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HAUTERIVIAN TO BARREMIAN FORAMINIFERA AND BIOSTRATIGRAPHY OF THE MOUNT GOODENOUGH FORMATION, AKLAVIK RANGE, NORTHWESTERN DISTRICT OF MACKENZIE

S.P. Fowler and W.K. Braun

1993

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PREFACE

The Mount Goodenough Formation of northern Yukon and adjacent Northwest Territories is a major Lower Cretaceous clastic succession that is exposed throughout the Richardson Mountains to the west of the Mackenzie Delta. The discovery of hydrocarbons in several Lower Cretaceous formations in the subsurface of the delta area emphasizes the need for a more complete understanding of the geology of this region of northern Canada. Paleontological data can aid in this understanding by helping to reconstruct the depositional environment, geological history, and paleogeography of the area, as well as providing age control and correlations.

This report presents paleontological data from the Mount Goodenough Formation based on three microfaunal assemblages of Foraminifera. The results derived from this study present interpretations that will aid in an understanding of the tectono-stratigraphic history of the area and the adjacent Canada Basin and will have a direct application to the petroleum exploration industry.

Elkanah A. Babcock
Assistant Deputy Minister
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PRÉFACE

La Formation de Mount Goodenough dans le nord du Yukon et les régions adjacentes des Territoires du Nord-Ouest est une importante succession clastique du Crétacé inférieur, qui affleure dans l'ensemble des monts Richardson à l'ouest du delta du Mackenzie. La découverte d'hydrocarbures dans plusieurs formations du Crétacé inférieur en subsurface du delta met en relief le besoin de mieux comprendre la géologie de cette région du Nord canadien. Dans ce but, les données paléontologiques peuvent être utiles puisqu'elles permettent de reconstituer le milieu de sédimentation, l'évolution géologique et la paléogéographie de la région, mais aussi de corroborer les âges obtenus et d'établir des corrélations chronostratigraphiques.

Le mémoire présente des données paléontologiques relatives à la Formation de Mount Goodenough, basées sur trois assemblages microfauniques à foraminifères. Les résultats fournis par cette étude donnent lieu à des interprétations qui aideront à mieux comprendre l'évolution tectonostratigraphique de la région et du Bassin Canada adjacent, et auront une application directe dans le milieu de l'industrie de l'exploration pétrolière.

Elkanah A. Babcock
Sous-ministre adjoint
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CONTENTS

1 Abstract/Résumé
3 Summary
4 Sommaire
6 Introduction
6 Acknowledgments
6 Tectonic elements
9 Mount Goodenough Formation
10 Biostratigraphic framework
10 Megafaunas
11 Microfaunas
11 Foraminiferal assemblages
11 Martin Creek section—assemblage 1
12 Goodenough Creek section—assemblages 1, 2, 3
14 Biostratigraphy
14 Environmental considerations
14 Biostratigraphic considerations
15 Comparison with other foraminiferal assemblages
15 Conclusions
16 Systematic paleontology
16 Genus *Bathysiphon*
18 Genus *Hippocrepina*
19 Genus *Hyperammina*
19 Genus *Psamminosphaera*
19 Genus *Saccammina*
20 Genus *Pelosina*
20 Genus *Ammodiscus*
21 Genus *Glomospira*
22 Genus *Glomospirella*
22 Genus *Lituotuba*
23 Genus *Reophax*
24 Genus *Miliammina*
25 Genus *Haplophragmoides*
26 Genus *Cribrostomoides*
27 Genus *Labrospira*
27 Genus *Ammobaculites*
29 Genus *Recurvoides*
31 Genus *Trochammina*
32 Genus *Verneuilina*
32 Genus *Gaudryina*
33 Genus *Uvigerinammina*
33 Genus *Verneuilinoides*
34 Genus *Arenobulimina*
34 Genus *Quinqueloculina*
35 Genus *Nodosaria*
37 Genus *Dentalina*
39 Genus *Geinitzinita*
39 Genus *Pseudonodosaria*
40 Genus *Lenticulina*
41 Genus *Darbyella*
42 Genus *Astacolus*
43 Genus *Citharina*
44 Genus *Frondicularia*
45 Genus *Marginulina*

47 Genus *Marginulinopsis*
49 Genus *Saracenaria*
51 Genus *Vaginulina*
52 Genus *Vaginulinopsis*
53 Genus *Lingulina*
53 Genus *Lingulonodosaria*
54 Genus *Eoguttulina*
54 Genus *Globulina*
55 Genus *Pyrulinoides*
55 Genus *Tristix*
56 Genus *Oolina*
57 Genus *Praebulimina*
57 Genus *Bolivina*
58 Genus *Spirillina*
58 Genus *Patellina*
58 Genus *Quadrimorphina*
59 Genus *Conorboides*
59 References

Figures

7 1. Index map, northwestern Northwest Territories
8 2. Tectonic elements of the study area
9 3. Relationship of measured sections to lithostratigraphic units and, approximately, to Boreal stages and local macrofossil zonation
12 4. Relationship of measured sections and foraminiferal assemblages to depositional environments, transgressions, regressions, and global sea level changes
in pocket 5. Distribution chart no. 1, section WB-9-72, Martin Creek
in pocket 6. Distribution chart no. 2, section WB-12-72, Goodenough Creek, Mount Goodenough

