the horizontal scale for each sample, and these were then connected such that each species is

represented by an area on the graph. The width of that area at each sample corresponds to the percent abundance of the species in that sample.

Some explanation of the colour coding and the species involved is also required. Both Figures 6 and 8, which are for the planktonic foraminifera of the Toolonga Calcilutite and Korojon Calcarenite respectively, are based on the same thirteen planktonic species. They are plotted in the same sequence and given the same colour coding for both figures. The sequences used for both the planktonic and benthonic foraminifera correspond to the order in which the species occur in the systematic paleontology. No two species in Figures 4, 6 and 8 are represented by the same colour. Figure 4, which depicts the percent abundances of major benthonic species of the Gearle Siltstone, has ten species. No correspondence exists between the species colour codes of the planktonic and benthonic components, nor is there any correspondence, other than accidental, between the colour codes for the benthonic components of the three formations. There are some benthonic species in common between the formations on the graphs, but as a general rule they are represented by different colours on the figures. This was done in order that the same sequence of colours should occur on each graph, for ease of reading.

Twenty-five species were used for Figure 5, which depicts the percent abundances of major benthonic species of the Toolonga Calcilutite, and twenty-seven species were used for Figure 7, which is the corresponding graph for the Korojon Calcarenite. The high number of species meant that in most cases the same colour had to be used for two species, but never more than two. The species are plotted in sequence according to the systematic paleontology. A sequence of colours was chosen for maximum readability, and once this sequence was exhausted,

was repeated until all species were represented by a colour. The exception is white, which was used to represent the frequently most abundant species, without regard to sequence. There should be little confusion concerning which of two species a particular colour band represents.

With this introduction, the reader should be able to use the graphs as a guide to the following discussion, which will describe the characteristics of the foraminiferal fauna and the changes that occur therein going up the Upper Cretaceous portion of the stratigraphic succession at C-Y Creek. Only major or significant changes will be discussed. The reader is referred to Figs. 4 to 8 for details of the changes that occur in the percent abundance of each species represented, from sample to sample.

4.3.2. CHARACTERISTICS OF THE FORAMINIFERAL FAUNAS THROUGH THE SECTION.

i) Gearle Siltstone (76897-98, 901).

a) Benthonic Component (Figure 4).

The three samples were correlated without reference to the foraminiferal fauna. Sample 76898 was known to be collected 1 m below 76897, which was at most 0.05 m (2 inches) below the contact of the Gearle Siltstone and Toolonga Calcilutite. Sample 76901 was collected 0.3 m below a sample from the Toolonga, which meant that it was, at the highest, stratigraphically equivalent with 76897, and at the lowest 0.3 m below that sample, meaning it was above sample 76898.

The predominantly to exclusively arenaceous fauna of the Gearle Siltstone is composed, at C-Y Creek, of ten principal species, which are either found only in the Gearle, or are of very limited occurrence elsewhere in the section, commonly the lower Toolonga Calcilutite. Their distribution and percent abundances are represented in Figure 4, and are not discussed further in this section.

b) Planktonic Component.

The portion of sample 76901 that was processed contained no planktonic foraminifera, while that of 76897 contained three specimens, and 76898 one specimen. No significance is attached to them in the present study. They are regarded as contamination, probably introduced from incompletely cleaned sieves.

ii) Toolonga Calcilutite (76888-89, 76894-96, 76899-900, 76902-904).

a) Benthonic Component (Figure 5).

The benthonic foraminifera of the Toolonga Calcilutite serve to divide the formation into three large intervals.

The first interval consists of samples 76896, 76899, and 76900, and is the lowermost interval of the Toolonga. This is known from the occurrence 0.05 m (2 inches) below 76896 of sample 76897 of the Gearle Siltstone. Its dominant benthonic foraminiferal characteristics include the presence in significant abundance of the species Haplophragmoides fraseri Wickenden, Haplophragmoides sp. C, and Ammobaculites subcretaceus Cushman and Alexander. These species occur only in the Gearle Siltstone and these three samples of the Toolonga Calcilutite. Valvulineria undulata Belford is restricted in the present study to these three samples, and occurs in each of them in significant abundance. Gaudryina pulvina Belford also serves as an excellent indicator of this interval, for its occurrence in abundances exceeding 25 percent in this portion of the section. Elsewhere in the Toolonga Calcilutite, its maximum percent abundance is less than 15.

The second interval consists of samples 76902, 76903, 76895, and 76894, and has characteristics of the first interval and the third interval, as well as some of its own which are, unfortunately, not universally present in this second interval.

The second interval is distinguished from the first interval by the absence of Haplophragmoides fraseri, Haplophragmoides sp. C, and Ammobaculites subcretaceus from the former, as well as its much reduced abundance of Gaudryina pulvina. The presence of Silicosigmoilina californica Cushman and Church in some abundance in the second interval also serves to distinguish the first two intervals from each other, as does the very abundant occurrence of Reussella szajnochae (Grzybowski) in the first three samples of the second interval.

The second interval is distinguished from the third interval by the presence in abundance in the second interval of Angulogavelinella sp. B and Gavelinella canalicula (Belford), and the significantly greater percent abundance of Dorothia oxycona Reuss in the second interval.

The third interval consists of samples 76904, 76889, and 76888. It is distinguished from the other two intervals by the absence of significant abundances of Gaudryina pulvina in this third interval, and by the occurrence in significant abundance of Gyroidinoides nodus (Belford) and Gavelinella eriksdalensis (Brotzen). Pyramidina triangularis (Cushman and Parker) and Anomalinoides rubiginosa (Cushman) also occur in these three samples in quite significant abundance, and in addition do not occur elsewhere in the Toolonga Calcilutite.

b) Planktonic Component (Figure 6).

The planktonic components of the first three samples of the Toolonga Calcilutite going up the section are not statistically reliable, because the numbers are far too low (see Table 1, section 4.2.1). Fortunately, the samples 76896, 76899, 76900, and 76902 were of known stratigraphic sequence when collected. No significance, other than for possible age determinations, will be attached to the planktonic foraminifera of the first three samples.

Going up the section from sample 76902, some important events may be noted. Globigerinelloides volutus (White) and Hedbergella planispira (Tappan) make their first appearance in sample 76903, the latter in significant abundance. There is little change by sample 76895, but some changes occur by sample 76894. There is a drastic reduction in the percent abundance of H. planispira from 76895 to 76894, and Globigerinelloides multispirina (Lalicker) makes its first appearance in the Upper Cretaceous of C-Y Creek. The only other events of significance are the first appearance of Pseudotextularia elegans (Rzehak) in sample 76904, and the last appearance, in sample 76904, of H. planispira, until three isolated occurrences much farther up the section, in samples 76874, 76868, and 76870. There is some question, therefore, if the two stratigraphically isolated forms are in fact both H. planispira. Hanzliková commented on this problem, when she stated that the "forms termed H. planispira are recorded from the Aptian-Albian to Maastrichtian the world over. It is likely that many of these records do not correspond to the same taxon" (Hanzliková, 1972, p.101).

From sample 76902, there is a general tendency to increasing abundance, commonly followed by decreasing abundance in the upper few samples, for the species Heterohelix globulosa (Ehrenberg), H. pulchra (Brotzen), Globigerinelloides alvarezii (Eternod Olvera), G. volutus (White), and Globotruncana arca (Cushman). Globotruncana bulloides Vogler and G. ventricosa White, which never occurs in great abundance from sample 76902 upwards, both have a tendency to decrease in abundance up section.

iii) Korojon Calcarenite (76868, 76870-87, 76890-93).

a) Benthonic Component (Figure 7).

The number of samples and species involved prohibits a detailed examination of the stratigraphic succession of foraminiferal faunas in

the Korojon Calcarenite, but some notes will be made herein concerning significant events.

There are four maxima and corresponding minima in the abundance of Spiroplectammina grzybowskii Frizzell, and with the exception of samples 76890 and 76887, Textularia subconica Franke occurs in significant abundance only above and including sample 76876.

The species belonging to the superfamily Buliminacea are quite significant and useful in detailed local correlations. Praebulimina carseyae (Plummer) occurs sporadically from sample 76891 up, but occurs at greater than 2 percent abundance only and consistently from sample 76874 to the top of the section as known at C-Y Creek. There are three intervals wherein P. cushmani (Sandidge) occurs in quite high abundances, these intervals being from sample 76892 to 76890, from sample 76878 to 76877, and from sample 76873 to 76870. P. navarroensis (Cushman and Parker) occurs in abundance in the interval from sample 76890 to 76885, and occurs in only one other sample, 76892. Its presence is thus a useful index of the lower portion of the Korojon Calcarenite. Above sample 76885, beginning with 76884 and including all samples to the top of the section, Pyramidina prolixa (Cushman and Parker) occurs in quite significant abundances, with a minimum of 2.1 percent in sample 76872. Bolivina incrassata gigantea Wicher is found in quite significant abundance only in the interval from sample 76887 to 76882, although it does occur elsewhere in abundances sufficiently great to be represented in Figure 7. The species Bolivinoidea decorata australis Edgell occurs in the interval from sample 76893 to 76875, but in quite high abundance only in the interval from sample 76891 to 76876.

Cibicides beaumontianus (d'Orbigny) is found in significant abundance only in the interval from sample 76882 to 76876, and is a quite

useful index of the middle part of the section. Loxostomum eleyi (Cushman) is present in significant abundance in several samples in several portions of the section, but only in the interval from sample 76893 to 76886 is it a major element of the benthonic foraminiferal fauna.

The middle and upper portion of the section are characterized by the presence in significant abundance of Alabamina dorsoplana (Brotzen), which occurs from sample 76882 up, but nowhere below. Globorotalites umbilicatus (Loetterle) does not occur above sample 76884, but unfortunately it is absent from samples 76890 and 76887, and so its presence or absence cannot be used in itself as an index of the lower part of the Korojon Calcarenite. The last very useful benthonic species in the Korojon Calcarenite is Angulogavelinella sp. A which occurs in all samples up to 76891, although not in significant abundance in this sample. This species is an excellent index to the lower part of the Korojon Calcarenite, although it is also known from the Toolonga Calcilutite in low abundance.

The other species whose percent abundances are depicted in Figure 7 are not in themselves immediately useful or diagnostic of portions of the section. The reader is referred to Figure 7 for details of the distribution of these species.

b) Planktonic Component (Figure 8).

From the standpoint of precise local correlation, the planktonic foraminifera of the Korojon Calcarenite are disappointing. The reader is referred to Figure 8 for details of what fluctuations occur in the percent abundances of the thirteen numerically significant planktonic species. Only four will be discussed herein.

Although it is not ubiquitous in samples below 76875, Globigerinelloides alvarezii (Eternod Olvera) does not occur above this point in the

section. Therefore, the presence of this species in a sample serves to place an upper limit on the stratigraphic occurrence of that sample.

The species Globotruncana linneiana (d'Orbigny) is almost ubiquitous, having been undetected only in sample 76892. However, its percent abundance rises to something on the order of 1.0 only and universally in the interval from sample 76884 to 76875, and it is significantly higher in the interval from sample 76881 to 76876, except for sample 76878.

Globotruncana ventricosa White is present in all samples of the Korojon Calcarenite up to and including 76884, although it never occurs in any great abundance, the maximum being 0.6 percent in sample 76890. Nevertheless, its presence in a sample places an upper limit on the possible stratigraphic occurrence of that sample.

Finally, Rugoglobigerina macrocephala Brönnimann is restricted in its occurrence at C-Y Creek to samples stratigraphically above and including 76885, although it is not ubiquitous in this interval. However, it is restricted in its occurrence in abundances of one percent or more to the interval which includes all samples from 76879 up.

4.4. CORRELATION OF THE FORMATIONS WITH STANDARD EUROPEAN STAGES.

4.4.1. INTRODUCTION.

One might expect the abundant and quite diverse foraminiferal fauna to furnish an excellent basis for the correlation of the samples from C-Y Creek with the standard European stages. Such is not the case, however. This is caused largely by the fact that the range zones reported for most planktonic species are not the same for different study areas. In addition, differences in interpretation of the identity or range of variation of the species contribute to differences between various authors' reported range zones. The consequence is that only general

constraints can be placed on the ages of the samples from C-Y Creek examined in the present study.

The three formations will be discussed in ascending stratigraphic order, and the reader is referred to Appendices III and IV for the occurrences of the species by sample, arranged in stratigraphic order.

4.4.2. CORRELATION WITH STANDARD EUROPEAN STAGES.

i) Gearle Siltstone.

The only planktonic specimens found in the three samples of the Gearle Siltstone are thought by the present author to be the result of contamination. A significant number of the benthonic species could not be identified at the species level, and only two of the species have reported range zones which may place constraints on the age of the Gearle Siltstone. Haplophragmoides fraseri Wickenden ranges throughout the Mid Turonian in Shasta County, California (Sliter, 1968) and Ammobaculites subcretaceus Cushman and Alexander has a range of Late Cenomanian to Turonian in the Gulf Coast (Cushman, 1946). This would suggest a Turonian age for the upper portion of the Gearle, which is in accord with the determinations of Condon et al. (1956), McWhae et al. (1958), Belford (1959), and Condon (1968).

However, these two species range in the present study into the lowermost three samples of the Toolonga Calcilutite, which are almost certainly Santonian at the oldest (see discussion in following section). Thus the reported ranges of H. fraseri and A. subcretaceus are not directly applicable to the Australian Upper Cretaceous. This is probably due to the facies control of benthonic foraminifera, which results in the stratigraphic occurrence of species being controlled by the occurrence of favourable facies as much as by evolution.

A Turonian age for the upper portion of the Gearle Siltstone is not inconsistent with the data, but there is no definite evidence known to

this author which supports the Turonian age determined for the Gearle by other authors.

ii) Toolonga Calcilutite.

A few planktonic species occur in sample 76896, which is 0.05 m (2 inches) above the Gearle Siltstone. They are useful in placing constraints on the age of commencement of deposition of the Toolonga Calcilutite at C-Y Creek. Globigerinelloides alvarezii (Eternod Olvera) has a reported range of Santonian to Maastrichtian (Sliter, 1968), G. volutus (White) has a reported range of Mid Campanian to Late Maastrichtian in the Gulf Coast (Pessagno, 1967), and Globotruncana arca (Cushman) has as its oldest reported range Santonian to Maastrichtian (Sliter, 1968), although a Campanian to Maastrichtian range is more commonly reported (several authors). It would seem that on the basis of these three species, the Toolonga Calcilutite is, at the oldest, Santonian in age.

Belford (1960) reported the ranges of a number of benthonic species which are restricted in the present study to the lower part of the Toolonga Calcilutite. Valvulineria undulata (Belford), which occurs in the interval from sample 76896 to 76900, is Mid Santonian, Gavelinella canalicula (Belford), which occurs in the interval from sample 76896 to 76904, is Mid to Late Santonian, and Tritaxia trifida (Belford), which is found in the interval from sample 76896 to 76894, is also Mid to Late Santonian in range.

Ranges of benthonic species are somewhat unreliable, because of the strong facies control of benthonic faunas. This means that local ranges may be controlled by changes in facies through time, and not by evolutionary processes. It is known that there are facies differences between C-Y Creek and the Murchison River area, where Belford's (1960) study was carried out.

There are other constraints on the ages of samples 76903 to 76904, which suggest a Campanian age for them. It seems safe, however, to assign a Santonian age to the interval represented by the samples from 76896 to 76902.

Praeglobotruncana havanensis (Voorwijk) is reported by several authors to be Maastrichtian, but Bolli (1951) reported its range as Mid Campanian to Maastrichtian, and Hanzliková (1972) reported the range as Campanian to Maastrichtian. Samples 76903 and 76895 may thus be Campanian, a conclusion supported by the presence in 76895 of Globigerinelloides multispina (Lalicker), for which the oldest reported range is Campanian to Early Maastrichtian (Hanzliková, 1972).

Ranges of Early to Mid Campanian were reported by Belford (1960) for Dorothia pupa (Reuss), whose first occurrence is in sample 76904, D. biformis Finlay, whose first occurrence is in 76895, D. conicula Belford, whose first occurrence is in 76889, Dentalina pertinens Cushman, whose first occurrence is also in sample 76889, and Pyramidina triangularis (Cushman and Parker), whose first occurrence is in 76904. Pyrulina cylindroides (Roemer), whose reported range is Early Campanian, has its first occurrence in sample 76904.

These ranges considered along with those of Praeglobotruncana havanensis and Globigerinelloides multispina, suggest a Campanian age, certainly for the interval from sample 76904 upwards to the top of the Toolonga. This is supported by the Campanian range reported for Dorothia pupa by Sliter (1968). Most likely, however, the interval from sample 76903 to the top of the Toolonga Calcilutite is Campanian in age.

In summary, the deposition of the Toolonga Calcilutite at C-Y Creek probably commenced in the Santonian, and terminated well into the

Campanian, with the transition from the Santonian to the Campanian occurring around the time of deposition of sample 76903.

iii) Korojon Calcarenite.

Few constraints can be placed on the age of the Korojon Calcarenite using its foraminiferal fauna. From the age of the uppermost portion of the Toolonga Calcilutite, the lowermost Korojon Calcarenite must be Early Campanian at the oldest.

The benthonic species Bolivinoides decorata australis Edgell is the most stratigraphically useful form for the bulk of the section. Its reported ranges are Mid to Late Campanian (Edgell, 1954), and Late Campanian to Early Maastrichtian (Mello, 1969). The similar, perhaps stratigraphically equivalent form, B. decoratus (Jones) has reported ranges of Mid to Late Campanian (Barr, 1970; Petters, 1977), and Campanian to Early Maastrichtian (Hanzliková, 1972).

The presence of B. decorata australis in sample 76893 would indicate that that sample was deposited no earlier than in Mid Campanian time, and the position of sample 76893 1.5 m above 76892, the lowermost sample of the Korojon Calcarenite, suggests that the deposition of the Korojon commenced in Mid, or perhaps latest Early Campanian time.

B. decorata australis persists through sample 76875, and it is likely that that sample is no younger than Late Campanian, although there is some possibility that it could be Early Maastrichtian, based on Mello's (1969) reported range zone for that species.

However, Globotruncana lapparenti Brotzen has reported range zones of Turonian to Late Campanian (Bolli, 1951), Late Turonian to Early Campanian (Edgell, 1957), and Early Santonian to Late Campanian (Pessagno, 1967). The presence of that species in sample 76873 would indicate, therefore, that at the youngest that sample is Late Campanian.

The range of Mid to Late Campanian reported by Edgell (1954) for B. decorata australis is thus supported for the Carnarvon Basin.

The ages of samples 76868, 76872, and 76871 are indeterminate, because no species occur in them that are restricted to either the Campanian or Maastrichtian. This conclusion is based on a literature survey by this author which found that reported range zones conflicted too often to allow definite range zones to be established.

The age of sample 76870 may be established with confidence, however. The benthonic species Bolivinoidea decorata gigantea Hiltermann and Koch and B. draco draco (Marsson) have the same reported ranges, those being Maastrichtian (Edgell, 1954; Hanzliková, 1972), or late Early to Late Maastrichtian (Barr, 1970; Petters, 1977; and Sliter, 1968 for the latter species only), and both occur in sample 76870 and that sample only, in the present study.

Three planktonic species are restricted to that sample in the present study. Globotruncana elevata (Brotzen) has reported ranges of Campanian to Early Maastrichtian (Sliter, 1968), Mid Campanian to Late Maastrichtian (Pessagno, 1967), Latest Campanian to Maastrichtian (Douglas, 1969), and Maastrichtian (Edgell, 1957). The species Racemiguembelina fructicosa (Egger) is reported to be Maastrichtian (Hanzliková, 1972) or Late Maastrichtian (Pessagno, 1967) in age.

Finally, Globotruncana contusa (Cushman) is reported to be Maastrichtian by Bolli (1951), Edgell (1957), and Hanzliková (1972), and Mid to Late Maastrichtian by Pessagno (1967). This latter range is supported by van Hinte (1976), who gave the range of G. scutilla (author unknown) as Late Campanian to Mid Maastrichtian. This species, which is intermediate between G. fornicata Plummer and G. contusa, is probably equivalent to the forms assigned to G. contusa in the present study.

The presence of these five species found uniquely in sample 76870 establishes the age of that sample as Maastrichtian, likely Early or Mid Maastrichtian. G. bulloides Vogler, which has as the upper limit of its range zone the Early Maastrichtian (Bolli, 1951; Pessagno, 1967), is present in sample 76870. Thus the age of sample 76870 is firmly established as Early Maastrichtian.

The foraminiferal faunas of the samples of the Korojon Calcarenite collected at C-Y Creek allow the following constraints to be placed on the age of deposition of the Korojon Calcarenite. Deposition of the Korojon began sometime in the Mid, or possibly latest Early Campanian, and continued through the Campanian. The interval from sample 76868 to sample 76871 was deposited sometime during the close of the Campanian and/or the beginning of the Maastrichtian, and the uppermost Korojon Calcarenite, represented in this study by sample 76870, was deposited during the Early Maastrichtian.

4.4.3. DISCUSSION.

It became apparent that the range zones of several species, especially planktonic species, of Upper Cretaceous foraminifera at C-Y Creek do not correspond to those reported for the same species in other areas of the world. This was not too surprising, in view of the fact that this situation exists even in separate studies done for California and the Gulf Coast of the United States.

Unfortunately, there are as yet no independent controls on the ages of the samples at C-Y Creek, aside from questionable ammonite and pelecypod determinations. Perhaps nannofossil studies would allow precise and detailed correlation of the section at C-Y Creek with the standard European stages. Were this done, then the local range zones of the planktonic foraminifera in particular could be determined. The planktonic foraminifera would then be powerful tools for correlation within the Carnavon Basin, in all likelihood.

CHAPTER 5. PALEOECOLOGY.

5.1. INTRODUCTION.

One of the limitations of the present study is the lack of observations concerning field relationships of the samples, and the sedimentary textures and structures of the enclosing rocks. This means that some of the most important criteria for establishing the environment of deposition of the individual samples or formations are not available to the present author. All subsequent discussion of the environments of deposition are based on the assumption that the sediments have not undergone mass transport of any kind. There is no evidence to verify or refute this assumption, but no papers known to this author suggest that the sediments are in anything but their primary place of deposition.

The only tool, other than sample lithology, available to the present author is the foraminiferal fauna of each sample. There are some major problems or limitations associated with this tool, however.

Paleontologists frequently use observations of the environmental preferences of modern organisms to postulate preferences of ancient organisms. This procedure is limited severely by the fact that taxa may change their preference through geologic time, especially a period such as that encompassed from the Cretaceous to the Recent (Takayanagi, 1960). It is also limited by the fact that, as one goes farther back into the fossil record, the number of species and genera common to Recent faunas decreases. Consequently, so does the reliability of any environmental reconstruction based on the faunas, specifically foraminiferal faunas.

"It would be manifestly suspect to attempt precise ecologic interpretations from a fauna in which all of the species and even a few of the genera are extinct" (Bandy, 1951, p.490). Graham and Church (1963) came to much the same conclusion, stating that one "must keep in mind

that he is concerned here with animals and plants of a period so long ago... whose life habits may have been so vastly different from those of Recent organisms that any explanation of the ecology of the times is open to question" (*ibid.*, p.11).

Takayanagi (1960) added to this the possibility, even likelihood, that changes would occur in the composition of the foraminiferal fauna before its preservation in the rock, caused by such things as current sorting.

Sliter and Baker (1972) constructed a detailed model for the Cretaceous of southern California and Baja California, Mexico, which explained the bathymetric distribution of benthonic foraminifera. The model was based on analogy to Recent foraminiferal faunas, found mostly along the eastern Pacific margin. Five zones, the inner and outer shelf, and the upper, middle, and lower slope, were recognized by those authors. A number of the genera used to characterize these zones are common to the present study. However, the correspondence of any of the faunas of the present study to those of any one of the five zones is very poor. Rather, numerous genera are found in common with two or more of the zones of Sliter and Baker. The application of their model to the present study is at best inconclusive, and this should not be too surprising. As those authors stated, "the depth range of a species is recognized as a function of one or more limiting variables,... [including] substrate" (Sliter and Baker, 1972, p.169), and "extending the proposed bathymetric model for Cretaceous foraminifera into different latitudes or substrates imposes problems" (*ibid.*, p.180). They emphasized that "the present model applies to middle-latitude Cretaceous foraminifera in a clastic, continental-margin environment with varying rates of sedimentation" (*ibid.*, p.180).

The Toolonga Calcilutite and Korojon Calcarenite are definitely calcareous, not clastic, units, and would only by chance have corresponded to the study area of Sliter and Baker in paleolatitude. For these reasons, their model is not used herein.

In spite of the limitations, the foraminiferal faunas of the present study have implications for the depositional environments of the three formations involved in the present study.

5.2. PALEOECOLOGY OF THE FORMATIONS.

i) Gearle Siltstone.

The Gearle Siltstone is a very fine-grained, predominantly terrigenous clastic unit. In the three samples of this unit in the present study, the minimum weight percent of silt size or finer material is 99.6. The predominantly fine-grained nature of the Gearle implies that it was deposited in an area with very low mechanical energy, else the sediment could not have been deposited.

This would suggest that the Gearle Siltstone was most likely deposited either in a deep marine basin, or in a shallow, near-shore lagoon or other body of water with restricted circulation. In this author's opinion, the evidence of the foraminiferal fauna favours the latter hypothesis.

Trujillo (1960) referred to a number of studies on Recent Gulf Coast foraminifera, and noted that "such arenaceous genera as Ammobaculites, Haplophragmoides, and Trochammina have a wide tolerance for changes in salinity and are commonly the only representatives found in lagoons and brackish water environments" (ibid., p.300). Turbidity was also thought to be a factor causing a primarily arenaceous fauna, and if the level of turbidity was high enough, would result in a reduction in the number of foraminifera per gram of sediment. This is

thought to be a reflection of the reduced organic activity caused by shielding of the bottom from sunlight.

Takayanagi (1960) supported these observations, as did Graham and Church (1963), although it must be noted that such assemblages were not found in Takayanagi's study. In addition to the arenaceous forms, which were dominant, Takayanagi noted the occurrence of Bathysiphon, a supposed deep-water genus, and numerous nodosarians and rotaliids. These he took to indicate that the Hokkaido assemblages were representatives of deep water environments.

The Gearle Siltstone is characterized by foraminiferal faunas in which arenaceous specimens comprise at least 95 percent. Haplophragmoides comprises at least 20 percent, and Ammobaculites is present, though not necessarily in great abundance. In addition, the associated calcareous perforate forms thought by Takayanagi to distinguish the deep water from shallow water faunas are all but absent from the Gearle Siltstone as sampled in the present study.

The number of specimens per gram of sediment, or foraminiferal number, reaches a maximum of 8.8, in sample 76898. Three samples of the Toolonga Calcilutite have foraminiferal numbers of 16.5, 32.7, and 33.7, but all other samples in the present study have foraminiferal numbers exceeding 100, and several exceed 1000.

Further evidence for a shallow water origin for the Gearle Siltstone lies in the total absence of planktonic foraminifera. By the Albian and Turonian, abundant and quite diverse planktonic foraminiferal faunas had evolved. Planktonic foraminifera are known to be borne by surface currents. One would expect, therefore, that if the site of deposition of the Gearle Siltstone were exposed to ocean or marine surface currents, planktonic foraminifera would have been deposited therein. Were the site of deposition a deep basin, below the calcite compensation

depth, the planktonic tests could have been dissolved before deposition. One would then be hard pressed to explain the presence of the few intact calcareous specimens, or the ability of the arenaceous forms to use calcareous cement.

The Gearle Siltstone was, therefore, almost certainly deposited in a shallow water, lagoonal basin isolated from open marine influences and surface currents by some barrier or by the shallow nature of the basin. This would also have resulted in the abnormally low salinities suggested by the predominantly arenaceous fauna.

ii) Toolonga Calcilutite and Korojon Calcareenite.

No discussion of the environment of deposition of either the Toolonga Calcilutite or Korojon Calcareenite is likely to be fruitful without reference to the other. For this reason, the two formations are included in this single section.

In general, such parameters as the planktonic:benthonic ratio, the foraminiferal number, and the percent arenaceous specimens in the benthonic component display significant overlap among the samples of the two formations. They are thus of very limited usefulness in distinguishing the environments of deposition of the two formations.

The planktonic:benthonic ratio, which may reflect a difference in the influence of surface currents, is also characterized by significant overlap between samples of the two formations. The exception is the lowermost interval of the Toolonga, represented by samples 76896, 76899, and 76900. The planktonic:benthonic ratios are 0.17, 0.01, and 0.04 respectively. The minimum reliable figure for the Korojon is 0.31, from sample 76879, and for other samples of the Toolonga is 0.24, from sample 76902. Sample 76877 of the Korojon Calcareenite, because it did not disaggregate appreciably, has an abnormally low planktonic:benthonic ratio, and a low foraminiferal number.

On average, the foraminiferal number for samples of the Toolonga Calcilutite is lower than that for samples of the Korojon Calcarenite. However, there are so many individual exceptions to this that it would be fruitless to attempt to distinguish the environments of deposition of the two units on this basis. Extreme low values are recorded for samples 76896, 76899, and 76900, with 32.7, 33.7, and 16.5 specimens per gram of sediment processed, respectively. The minimum recorded for the Korojon Calcarenite is 196.4, in sample 76879, and for the other samples of the Toolonga, 149.9, in sample 76902.

No consistent distinction may be made between the Toolonga and Korojon on the basis of the percent arenaceous specimens, either. However, samples 76896, 76899, and 76900 again have abnormal values, those being 50.9, 56.9, and 56.9 respectively. The maximum reliable value for the Korojon is 33.3, in sample 76875, and for other samples of the Toolonga is 42.0, in sample 76895.

The interval represented by samples 76896, 76899, and 76900 will receive special consideration later. With the exception of these three samples, there is a significant planktonic component to the faunas, which ranges from approximately 15 percent to well over 75 percent. It indicates that the Toolonga Calcilutite and Korojon Calcarenite were deposited in an open marine environment, with significant influence of surface currents bearing planktonic foraminifera.

The three criteria which serve to distinguish the Toolonga Calcilutite from the Korojon Calcarenite, namely the lithology, percent Cibicides succedens Brotzen in the benthonic component, and percent Rugoglobigerina rugosa (Plummer) in the planktonic component, have implications for the differences in environment of deposition of the two formations.

The Toolonga Calcilutite is a mainly fine-grained calcareous unit, whereas the Korojon Calcarenite has a much higher proportion of sand-size material. In essence, however, the only difference between the two formations is the presence of significant organic debris in the Korojon. This debris is in the form of fragments, of various sizes, of the giant pelecypod Inoceramus, as well as other molluscs and echinoderms, and is contained in a calcareous mud matrix otherwise equivalent to that of the Toolonga.

A simplistic view would be that the Toolonga Calcilutite was deposited in a deeper water environment than the Korojon Calcarenite. The consequent lower mechanical energy would account for the finer-grained nature of the Toolonga. This view was expressed by Condon (1968). However, it is entirely possible, and in the present author's opinion, perhaps more likely, that the Toolonga represents deposition in as shallow, if not a shallower, part of the Carnavon Basin than that in which the Korojon Calcarenite was deposited.

Although a more thorough analysis of the distribution of these two units within the Carnavon Basin is required, in general, the Toolonga Calcilutite is more widespread and is known even from the margins of the basin. The Korojon Calcarenite is restricted to the northern half of the basin, and is central, not marginal. It is very difficult to imagine the marginal unit representing deposition in significantly deeper waters than the central unit, unless an unusual basin configuration is postulated.

Assuming that the sediments of the Korojon Calcarenite have not been transported over significant distances, it would seem reasonable to suppose that the Korojon represents deposition on or near shell banks dominated by Inoceramus. This hypothesis was advanced by Condon (1968).

The present author proposes that the Carnarvon Basin was, at the time of deposition of the Toolonga Calcilutite, a shallow, warm, open marine shelf, without significant influx of terrigenous detritus. This would permit the deposition of calcareous muds, and the development of a fairly abundant and diverse foraminiferal fauna.

Some set of circumstances then allowed the development of localized but extensive shell banks, in that part of the Carnarvon Basin represented by the Korojon Calcarenite. This may have included some stabilization of the calcareous mud substrate to provide a suitable foundation for the formation of shell banks. Probably, part of the shelf, above wave base, was brought into the zone of strong wave action. This would have encouraged organic activity, and the growth of shell banks based on the initial abundant growth. This would occur in much the same way that reefs grow in the zone of breaking waves in modern seas.

This high mechanical wave energy would also account for the high mechanical destruction of the valves of Inoceramus and other organic debris, which characterizes the Korojon Calcarenite.

The persistence of the Toolonga Calcilutite farther south and east, to the margins of the Carnarvon Basin, as a lateral equivalent of the Korojon Calcarenite, is consistent, if not indeed more reasonable, with this model. A proper examination of the distribution of these two formations in the Carnarvon Basin, with particular attention paid to field relationships, and the paleoslopes, is critical to the resolution of this problem.

The Korojon Calcarenite is distinguished from the Toolonga Calcilutite by the much higher abundance of Cibicides succedens in the former, and the almost complete absence of this species from the latter formation. C. succedens is an attached foraminifer, if the habit of this genus has remained the same since the Cretaceous. The nature of

the substrate to which it would be attached may be critical to the present discussion. If it were attached to plants, this would imply that the Korojon was deposited in the photic zone, unless the species were attached to floating vegetation, and fell from this to bottom depths beyond the photic zone. The absence of this species from the Toolonga might imply deposition beyond the photic zone. There is nothing, however, to suggest that C. succedens need have been attached to plants. This author proposes that the high abundance of C. succedens in the Korojon Calcarenite was caused by the presence of extensive shell banks, which served as a stable substrate for this attached foraminifer. The absence of this species from the Toolonga would have been due to the lack of sufficient stable substrate in the carbonate muds of the shallow marine shelf which formed the Toolonga Calcilutite.

Further support for a shallow water origin for the Toolonga Calcilutite is found in the lowermost part of that formation, represented by samples 76896, 76899, and 76900. The foraminifera of these samples exhibit no solution effects. It seems unreasonable, therefore, to explain the very low planktonic:benthonic ratio on the basis of solution of planktonic foraminifera below the calcite compensation depth. The very low planktonic:benthonic ratio would be much more easily explained by hypothesizing that this part of the Toolonga was deposited in waters too shallow to be significantly influenced by surface marine currents and their associated planktonic foraminifera. This is of course consistent with the view, held by most authors, that the Toolonga is the first unit of a calcareous succession which transgressed, following the regression at the close of deposition of the Gearle Siltstone. The near-shore and/or shallow water location of these samples, above wave base, would result in much reduced oxygenation. The relatively lower oxygen levels would restrict or limit the amount of organic activity

in the waters, which could explain the very low foram number. This foram number may, however, be influenced by sedimentation rates as much as by levels of organic activity. This near-shore environment may also have been characterized by abnormal salinities. Such salinities are characteristically tolerated more readily by arenaceous forms, which are unusually abundant in these samples, though not to the same extent as in the Gearle Siltstone.

The marked difference between the percent abundance of Rugoglobigerina rugosa in the Korojon and the Toolonga almost certainly has implications for the nature of the surface currents which influenced the area of deposition of the two formations.

R. rugosa is not only relatively much more abundant in the Korojon, but the specimens on average achieve a much larger size, with a wider, more open umbilicus. An index of this is the fact that R. rugosa occurs in the >60 mesh fraction of only four of the samples of the Toolonga, with a maximum abundance of 14 percent. By comparison, this species always comprises well over 60 percent of the planktonic component of the >60 mesh fraction in the Korojon.

This size reduction of R. rugosa in the Toolonga is almost certainly not a depositional effect, however, as abundant specimens of Globotruncana occur in the >60 mesh fraction of samples of the Toolonga for which the planktonic component is significant. It would also be reasonable to expect any current sorting of foraminifera to have an approximately equal effect on specimens of both genera, as their overall shape, and hence hydrodynamic properties, are not much different.

The possibility exists that the specimens of R. rugosa in the Toolonga are predominantly juveniles, not adult specimens, or that they are some ecophenotypic variant. The relative size of the umbilicus is known, from breaking down adult specimens one chamber at a time, to

increase in the ontogeny of individuals. One would be hard pressed to explain the absence of adult specimens in the Toolonga, however.

Whatever the explanation, the difference between the percent abundance of R. rugosa in samples from the Korojon Calcarenite and in those from the Toolonga Calcilutite points to some difference in the nature of the surface waters at the sites of deposition. This may well be an effect of nutrient supply, which could differ between waters over a shallow, relatively quiet marine shelf and a deeper, more turbulent shell bank with abundant organic activity. It is impossible to explore this subject further in the present study.

There seems to be little doubt that the Korojon Calcarenite is the record of extensive shell banks, dominated by the pelecypod Inoceramus, that existed on a warm, fairly shallow, open marine shelf or epicontinental sea. Condon (1968) proposed that the Toolonga Calcilutite represented deposition in deeper, quieter waters of the Carnarvon Basin. However, it is the present author's opinion that the Toolonga Calcilutite represents deposition of calcareous muds on a slightly more shallow, warm, open marine shelf or epicontinental sea, quite possibly above wave base. Some processes occurred to deepen and/or stabilize part of this shelf, such that strong wave action was able to stimulate abundant organic activity and growth of the shell banks preserved as the Korojon Calcarenite. Deposition of the Toolonga Calcilutite as shallow water calcareous muds, without significant organic detritus, continued farther south and east, contemporaneous with the Korojon Calcarenite, at least in part.

This may be supported by Belford's (1959) conclusion that "the Campanian beds of Western Australia were deposited in a shallow epicontinental sea" (ibid., p.640). Belford elaborated no further, however, on the environment of deposition of each of the Toolonga Calcilutite and Korojon Calcarenite.

CHAPTER 6. PALEOBIOGEOGRAPHY OF C-Y CREEK.

6.1. INTRODUCTION.

The Late Cretaceous was characterized by three biogeographic provinces, the Tethyan, Boreal or Pacifican (Northern Hemisphere) or Austral (Southern Hemisphere), and the Transitional (Douglas and Rankin, 1969; Scheibnerová, 1971; Douglas, 1972; Scheibnerová, 1973; and Sliter, 1976). These provinces correspond to watermasses, with the Tethyan being the warmer, approximately equatorial or tropical watermass, the Boreal or Austral being the colder, subpolar watermass, and the Transitional being transitional between the other two. These watermasses, or provinces as they will hereafter be referred to, were characterized by certain faunal associations, including planktonic foraminifera.

Although the planktonic foraminiferal faunas of C-Y Creek have implications for the paleobiogeoprovince to which the Carnavon Basin belonged, they do not have direct significance for the paleolatitude of Australia. The watermass properties were dependent on the distribution of landmasses and the circulation patterns and nature of major ocean currents.

Excellent and quite detailed discussions of the distribution of landmasses and oceanic circulation patterns are given by Berggren and Hollister (1974) and Sliter (1976), and in less detail by other authors. The reader is referred to these other papers, as no attempt will be made herein to describe these subjects. No observations were made during the course of the present study to permit the contribution of significant new information about landmass distribution or current patterns.

The planktonic foraminiferal faunas of the present study will be examined, on a gross scale, with reference to each of the three Late Cretaceous biogeoprovinces, namely the Tethyan, Austral, and Transitional. It must be noted that the Boreal and Austral biogeoprovinces

are characterized by the same faunas (Scheibnerová, 1971; Scheibnerová, 1973; Sliter, 1976). The reader is referred particularly to Figure 12 of Sliter (1976), which summarizes the occurrence of species within these three biogeoprovinces

6.2. PALEOBIOGEOGRAPHY OF THE CARNARVON BASIN.

The Austral biogeoprovince was characterized, in the Late Cretaceous, by a low diversity planktonic foraminiferal fauna either dominated by Hedbergella and other globigerine forms, or with a subequal number of keeled specimens, few of them single keeled, plus heterohellicids and Globigerinelloides. The heterohellicid fauna was of much lower diversity than that of the Tethyan province (Sliter, 1968; Douglas and Rankin, 1969; Douglas, 1972; Scheibnerová, 1973; Sliter, 1976). Berggren and Hollister (1974) felt that Heterohelix and Globigerinelloides were numerically the most important constituents of the Austral planktonic foraminiferal faunas. What characterizes the Austral province is the absence of the species which characterize the Tethyan and Transitional provinces, and concurrent increased abundance of the species present in it.

Scheibnerová (1971) characterized the biogeoprovinces by their benthonic foraminifera, but it is the opinion of the present author that this is not a sound practice. The facies control of benthonic foraminifera is too strong to allow them to be used to characterize biogeoprovinces. For example, Scheibnerová (1971) characterized the Boreal (equivalent to the Austral) province by a dominance of arenaceous specimens in the benthos. However, dominance of arenaceous forms may be caused by conditions of the bottom watermass properties that are independent of the biogeoprovince, or surface watermass properties. There are other problems with the work of that author, which include her contention that the genera Hedbergella and Praeglobotruncana are unknown

from strata younger than Coniacian, and her inclusion of Heterohelix and Rugoglobigerina in the benthos.

The faunas of the present study are dominated by Rugoglobigerina rugosa, and various double-keeled species of Globotruncana, including G. fornicata, G. linneiana, and G. bulloides, which may be the equivalent of G. marginata sensu Sliter, 1976. These species were thought by Sliter (1976) to be restricted to the Tethyan and Transitional provinces. The dominance of Hedbergella thought to characterize the Austral province is not observed in the present study. It seems safe to conclude, therefore, that the faunas of C-Y Creek did not belong to the Austral biogeoprovince.

The Tethyan province was characterized, in the Late Cretaceous, by the maximum diversity of planktonic foraminifera (several authors), and is the only province uniquely characterized by certain species. According to Sliter (1968), the Tethyan biogeoprovince was characterized by the genera Abathomphalus, Plummerita, and Trinitella, and a number of species. Of these species, Sliter (1976) reassigned all but Globotruncana gansseri to both the Tethyan and Transitional provinces, which latter province he had not recognized in 1968. Scheibnerová (1973) proposed that all globotruncanids were tropical or Tethyan, but this is at extreme variance with other authors, and is not regarded herein as a valid criterion of the Tethyan province.

Berggren and Hollister (1974) included Praeglobotruncana havanensis as a diagnostic member of the Tethyan fauna, but Sliter (1976) felt that this species was found in Tethyan, Transitional, and rarely Austral, faunas. Sliter (1968) had felt that Rugoglobigerina rugosa was a characteristic warm-water species, but in that paper had not recognized the existence of the Transitional province as such. His paper of 1976 extended the occurrence of that species beyond the Tethyan to include

the Transitional province. Two single-keeled species, Globotruncana calcarata and G. aegyptiaca, were included by Sliter (1976) in the list of species diagnostic of the Tethys.

All of the species in that list are absent from the present study. The absence of these species is by no means conclusive proof that the Carnarvon Basin was not a part of the Tethyan biogeoprovince in the Late Cretaceous, but it is highly suggestive of that.

The Transitional biogeoprovince has been recognized by a number of authors, but the work of Sliter (1976) is followed herein, because his paper lists clearly the species composition of this province's foraminiferal fauna. Other workers to a greater or lesser extent support his work, occasionally on the basis of their reports of characteristically Tethyan or Austral species occurring, in reduced abundances, in other provinces.

According to Sliter (1976), the species Rugoglobigerina rugosa, R. macrocephala, Globotruncana contusa, G. elevata, G. fornicata, G. linneiana, G. ventricosa, Gublerina cuvillieri, Pseudotextularia elegans, and Racemiguembelina fructicosa all are characteristic of both the Tethyan and Transitional faunas, but never those of the Austral province. On the basis of this, and the absence of all species thought by Sliter to be diagnostic of the Tethyan biogeoprovince in the Late Cretaceous, the foraminiferal faunas at C-Y Creek are herein assigned to the Transitional biogeoprovince.

The discussion of any implications this has for the paleogeography of Australia and the associated oceanic circulation patterns of the Late Cretaceous will not be undertaken herein, because there is not a sufficient basis in the present study for such a discussion. It is noted, however, that Sliter (1976) assigned the Carnarvon Basin foraminiferal faunas of Edgell (1957) and Belford (1960) to the Transitional biogeoprovince of the Late Cretaceous.

CHAPTER 7. CONCLUSIONS.

1. The Upper Cretaceous foraminifera of C-Y Creek, Western Australia, are seen to comprise a qualitatively diverse and abundant fauna, with 92 genera and 268 species and subspecies identified by the present author. There are 22 genera and 50 species of agglutinated foraminifera, 2 genera and 2 species of porcellaneous foraminifera, and 68 genera and 215 species with 2 subspecies of calcareous perforate foraminifera, which are numerically the most important forms.

Qualitatively, the planktonic component is remarkably constant in species composition throughout the succession at C-Y Creek, with only 9 genera and 24 species. The planktonics are, however, quite important to the local biostratigraphy.

Of the 268 species and subspecies identified by the present author, 38 species belonging to 29 genera could not be identified. A number of these species are considered to be probable new species, but many could not be identified at species level due to insufficient numbers of specimens and/or poorly preserved specimens.

2. The Upper Cretaceous foraminiferal faunas of C-Y Creek allow the resolution of a major stratigraphic problem with this succession, and they also provide information pertaining to other matters of interest.

The presence or absence of the Toolonga Calcilutite at C-Y Creek has long been a matter of controversy. It is the present author's opinion that a calcilutite can be consistently and reliably distinguished from the Korojon Calcarenite on the basis of hand specimen examination alone. This calcilutite is thought to be the Toolonga Calcilutite.

Evidence for a major difference between these two units, the calcilutite and the calcarenite, is also found in the foraminiferal faunas. This evidence is thought by the present author to support the

recognition of the Toolonga Calcilutite as a distinct formation at C-Y Creek. The Korojon Calcarenite is quite readily distinguished from the Toolonga Calcilutite at C-Y Creek by virtue of the former formation's much higher percent abundances of the planktonic species Rugoglobigerina rugosa (Plummer) and the benthonic species Cibicides succedens Brotzen. The present author recognizes, however, that thorough field work is desired to establish conclusively whether or not the calcilutite below the Korojon Calcarenite at C-Y Creek is indeed the Toolonga Calcilutite.

The Gearle Siltstone is readily distinguished by its dark, laminated, clastic lithology from both the Toolonga Calcilutite and Korojon Calcarenite. The Gearle may also be distinguished by its foraminiferal fauna, which is overwhelmingly arenaceous.

3. The foraminiferal faunas can be used to characterize not only the three formations examined in the present study, but also intervals within those formations, to allow detailed local correlation. This process of detailed local correlation was necessitated by the exposure of the formations at best in partial sections of the complete succession. The results of this procedure cannot, at present, be evaluated. In order to verify the results obtained herein, trends in the composition of the foraminiferal faunas from other measured sections would have to be compared to the trends of the present study.

4. The foraminiferal faunas allow somewhat imprecise correlation of the Upper Cretaceous formations at C-Y Creek with the standard European stages. The upper portion of the Gearle Siltstone is thought to be of possible, but not undoubted, Turonian age.

The Toolonga Calcilutite is thought to have been deposited beginning some time in the Santonian and terminating well into the Campanian. The Korojon Calcarenite is determined to have been deposited beginning in Mid, or perhaps latest Early Campanian time. The uppermost sample

of the Korojon Calcarenite, which is of indeterminate vertical distance below the overlying Miria Marl, is of undoubted Early Maastrichtian age.

All age determinations of the present study are in accord with those advanced or supported by the majority of foraminiferal studies for the Carnarvon Basin.

5. The foraminiferal faunas are very important to the interpretation of the depositional environments of the three formations examined in the present study.

The Gearle Siltstone is the first formation of the Upper Cretaceous succession at C-Y Creek. It was deposited by a regressing sea, and marks the termination of the predominantly terrigenous clastic Winning Group. The Gearle almost certainly was deposited in a shallow water, lagoonal basin isolated from most open marine influences. The resultant abnormally low salinities were responsible for the overwhelmingly arenaceous foraminiferal fauna of the Gearle.

Following a period of erosion, transgression occurred, resulting in deposition of the open marine, predominantly calcareous sediments of the Toolonga Calcilutite and Korojon Calcarenite.

Unlike previous authors who interpreted the Toolonga Calcilutite as a deeper water sediment than the Korojon Calcarenite, the present author interprets the Toolonga as a shallow water deposit.

The transgression produced a shallow, warm, open marine shelf, which was characterized by a minimal influx of terrigenous detritus. The calcareous muds which were deposited on this shelf, and qualitatively abundant and diverse foraminiferal fauna, were preserved as the Toolonga Calcilutite. Locally, the growth of Inoceramus-dominated shell banks was initiated by some unknown process, and the resultant sediments and rich foraminiferal faunas were preserved as the Korojon Calcarenite.

There was no evidence in the present suite of samples pertaining to the close of deposition of the Korojon Calcarenite, because the uppermost Korojon possibly was not sampled.

6. The planktonic component of the foraminiferal faunas at C-Y Creek compares favourably with that fauna thought by Sliter (1976) to characterize a biogeoprovince transitional from the warmer Tethyan to colder Austral or Boreal biogeoprovince. The present biogeoprovince is known as the Transitional biogeoprovince.

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APPENDIX I.

SAMPLE LITHOLOGIES, STRATIGRAPHIC RELATIONSHIPS, AND PROCESSING DATA.

The reader is referred to section 1.3.1, "Location and Details of Sampling", and Figures 1 and 2, for the exact location of the samples described below. In the following descriptions, "b.p.s." means "below previous sample", and "a.p.s." means "above previous sample".

- 76865 - Hard, brittle, light buff-tan coloured, almost chalky calcarenite(?), low specific gravity. 25.45 g processed; hammered.
- 76866 - Hard, brittle, bleached to chalky calcarenite(?), low specific gravity; some bryozoal material. 21.03 g processed; hammered.
- 76867 - Hard, brittle, bleached looking calcarenite(?), low specific gravity; with bryozoal(?) material; weathers mid-brown. 26.98 g processed; hammered.
- 76868 - Soft, non-laminated, very pale creamy grey calcarenite; with large Inoceramus fragments, and abundant prisms. 13.58 g processed.
- 76869 - Unconsolidated, light grey-brown ~~fine-grained~~ sediment; with uncommon Inoceramus fragments, and prisms; abundant Recent organic debris. 23.44 g processed, not scraped.
- 76870 - Very soft, friable, creamy brown calcarenite; with Inoceramus fragments (1-2 mm) and prisms. 11.95 g processed, too soft and friable to scrape completely.
- 76871 - 1 m b.p.s. - Very soft, friable creamy brown calcarenite; some Inoceramus plates and fragments, abundant prisms. 12.45 g processed.
- 76872 - 1 m b.p.s. - Very soft, friable, light grey calcarenite; large plates and fragments of Inoceramus, abundant prisms. 11.44 g processed.

- 76873 - 2 m b.p.s. - Very soft, friable, waxy-feeling grey-brown calcarenite; large plates and fragments of Inoceramus, and prisms, visible as pink to cream-coloured against dark matrix. 11.37 g processed.
- 76874 - 2 m b.p.s. - Very soft, friable, dark grey-brown calcarenite; abundant Inoceramus fragments and some prisms, visible as in 76873. 10.41 g processed.
- 76875 - 1 m b.p.s. - Very soft, friable, waxy, dark brown calcarenite; small fragments and uncommon prisms of Inoceramus visible as in 76873; abundant green internal molds of planktonic foraminifera. 10.32 g processed.
- 76876 - 2 m b.p.s. - Soft, friable, creamy calcarenite; abundant Inoceramus fragments and prisms. 10.06 g processed.
- 76877 - x m b.p.s. - Hard, cream-coloured to bleached-looking calcarenite; abundant Inoceramus fragments and prisms. 10.12 g processed; hammered.
- 76878 - 1.85 m b.p.s. - Very soft, friable, waxy, creamy golden-brown calcarenite; with abundant Inoceramus fragments and prisms. 10.38 g processed.
- 76879 - Soft, friable, creamy white calcarenite; abundant Inoceramus fragments and prisms. 9.45 g processed.
- 76880 - 1.25 m b.p.s. - Soft, friable, creamy yellow-brown calcarenite, porous; with abundant Inoceramus fragments and prisms. 9.76 g processed.
- 76881 - 1.5 m b.p.s. - Very soft, friable, creamy brown calcarenite, porous; with abundant Inoceramus fragments and prisms. 10.10 g processed.

- 76882 - Soft, friable, yellow-brown to straw-coloured calcarenite; large plates, abundant fragments and prisms of Inoceramus. 10.47 g processed.
- 76883 - 2 m b.p.s. - Soft, friable, dark yellow-brown calcarenite; Inoceramus prisms uncommon; abundant green internal molds of foraminifera. 9.85 g processed.
- 76884 - Soft, friable, straw-coloured calcarenite; some Inoceramus plates and fragments, abundant prisms; some green internal molds of foraminifera. 11.11 g processed.
- 76885 - Soft, waxy, mid to dark brown-yellow calcarenite; some Inoceramus fragments and abundant prisms; few green internal molds of foraminifera. 10.04 g processed.
- 76886 - Soft, waxy, mid grey-brown calcarenite; Inoceramus fragments and prisms uncommon. 10.37 g processed.
- 76887 - 1.75 m b.p.s. - Soft, friable, brittle, light grey-brown calcarenite; several large Inoceramus fragments, and prisms. 10.85 g processed.
- 76888 - Soft, fairly dark green-brown calcilutite; weathered into small (2-3 mm) fragments; few Inoceramus fragments; much gypsum as large irregular crystals. 20.60 g processed; not scraped.
- 76889 - Soft, friable, brittle, light green-grey calcilutite; much gypsum as large irregular crystals. 20.10 g processed; most not scraped.
- 76890 - Hard, brittle, creamy coloured calcarenite; some Inoceramus fragments and abundant prisms. 20.66 g processed.
- 76891 - Hard, brittle, light creamy yellow-brown calcarenite; abundant Inoceramus fragments and prisms. 11.21 g processed; hammered, but thereafter was friable.

- 76892 - Soft, waxy, dark brown-grey calcarenite; common Inoceramus fragments and some prisms, visible as in 76873. 10.96 g processed.
- 76893 - 1.5 m a.p.s. - Soft, friable, brittle, creamy grey calcarenite; several fragments of Inoceramus, and prisms. 11.42 g processed.
- 76894 - Soft, brittle, creamy yellow-brown calcilutite; weathered to angular fragments 0.5 to 1.5 cm; with large irregular crystals of gypsum. 4.93 g processed.
- 76895 - Soft, friable, brittle, cream to pale green calcilutite; weathered to angular fragments 0.5 to 2.0 cm. 5.97 g processed; difficult to scrape.
- 76896 - Soft, waxy, grey-green calcilutite; with large gypsum crystals. 14.76 g processed.
- 76897 - 0.05 m b.p.s. - Very soft, strongly waxy and coherent, very dark brown-grey mudstone; laminated with alternating light and dark layers on the order of 1 mm thick, undulating and not of constant thickness in hand specimen, with slight parting tendency along laminations; some brittle oxide patches, on the order of 1-2 mm diameter; very little calcareous content in sediment proper. 25.27 g processed.
- 76898 - 1 m b.p.s. - Very soft, waxy, but more brittle than 76897, dark grey-brown mudstone; with thin undulating colour laminations on order of 1 mm, that serve as parting planes; very little calcareous content. 25.10 g processed.
- 76899 - Soft, brittle, somewhat waxy, light green-grey calcilutite; some small oxide patches. 15.22 g processed.
- 76900 - 0.9 m a.p.s. - Soft, brittle, light creamy grey calcilutite, porous; some small oxide patches. 16.80 g processed.

76901 - 0.3 m below sample 76899 - Soft, very waxy, coherent, very dark brown-grey mudstone; well and thinly laminated as in 76897 and 76898; with oxide patches. 23.37 g processed.

76902 - 2 m above sample 76900 - Soft, brittle, creamy calcilutite; some associated gypsum. 22.29 g processed.

76903 - Soft, brittle, creamy to chalky calcilutite, porous; associated gypsum. 22.37 g processed.

76904 - Soft, waxy, green-grey calcilutite; poorly laminated. 22.23 g processed.

APPENDIX II.

PROCESSING OF SAMPLES FOR EXTRACTION OF FORAMINIFERA.

The aim of processing the samples examined in the course of the current study was to enable the extraction of a representative association (i.e. 300 foraminifera or more) of the foraminiferal fauna from each mesh fraction of each sample, and to obtain representatives of a major proportion of the species present in each sample.

To that end, normally between 9.0 and 26.0 grams of dry sediment were processed, using the following procedure.

1. As few and as large pieces of sample as possible, on the order of 10-25 g, are scraped clean of surface contamination using a knife or spatula blade, which is wiped clean after each pass.
2. The sample is then weighed, and broken into pieces on the order of fingernail size, which are then placed in a beaker half-filled with water. This is then placed on a hot plate, but not brought to boiling, for as long as is required for the majority of the sample to disaggregate.
3. Lumps which are not yet disaggregated are gently crushed in a mortar using a pestle, or in the beaker using a glass rod, until no significant lumps remain which can be disaggregated.
4. The sample is left to cool, and a nest of sieves is set up, using, in order down the nest, 35, 60, 120 and 230 U.S. standard sieve sizes. These sizes correspond to screen openings of 0.500, 0.250, 0.125, and 0.063 mm respectively. That is, all material whose minimum diameter is less than sand size passes through the bottom sieve and is not retained.
5. The disaggregated sample, which is still in the beaker, is placed in an ultrasonic vibrator for 15 seconds to remove much fine

material still adhering to large particles and foraminifera, and then is washed through the nest of sieves.

6. Each mesh fraction, starting with the 35 mesh fraction and working down, is then returned to a beaker. It is then ultrasonically vibrated for one or two periods of 15 seconds, then washed through the sieve from which it was taken, and all the remaining sieves, set up as a nest.

7. All four mesh fractions are then washed into separate dishes of known weight and dried, after which they are weighed. Because the disaggregation was rarely 100% complete, no significance is attached in the present study to the weights so obtained. All that can be determined using the sample weight and the four mesh fraction weights is the minimum percent of silt plus clay-size material in the sample.

8. The material for each mesh fraction is transferred to a folded paper "envelope", labelled, which is then placed in a labelled resealable sterilized plastic bag. The material is subsequently examined for foraminifera, which are picked according to the procedure outlined in section 1.3.2, Method of Study.

Exceptions to the procedure outlined above are noted in Appendix I at each sample for which they occurred. They belong to one of two categories.

If a sample was too hard to be broken by hand or knife into fingernail-size pieces, it was wrapped in several layers of newspaper and struck with a metal hammer to reduce it to suitably small pieces. Such samples are usually described as "Hard,...", and have the note "hammered" after the weight of sample processed. Usually, samples processed in this manner did not disaggregate to any great extent, even after addition of H_2O_2 .

There were some samples which consisted of unconsolidated or highly weathered material in pieces too small to scrape to remove surface contamination. There were also a few samples which occurred as large enough pieces to scrape, but they were too soft, and crumbled when even slight pressure was applied to scrape them. Such samples have the note "not scraped" after the weight of sample processed.

Sample No.	Species
76888	Verneullina cretosa
76889	Verneullina parri
76904	Gaudryina austinapa
76894	Gaudryina convexa
76895	Gaudryina faujasi
76903	Gaudryina glabrella
76902	Gaudryina laevigata
76900	Gaudryina pulvina
76899	Gaudryina pyramidata
76896	Gaudryina rugosa
76897	Gaudryina sp.
76901	Heterostomella austinana
76898	Pseudospiro. compressiuscula

Appendix IIIc. Occurrence of species by sample, in stratigraphic order,
Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species									
	Nodosaria affinis									
	Nodosaria aspera									
	Nodosaria limbata									
	Nodosaria obscura									
	Nodosaria proboscidea									
	Astacolus cretaceus									
	Astacolus sp.									
	Chrysalogonium cretaceum									
	Citharina geisendörferi									
	C. sp. cf. C. strigillata									
	Citharina sp. A									
	Citharina sp. B									
	Dentalina alternata									
76888	X									
76889	X									
76904	X	X								
76894	X									
76895	X	X								
76903		X								
76902		X								
76900										
76899										
76896										
76897										
76901										
76898										

Appendix IIIe. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species
76888	Lagena semiinterrupta
76889	Lagena semiornata
76904	Lagena sulcata
76894	Lagena trigona
76895	Lagena sp. A
76903	Lagena sp. B
76902	Lenticulina davisi
76900	Lenticulina isidis
76899	Lenticulina macrodisca
76896	Lenticulina mediolodensis
76897	Lenticulina modesta
76901	Lenticulina oblonga
76898	Lenticulina ovalis

Appendix IIIh. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species									
	Lenticulina pseudosecans									
	Lenticulina revoluta									
	Lenticulina rotulata									
	Lenticulina spissocostata									
	Lenticulina subangulata									
	Lenticulina velascoensis									
	Lenticulina williamsoni									
	Marginulina bullata									
	Marginulina curvatura									
	Marginulina directa									
	Marginulina jonesi									
	Marginulina obliquinoda									
	Marginulina reiseri									
76888	X	X								
76889	X	X	X							
76904	X	X	X							
76894			X							
76895		X	X							
76903	X		X							
76902	X	X	X							
76900			X							
76899			X							
76896			X							
76897										
76901										
76898			X							

Appendix IIII. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species
76888	X Marginulina trunculata
76889	X Neoflabellina reticulata
76904	X Neoflabellina rugosa
76894	X Planularia dissona
76895	X Planularia liebusi
76903	X Planularia striolata
76902	X Pseudonodosaria appressa
76900	X Pseudonodosaria humilis
76899	X Pseudonodosaria manifesta
76896	X Pseudonodosaria obesa
76897	X Pseudonodosaria parallela
76901	X Saracenaria navicula
76898	X Saracenaria pseudonavicula

Appendix IIIj. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species											
76888	X											
76889		X										
76904	X											
76894	X											
76895												
76903		X										
76902	X	X										
76900												
76899												
76896	X											
76897												
76901												
76898												

Appendix IIII. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species
76888	Fissurina sandiegoensis
76889	Fissurina seguenziana
76904	Fissurina semiconcentrica
76894	Praebulimina carseyae
76895	Praebulimina cushmani
76903	Praebulimina kickapoensis
76902	Praebulimina navarroensis
76900	Praebulimina reussi
76899	Pyramidina proluxa
76896	Pyramidina triangularis
	Bolivina incrassata gigantea
76897	Bolivinoidea compressa
76901	B. decorata australis
76898	

Appendix IIIa. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcillite.

Sample No.	Species
76888	<i>Bolivinoidea decorata gigantea</i>
76889	<i>Bolivinoidea draco draco</i>
76904	<i>Loxostomoidea sp.</i>
76894	<i>Eouvigerina americana</i>
76895	<i>Eouvigerina gracilis</i>
76903	<i>Stilostomella horridens</i>
76902	<i>Stilostomella pseudoscripta</i>
76900	<i>Reussella cimbrica</i>
76899	<i>Reussella szajnochae</i>
76896	<i>Pseudouvigerina cristata</i>
76897	<i>Pseudouvigerina sp.</i>
76901	<i>Conorbina sigmoidalis</i>
76898	<i>Conorbina supracretacea</i>

Appendix IIIIn. Occurrence of species by sample, in stratigraphic order,
 Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species
76888	Epistominella sp.
76889	Heronallenia minuta
76904	Heronallenia sp.
76894	Valvulineria infrequens
76895	Valvulineria lenticula
76903	Valvulineria nonionoides
76902	Valvulineria undulata
76900	Nuttallinella coronula
76899	Heterohelix globulosa
76896	Heterohelix pulchra
76897	Gublerina cuvillieri
76901	Gublerina sp. A
76898	Gublerina sp. B

Appendix IIIo. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species
76888	X Pseudotextularia elegans
76889	X Racemiguembelina fructicosa
76904	X Globigerinelloides alvarezi
76894	X Globigerinelloides multispina
76895	G. subcarinatus
76903	X Globigerinelloides volutus
76902	Hedbergella planispira
76900	Praeglobotruncana havanensis
76899	Globotruncana arca
76896	X Globotruncana bulloides
76897	Globotruncana contusa
76901	Globotruncana elevata
76898	X Globotruncana fornicata

Appendix IIIp. Occurrence of species by sample, in stratigraphic order,
Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species										
	Cibicides ribbingi										
	Cibicides succedens	X				X					
	Cibicides sp.										
	Planorbulina sp.										
	Carpenteria globosa					X					
	Pleurostomella subnodosa					X					
	Ellipsoglandulina sp.										
	Ellipsoidella binaria						X				
	Ellipsoidella solida						X				
	Bandyella greatvalleyensis						X				
	Coryphostoma plaita										
	Loxostomum eleyi										
	Quadriform. akomorphinoides										
76888											X
76889											X
76904											X
76894											X
76895											
76903											X
76902							X				X
76900											
76899										X	
76896											
76897											
76901											
76898											

Appendix IIIr. Occurrence of species by sample, in stratigraphic order, Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species
76888	Globorotalites conicus
76889	Globorotalites multiseptus
76904	Globorotalites umbilicatus
76894	Gyroidinoides bandyi
76895	Gyroidinoides girardanus
76903	Gyroidinoides globosus
76902	Gyroidinoides nodus
76900	Gyroidinoides (?) sp.
76899	Anomalinoidea rubiginosa
76896	Angulogavelinella sp. A
76897	Angulogavelinella sp. B
76901	Gavelinella canalicula
76898	Gavelinella cayeuxi

Appendix Ilt. Occurrence of species by sample, in stratigraphic order,
Gearle Siltstone and Toolonga Calcilutite.

Sample No.	Species											
	Bathysiphon alexanderi											
	Webbinelloidea similis		X									
	Webbinelloidea sp.			X								
	Ammodiscus cretaceus				X							
	Glomospira charoides					X						
	Glomospira gordialis						X					
	Turritella sp.							X				
	Silicosigmoilina californica								X			
	Haplophragmoides advenus											
	Haplophragmoides formosus											
	Haplophragmoides fraseri											
	Haplophragmoides sp. A											
	Haplophragmoides sp. B											
76870				X								
76871			X			X				X		
76872		X				X				X		
76868			X			X	X			X		X
76873			X			X				X		
76874												
76875										X		
76876		X					X	X				
76877												
76879		X				X						
76878			X			X				X		
76880		X				X	X					
76881		X				X					X	
76891							X			X		
76882				X		X						
76883			X							X		
76884										X		
76885			X	X						X		
76886				X						X		
76887		X	X			X				X		
76890		X				X	X			X		
76893		X				X	X			X		
76892			X							X		

Appendix IVa. Occurrence of species by sample, in stratigraphic order,
Korojon Calcarenite.

Sample No.	Species											
76870												
76871						X				X		
76872						X				X		
76868							X			X		
76873							X			X		
76874							X			X		
76875										X		
76876						X				X		
76877												
76879												
76878							X			X		
76880							X			X		
76881							X			X		
76891						X				X		X
76882						X				X		
76883							X			X		
76884							X			X		
76885						X	X			X		
76886						X	X			X		
76887							X			X		
76890						X				X		
76893						X	X			X		
76892							X			X		
	Haplophragmoides sp. C											
	Recurvoides sp. A											
	Recurvoides sp. B											
	Ammobaculites subcretaceus											
	Haplophragmium lueckei											
	Placopsilina sp.											
	Spiroplectamina grzybowskii											
	Spiroplectamina laevis											
	Spiroplectamina semicomplanata											
	Spiroplectamina sp.											
	Textularia subconica											
	Textularia sp.											
	Trochammina texana											

Appendix IVb. Occurrence of species by sample, in stratigraphic order,
Korojon Calcareenite.

Sample No.	Species											
76870	X		X									X
76871	X	X	X					X				X
76872		X	X									
76868	X											X
76873	X	X	X		X			X				X
76874	X	X		X	X			X		X		X
76875	X	X	X		X			X			X	X
76876	X	X	X					X			X	X
76877												
76879			X					X				
76878			X					X				
76880			X					X			X	X
76881	X		X					X		X		X
76891								X				X
76882			X					X				
76883	X	X	X		X			X			X	X
76884	X		X					X				X
76885	X		X					X				X
76886		X		X				X				X
76887	X		X					X				X
76890			X					X				X
76893	X	X	X					X				X
76892	X	X						X			X	

Appendix IVe. Occurrence of species by sample, in stratigraphic order, Korojon Calcarenite.

Sample No.	Species												
	Dentalina basiplanata												
	Dentalina sp. cf. D. basitorta												
	Dentalina catenula												
	Dentalina cylindroides												
	Dentalina gracilis												
	Dentalina legumen												
	Dentalina luma												
	Dentalina megalopolitana												
	Dentalina pertinens												
	Dentalinoides canulina												
	Dentalinoides sp.												
	Fronicularia bicuspidata												
	Fronicularia bulla												
76870	X			X		X	X		X	X			X
76871	X			X		X	X	X				X	
76872	X				X	X	X	X	X	X			
76868	X					X		X				X	
76873	X		X	X	X	X	X	X	X	X		X	
76874	X					X	X		X	X		X	
76875	X		X	X	X	X	X		X	X		X	
76876	X			X	X	X	X			X		X	
76877													
76879							X					X	
76878	X		X	X	X	X	X		X			X	
76880	X			X		X	X		X				
76881	X				X	X	X		X	X		X	
76891	X			X					X			X	
76882	X		X		X	X	X			X		X	
76883	X	X	X		X	X	X	X	X	X		X	
76884	X		X		X	X	X					X	
76885	X	X	X		X	X	X		X	X		X	
76886	X		X	X	X	X	X		X	X			
76887	X	X	X		X	X	X		X		X	X	
76890	X		X		X	X	X						
76893	X				X	X			X		X	X	
76892	X		X		X	X	X	X	X			X	

Appendix IVf. Occurrence of species by sample, in stratigraphic order.
Korojon Calcarenite.

7690

7689

SAMPLE NUMBER

7688

7687

7686

7685

7684

7683

4 4
OF / DE

Sample No.	Species									
76870	X									
76871	X	X	X	X		X	X	X	X	X
76872	X				X	X		X		X
76868								X		
76873	X			X		X				X
76874	X	X	X				X	X	X	X
76875			X				X		X	
76876			X				X		X	X
76877										
76879								X	X	X
76878	X	X					X	X	X	X
76880	X							X	X	
76881								X	X	
76891								X	X	
76882	X	X	X						X	X
76883		X	X						X	X
76884	X	X					X			
76885	X	X	X				X	X	X	X
76886	X	X	X					X	X	X
76887		X							X	X
76890									X	X
76893								X	X	
76892									X	X

Appendix IVk. Occurrence of species by sample, in stratigraphic order,
Korojon Calcarenite.

Sample No.	Species									
	Ramulina arkadelphiana									
	Ramulina bullardae									
	Ramulina globulifera									
	Ramulina muricata									
	Oolina apiculata									
	Oolina delicata									
	Oolina simplex									
	Fissurina alata									
	Fissurina auriculata									
	Fissurina fimbriata									
	Fissurina laticarinata									
	Fissurina marginata									
	Fissurina meyeriana									
76870	X	X	X	X	X	X	X	X	X	X
76871	X		X		X			X	X	X
76872				X	X	X		X		
76868		X	X		X	X	X		X	X
76873	X		X	X	X			X	X	
76874	X	X	X		X	X	X		X	
76875	X			X	X	X		X		X
76876	X		X	X	X				X	
76877										
76879			X					X		X
76878			X		X				X	X
76880					X		X		X	X
76881		X						X		X
76891								X		X
76882						X			X	X
76883	X		X		X				X	
76884			X	X	X			X		
76885			X		X	X		X		X
76886					X			X	X	X
76887			X		X			X	X	
76890			X					X	X	
76893					X			X		
76892			X		X			X	X	X

Appendix IV1. Occurrence of species by sample, in stratigraphic order,
Korojon Calcarenite.

Sample No.	Species													
76870	X													
76871														
76872														
76868														
76873				X										
76874				X										
76875					X									
76876														
76877														
76879														
76878														
76880														
76881														
76891														
76882														
76883														
76884				X										
76885														
76886														
76887														
76890														
76893				X										
76892														

Appendix IVn. Occurrence of species by sample, in stratigraphic order, Korojon Calcarenite.

Sample No.	Species											
	Epistominella sp.											
	Heronallenia minuta											
	Heronallenia sp.											
	Valvulineria infrequens											
	Valvulineria lenticula											
	Valvulineria nonionoides											
	Valvulineria undulata											
	Nuttallinella coronula											
	Heterohelix globulosa											
	Heterohelix pulchra											
	Gublerina cuvillieri											
	Gublerina sp. A											
	Gublerina sp. B											
76870	X	X								X		
76871	X	X	X							X		
76872	X	X			X					X		
76868	X	X				X				X		
76873		X			X	X				X		
76874		X				X				X		
76875		X				X				X		X
76876		X				X				X	X	
76877										X		
76879		X			X	X				X		
76878		X			X	X				X		X
76880		X				X	X			X		
76881		X				X	X			X	X	
76891		X				X	X			X		X
76882						X	X			X		X
76883						X	X			X		X
76884		X				X	X			X	X	X
76885		X				X	X			X	X	
76886		X				X	X			X		X
76887		X				X	X			X	X	
76890			X			X				X		
76893		X			X	X	X			X		
76892		X				X	X			X		

Appendix IVo. Occurrence of species by sample, in stratigraphic order,
Korojon Calcarenite.

Sample No.	Species									
	Globotruncana lapparenti									
	Globotruncana linneiana									
	Globotruncana ventricosa									
	Rugoglobigerina hexacamerata									
	Rugoglobigerina macrocephala									
	Rugoglobigerina rugosa									
	Eponides biconvexa									
	Eponides birdi									
	Eponides concinna									
	Eponides diversus									
	Planulina sp.									
	Cibicides beaumontianus									
	Cibicides excavatus									
76870			X							
76871			X							
76872			X							
76868			X							
76873	X		X							
76874			X							
76875			X							
76876			X							
76877			X							
76879			X							
76878			X							
76880			X							
76881			X							
76891			X							
76882			X							
76883			X							
76884			X	X						
76885	X		X	X						
76886			X	X						
76887			X	X						
76890			X	X						
76893			X	X						
76892	X		X							

Appendix IVq. Occurrence of species by sample, in stratigraphic order, Korojon Calcarenite.

sample No.	Species									
	Glorotalites conicus									
	Glorotalites multiseptus									
	Glorotalites umbilicatus									
	Gyroidinoides bandyi									
	Gyroidinoides girardanus									
	Gyroidinoides globosus									
	Gyroidinoides nodus									
	Gyroidinoides (?) sp.									
	Anomalinoides rubiginosa									
	Angulogavelinella sp. A									
	Angulogavelinella sp. B									
	Gavelinella canalicula									
	Gavelinella cayeuxi									
76870		X		X	X	X	X		X	X
76871					X	X	X		X	X
76872		X		X	X	X				X
76868					X	X		X		
76873	X	X		X	X	X	X		X	X
76874	X	X		X	X	X	X		X	X
76875	X	X		X	X	X		X		X
76876	X	X		X	X	X	X		X	X
76877						X		X		X
76879	X	X			X	X				X
76878	X	X			X	X	X	X		X
76880	X	X			X	X		X		X
76881	X	X			X	X	X	X		X
76891	X	X			X	X	X		X	X
76882	X	X		X		X		X	X	X
76883	X	X		X	X	X	X		X	X
76884	X	X	X	X	X	X	X		X	X
76885	X	X	X	X	X	X	X		X	X
76886	X	X	X	X	X	X	X		X	X
76887	X			X	X	X		X	X	X
76890									X	X
76893	X		X		X	X	X		X	X
76892	X	X		X	X	X	X	X	X	X

Appendix IVt. Occurrence of species by sample, in stratigraphic order, Korojon Calcarenite.

APPENDIX V.

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<i>triangularis</i>	113
<i>Pyrulina</i>	101
<i>cylindroides</i>	101
<i>Quadrimorphina</i>	162
<i>allomorphinoides</i>	162
<i>camerata</i>	162
<i>conica</i>	163
<i>minuta</i>	163
<i>sp. A</i>	163
<i>sp. B</i>	164
<i>sp. C</i>	165
<i>Quinqueloculina</i>	54
<i>sphaera</i>	54
<i>Racemiguembelina</i>	132
<i>fruticosa</i>	132
<i>Ramulina</i>	101
<i>arkadelphiana</i>	102
<i>bullardae</i>	102
<i>globulifera</i>	102
<i>muricata</i>	103
<i>Recurvoides</i>	36
<i>sp. A</i>	36
<i>sp. B</i>	36
<i>Reussella</i>	119
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<i>szajnochae</i>	119
<i>Rugoglobigerina</i>	145
<i>hexacamerata</i>	145
<i>macrocephala</i>	145
<i>rugosa</i>	146
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<i>navicula</i>	93
<i>pseudonavicula</i>	94

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triangularis	95
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Silicosigmoilina	32
californica	32
Spiroloculina	54
sp.	54
Spirotecta	167
pellicula	167
Spiroplectammina	39
grzybowskii	39
laevis	40
semicomplanata	40
sp.	41
Stensioina	179
sp.	180
Stilostomella	118
horridens	118
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subconica	41
sp.	42
Tritaxia	49
trifida	49
Trochammina	42
texana	42
Turritellella	32
sp.	32
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lenticula	124
nonionoides	124
undulata	125
Verneuulina	43
cretosa	43
parri	43
Webbinelloidea	29
similis	29
sp.	30

PLATES 1-10.

PLATE 1.

- Figs. 1,2. Webbinelloidea similis Stewart and Lampe, specimen CUFC 2, sample 76868; length 0.61 mm, width 0.42 mm, thickness 0.16 mm; 1. free side, 2. edge view.
- Fig. 3. Webbinelloidea similis Stewart and Lampe, specimen CUFC 288, sample 76871; length 0.56 mm, width 0.37 mm, thickness 0.16 mm; 3. apertural view.
- Figs. 4,5. Webbinelloidea sp., specimen CUFC 3, sample 76870; length 1.46 mm, width 0.61 mm, thickness 0.18 mm; 4. free side, 5. edge view.
- Fig. 6. Turitellélla sp., specimen CUFC 7, sample 76870; diameter 0.39 mm, height 0.54 mm; 6. apertural view.
- Figs. 7,8. Haplophragmoides sp. A, specimen CUFC 12, sample 76897; diameter 0.52 mm, thickness 0.19 mm; 7. side view, 8. apertural view.
- Figs. 9,10. Haplophragmoides sp. B, specimen CUFC 13, sample 76899; diameter 0.46 mm, thickness 0.23 mm; 9. side view, 10. apertural view.
- Figs. 11,12. Haplophragmoides sp. C, specimen CUFC 14, sample 76899; diameter 0.27 mm, thickness 0.19 mm; 11. side view, 12. apertural view.

PLATE 1

PLATE 2.

- Figs. 1,2. Recurvoides sp. A, specimen CUFC 15, sample 76901; diameter 0.31 mm, thickness 0.15 mm; 1. side view, 2. apertural view.
- Figs. 3,4. Recurvoides sp. B, specimen CUFC 16, sample 76900; diameter 0.26 mm, thickness 0.22 mm; 3. side view, 4. apertural view.
- Figs. 5,6. Spiroplectammina sp., specimen CUFC 24, sample 76897; length 0.49 mm, width 0.20 mm, thickness 0.14 mm; 5. side view, 6. edge view.
- Figs. 7-9. Placopsilina sp., specimen CUFC 19, sample 76892; diameter 0.75 mm, thickness 0.34 mm; 7. umbilical view, 8. spiral view, 9. edge view.
- Figs. 10,11. Textularia sp., specimen CUFC 26, sample 76898; length 0.43 mm, width 0.22 mm, thickness 0.16 mm; 10. side view, 11. edge view.
- Figs. 12,13. Gaudryina sp., specimen CUFC 39, sample 76898; length 0.53 mm, width 0.35 mm, thickness 0.31 mm; 12. side view, 13. edge view.

PLATE 2

PLATE 3.

- Figs. 1,2. Astacolus sp., specimen CUFC 61, sample 76870; length 0.26 mm, width 0.18 mm, thickness 0.10 mm; 1. side view, 2. edge view.
- Fig. 3. Citharina sp. A, specimen CUFC 65, sample 76875; length 0.67 mm, width 0.17 mm, thickness 0.04 mm; 3. side view,
- Fig. 4. Citharina sp. B, specimen CUFC 66, sample 76903; length 0.69 mm, width 0.18 mm, thickness 0.10 mm; 4. side view.
- Fig. 5. Frondicularia sp., specimen CUFC 89, sample 76888; length 1.73 mm, width 1.11 mm, thickness 0.45 mm; 5. side view.
- Figs. 6,7. Dentalinoides sp., specimen CUFC 78, sample 76875; length 0.78 mm, diameter 0.12 mm; 6. side view, 7. edge view.
- Figs. 8,9. Lagena sp. B, specimen CUFC 99, sample 76874; length 0.41 mm, diameter 0.23 mm; 8. side view, 9. apertural view.
- Figs. 10-12. Lagena sp. A, specimen CUFC 98, sample 76887; length 0.31 mm, diameter 0.28 mm; 10. side view, 11. apertural view, 12. basal view.

PLATE 3

PLATE 4.

- Figs. 1,2. Lingulina sp., specimen CUFC 137, sample 76872; length 0.36 mm, width 0.28 mm, thickness 0.17 mm; 1. side view, 2. apertural view.
- Figs. 3,4. Ellipsocristellaria sp., specimen CUFC 138, sample 76871; length 0.42 mm, width 0.30 mm, thickness 0.28 mm; 3. side view, 4. apertural view.
- Figs. 5,6. Loxostomoides sp., specimen CUFC 175, sample 76874; length 0.69 mm, width 0.20 mm, thickness 0.18 mm; 5. side view, 6. edge view.
- Figs. 7-9. Epistominella sp., specimen CUFC 187, sample 76870; diameter 0.59 mm, thickness 0.23 mm; 7. umbilical view, 8. spiral view, 9. edge view.
- Fig. 10. Reussella szajnochae (Grzybowski), angular specimen CUFC 181, sample 76874; length 0.51 mm, width 0.34 mm; 10. side view.
- Fig. 11. Reussella szajnochae (Grzybowski), rounded specimen CUFC 182, sample 76903; length 0.43 mm, width 0.30 mm; 11. side view.
- Figs. 12,13. Pseudouvigerina sp., specimen CUFC 184, sample 76892; length 0.28 mm, diameter 0.21 mm; 12. face view, 13. edge view.

PLATE 4

PLATE 5.

- Figs. 1-3. Heronallenia sp., specimen CUFC 193, sample 76871; diameter 0.32 mm, thickness 0.23 mm; 1. spiral view, 2. umbilical view, 3. edge view.
- Figs. 4,5. Gublerina sp. A, costate specimen CUFC 198, sample 76886; length 0.42 mm, width 0.30 mm, thickness 0.13 mm; 4. side view, 5. edge view.
- Figs. 6,7. Gublerina sp. A, non-costate specimen CUFC 199, sample 76890; length 0.27 mm, width 0.20 mm, thickness 0.09 mm; 6. side view, 7. edge view.
- Figs. 8,9. Gublerina sp. B, specimen CUFC 200, sample 76870; length 0.49 mm, width 0.33 mm, thickness 0.12 mm; 8. side view, 9. edge view.
- Figs. 10,11. Racemiguembelina fructicosa (Egger), specimen CUFC 202, sample 76870; length 0.58 mm, diameter 0.44 mm; 10. side view, 11. edge view.

PLATE 5

PLATE 6.

- Figs. 1-3. Rugoglobigerina rugosa (Plummer), high-spined specimen CUFC 226, sample 76887; diameter 0.46 mm, thickness 0.31 mm; 1. spiral view, note detached final chamber, 2. umbilical view, 3. edge view.
- Figs. 4-6. Rugoglobigerina rugosa (Plummer), adult low-spined specimen CUFC 227, sample 76873; diameter 0.34 mm, thickness 0.19 mm; 4. spiral view, 5. umbilical view, 6. edge view.
- Figs. 7-9. Rugoglobigerina rugosa (Plummer), juvenile low-spined specimen CUFC 228, without tegilla, sample 76873; diameter 0.26 mm, thickness 0.16 mm; 7. spiral view, 8. umbilical view, note somewhat extraumbilical aperture, 9. edge view.
- Figs. 10-12. Rugoglobigerina rugosa (Plummer), juvenile low-spined specimen CUFC 229, with tegilla, sample 76886; diameter 0.24 mm, thickness 0.13 mm; 10. spiral view, 11. umbilical view, note tegilla, 12. edge view.

PLATE 7.

- Figs. 1-3. Rugoglobigerina rugosa (Plummer), medium-spined specimen CUFC 230, sample 76871; diameter 0.40 mm, thickness 0.25 mm; 1. spiral view, 2. umbilical view, 3. edge view.
- Figs. 4-6. Globotruncana contusa (Cushman), specimen CUFC 217, sample 76870; diameter 0.58 mm, thickness 0.42 mm; 4. spiral view, 5. umbilical view, 6. edge view, note spire is not as high as "typical" G. contusa.
- Figs. 7-9. Planorbulina sp., discoid specimen CUFC 243, sample 76875; diameter 0.82 mm, thickness 0.30 mm; 7. spiral view, 8. umbilical view, 9. edge view.
- Fig. 10. Planorbulina sp., enrolled specimen CUFC 244, sample 76880; length 0.57 mm, diameter 0.33 mm; 10. spiral side external.
- Figs. 11-13. Planulina sp., specimen CUFC 235, sample 76894; diameter 0.28 mm, thickness 0.11 mm; 11. side view, 12. side view, opposite side from Fig. 11, showing nearly planispiral nature of test, 13. edge view, showing asymmetry of test.

PLATE 7

PLATE 8.

- Figs. 1-3. Cibicides succedens Brotzen, high umbilicoconvex specimen CUFC 239, sample 76876; diameter 1.07 mm, thickness 0.40 mm; 1. umbilical view, 2. spiral view, 3. edge view.
- Figs. 4-6. Cibicides succedens Brotzen, low umbilicoconvex specimen CUFC 240, sample 76871; diameter 0.89 mm, thickness 0.40 mm; 4. umbilical view, 5. spiral view, 6. edge view.
- Figs. 7-9. Cibicides succedens Brotzen, inflated specimen CUFC 241, sample 76878; diameter 1.23 mm, thickness 0.55 mm; 7. umbilical view, 8. spiral view, 9. edge view.
- Figs. 10-12. Cibicides sp., specimen CUFC 242, sample 76874; diameter 0.50 mm, thickness 0.24 mm; 10. umbilical view, 11. spiral view, 12. edge view.

PLATE 9.

- Figs. 1,2. Ellipsoglandulina sp., specimen CUFC 247, sample 76871; length 0.98 mm, diameter 0.46 mm; 1. side view, 2. edge view.
- Figs. 3,4. Quadrिमorphina sp. A, specimen CUFC 257, sample 76870; length 0.49 mm, diameter 0.30 mm; 3. face view, 4. back view.
- Figs. 5,6. Quadrिमorphina sp. C, specimen CUFC 259, sample 76870; length 0.39 mm, diameter 0.17 mm; 5. face view, 6. edge view.
- Figs. 7-9. Quadrिमorphina sp. B, specimen CUFC 258, sample 76870; diameter 0.60 mm, thickness 0.25 mm; 7. umbilical view, 8. spiral view, 9. edge view.
- Figs. 10-12. Gyroidinoides (?) sp., specimen CUFC 274, sample 76889; diameter 0.31 mm, thickness 0.17 mm; 10. umbilical view, 11. spiral view, 12. edge view.

PLATE 10.

- Figs. 1-3. Angulogavelinella sp. A, specimen CUFC 276, sample 76893; diameter 0.64 mm, thickness 0.22 mm; 1. umbilical view, 2. spiral view, 3. edge view.
- Figs. 4-6. Angulogavelinella sp. B, specimen CUFC 277, sample 76895; diameter 0.45 mm, thickness 0.15 mm; 4. umbilical view, 5. spiral view, 6. edge view.
- Figs. 7-9. Gavelinella sp., specimen CUFC 286, sample 76870; diameter 0.53 mm, thickness 0.26 mm; 7. umbilical view, 8. spiral view, 9. edge view.
- Figs. 10-12. Stensioina sp., specimen CUFC 287, sample 76880; diameter 0.62 mm, thickness 0.24 mm; 10. umbilical view, 11. spiral view, 12. edge view.

PLATE 10

INDIAN OCEAN

INDIAN OCEAN

FIG.1. LOCALITY MAP OF C-Y CREEK, WESTERN AUSTRALIA.

FIG.1. LOCALITY MAP OF C-Y CREEK, WESTERN AUSTRALIA.

1494

Sample Locations,
Samples 76865-99 & 76900-04

Biologic Boundary,
Explanation in text

1.0 0.5 0.0 1.0
Kilometres

2 of

FIG. 2. SAMPLE LOCATION MAP, C-Y CREEK.

FIG. 2. SAMPLE LOCATION MAP, C-Y CREEK.

FIG. 1. PERCENT ABUNDANCES OF MAJOR GENITRICHIA IN THE SAMPLES 76897, 76901, 76898.

THE LAMING CLUB, 21, N. 2ND ST.

□

■

□

☐

10

1

■

□

10 20 30 40 50 60 70 80 90 100

2 of

76903-
76902-
76900-
76899-
76896-

Silicosigmoilina californica

Haplophragmoides fraseri

Haplophragmoides sp. C

Ammobaculites subcretaceus

Spiroplectammina grzybowskii

Verneuilina parri

Gaudryina pulvina

Tritaxia trifida

Dorothia bifurcata

Dorothia drycon

Pyramidina triangularis

Eouvierina americana

Reussella azajochae

Valvulineria undulata

Eponides concinna

Eponides diversus

Globorotalites conicus

Gyroldinoides bandyi

Gyroldinoides nodus

Anomalinoidea rubiginosa

Angulogavelinella sp. B

Gavelinella canalicula

Gavelinella eriksdalensis

Gavelinella erugata

Gavelinella stellula

Valvulina californica

Valvulinoides fraseri

Valvulinoides sp. C

Valvulites subcretaceus

Valvulinella grzybowskii

Valvulinella parri

Valvulinella pulvina

Valvulinella rifida

Valvulinellaiformis

Valvulinella xycona

Valvulinella triangularis

Valvulinella americana

Valvulinella szajnochae

Valvulinaria undulata

Eponides concinna

Eponides diversus

Globorotalites conicus

Gyroidinoides bandyi

Gyroidinoides nodus

Anomalinoidea rubiginosa

Angulogavelinella sp. B

Gavelinella canalicula

Gavelinella erikadalenae

Gavelinella erugata

Gavelinella stellata

104

RELATIVE ABUNDANCE OF MAJOR PLANKTONIC SPECIES, TOULONGA CALCAREOUS, BY DATE

RELATIVE ABUNDANCE

PLANKTONIC SPECIES, FOOTONGA CALCILUTITE, BY SAMPLE IN STRATIGRAPHIC ORDER.

PLATE 1. 11. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

10 20 30 40 50 60 70 80 90 100

SAMPLE NUMBER

76904-

76894-

76895-

76903-

76902-

76900-

76899-

76896-

Heterohelix globulosa

Heterohelix pulchra

Pseudotextularia elegans

Globigerinelloides alvarosi

Globigerinelloides multispinus

Globigerinelloides rotatus

Redbergella planispina

Globotruncana arca

Globotruncana bulloides

Globotruncana linneiana

Globotruncana ventricosa

Rugoglobigerina macrocephala

Rugoglobigerina rugosa

3 of

globulosa

pulchra

ularia elegans

elloides alvaresi

elloides multispina

elloides volutus

planispira

Globotruncana arca

Globotruncana bulloides

Globotruncana flaneliana

Globotruncana ventricosa

Rugoglobulites angusticollis

Rugoglobulites rugosa

4 of 4

FIG.7. PERCENT ABUNDANCES OF MAJOR BENTHONIC SPECIES, YOROJON CALCARENITE, BY SAMPLE 76

ABUNDANCES OF MAJOR LENTHONIC SPECIES, KOROROK, CALCARENITE, BY SAMPLE IN STRATIGRAPHIC ORDER

CUMULATIVE PERCENT ABUNDANCE

10 20 30 40 50 60 70 80 90 100

| 27 |

SAMPLE NUMBER

76877-

76879-

76878-

76880-

76881-

76891-

76882-

76883-

76884-

76885-

76886-

76887-

3 of 1

4 of

76886

76887

76890

76893

76892

*Silicosigmoilina californica**Spiroplectammina przyłowski**Textularia subconica**Verneuillina parri**Dorothia biformis**Dorothia oxycona**Praebulimina carseyae**Praebulimina cushmani**Praebulimina navarroensis**Pyramidina proluxa**Bolivina incrassata gigantea**Bolivinoidea decorata australis**Pseudouvierina cristata**Conorbina sigmoidalis**Conorbina supracretacea**Sponides conchius**Cibicides beaumontianus**Cibicides succedens**Loxostomum eleyi**Atabamina dorsoplana**Globorotalites conicus**Globorotalites umbilicatus**Angulogavelinella sp. A**Gavelinella cayeuxi**Gavelinella eriksdalensis**Gavelinella erupata**Gavelinella henbesti*

ina californica

monorbina supracretacea

ina gzytowski

ponides concinna

oconica

Cibicides beaumontianus

arri

Cibicides succedens

eris

Loxostomum eleyi

ina

Alabamina dorsoplana

arsevae

Globorotalites conicus

cushmani

Globorotalites umbilicatus

navarroensis

Angulogavelinella sp. A

olixa

Gavelinella cayeuxi

assata gigantea

Gavelinella eriksdalensis

decorata australis

Gavelinella erugata

ina cristata

Gavelinella henbesti

moidalis

CONTINUED

76877
76879

76878

76880

76881

76891

P
76882

76883

76884

76885

76886

76887

| 3 of |

| 4 of |

76883

76884

76885

76886

76887

76890

76893

76892

Heterohelix globulosa

Heterohelix pulchra

Pseudotextularia elegans

Globigerinelloides alvarezi

Globigerinelloides multispina

Globigerinelloides volutus

Hedbergella planispira

Globotruncana arca

Globotruncana bulloides

Globotruncana linneiana

Globotruncana ventricosa

Rugoglobigerina macrocephala

Rugoglobigerina rugosa

x globulosa

x pulchra

ularia elegans

elloides alvarezzi

elloides multispina

elloides volutus

a planispira

Globotruncana arca

Globotruncana bulloides

Globotruncana linneiana

Globotruncana ventricosa

Rugoglobigerina macrocephala

Rugoglobigerina rugosa

END

1 6 1 2 8 1

FIN