Plates

65 1-9. Illustrations of Foraminifera

HAUTERIVIAN TO BARREMIAN FORAMINIFERA AND BIOSTRATIGRAPHY OF THE MOUNT GOODENOUGH FORMATION, AKLAVIK RANGE, NORTHWESTERN DISTRICT OF MACKENZIE

Abstract

The Aklavik Range of the Richardson Mountains is one of a few areas in North America that contain exposures of marine, pre-Albian Lower Cretaceous rocks. These deposits, however, contain a relatively scarce megafauna. The upper Hauterivian to Aptian Mount Goodenough Formation from the Aklavik Range has yielded a rich foraminiferal microfauna including many species not previously known from the Boreal Faunal Province.

One hundred and nineteen species of Foraminifera were recorded from the Mount Goodenough Formation, 22 of which are new species. A sequence of three foraminiferal microfaunal assemblages and two subassemblages was recognized spanning late Hauterivian to late Barremian time. These dates are based on integration of the foraminiferal assemblages with the macrofossil zones (ammonites, belemnites, and bivalves) established for the northern Yukon and northwestern Northwest Territories. The foraminiferal assemblages are boreal in aspect; however, the agglutinated component of the microfauna exhibits a high degree of endemism, possibly reflecting restrictions between the northwestern Arctic regions and the world's major oceans.

Assemblage 1 from the Mount Goodenough Formation has yielded one of the richest and most diverse foraminiferal microfaunas known from the Boreal Faunal Province. This assemblage has been subdivided into two biofacies — a shallow-water biofacies corresponding approximately to the inner neritic zone and a deeper water biofacies corresponding approximately to the outer neritic zone. Assemblages 2 and 3 are noted for a decrease in foraminiferal species diversity and abundance, reflecting shallower water depths.

Foraminiferal distributions indicate a transgressive acme of late Hauterivian for the Mount Goodenough depositional complex. This transgressive acme was followed by a period of regression and progradation that lasted from latest Hauterivian to late Barremian time. Comparison with depositional complexes from western Canada shows that there is no record of a western Canadian transgression comparable to that of the Mount Goodenough depositional complex.

Résumé

Le chaînon Aklavik des monts Richardson est l'une des rares régions d'Amérique du Nord où s'observent des affleurements de roches marines du Crétacé inférieur (avant l'Albien). La mégafaune que renferment ces dépôts est relativement peu abondante. Cependant, une riche microfaune à foraminifères, avec notamment de nombreuses espèces de la Province faunique boréale jusque-là inconnues, a été décrite dans la Formation de Mount Goodenough du chaînon Aklavik qui s'échelonne du Hauterivien supérieur à l'Aptien.

La Formation de Mount Goodenough contient 119 espèces de foraminifères, dont 22 sont nouvelles. Une séquence de trois assemblages et de deux sous-assemblages fauniques à foraminifères a été identifiée; il a été établi qu'elle couvrait l'intervalle du Hauterivien tardif au Barrémien tardif, par intégration des assemblages à foraminifères avec les zones à macrofossiles (ammonites, bélemnites et bivalves) reconnues dans le nord du Yukon et dans la portion nord-ouest des Territoires du Nord-Ouest. Les assemblages à foraminifères ont un aspect caractéristique de la région boréale. Toutefois, la composante «foraminifères à test aggluiné» de la microfaune

manifeste un degré élevé d'endémisme, qui traduit peut-être la restriction des communications entre les régions de la partie nord-ouest de l'Arctique et les principaux océans du Globe.

L'une des faunes les plus riches et les plus diverses que l'on connaisse dans la Province faunique boréale a été décrite dans l'assemblage 1 de la Formation de Mount Goodenough. Cet assemblage a été subdivisé en deux biofaciès : l'un d'eau peu profonde, qui correspond approximativement à la zone néritique interne, et l'autre de d'eau plus profonde, qui correspond approximativement à la zone néritique externe. Dans les assemblages 2 et 3, il y a une diminution de la diversité et de l'abondance des espèces de foraminifères, qui témoigne d'un milieu encore moins profond.

La répartition des foraminifères indique que dans le cas du complexe sédimentaire de la Formation de Mount Goodenough, une transgression maximale associée au tout début du Hauterivien tardif a été suivie d'une période de régression et de progradation qui s'est échelonnée de la toute fin du Hauterivien tardif au Barrémien tardif. Une comparaison avec les complexes sédimentaires de l'Ouest canadien montre que dans cette région, il n'y a apparemment pas eu de transgression comparable à celle qui a été décrite dans le cas du complexe sédimentaire de Mount Goodenough.

Summary

The Mount Goodenough Formation of northern Yukon and northwestern Northwest Territories is a major clastic succession of Early Cretaceous age. In the Aklavik Range of the Richardson Mountains, this formation consists of approximately 300 m of shale with gradually increasing amounts of siltstone and sandstone in the upper part of the formation. The deposits of this formation contain a relatively scarce megafauna. Fortunately these deposits have yielded a rich foraminiferal microfauna that includes many species not previously known from the Boreal Faunal Province.

The deposits of the Mount Goodenough Formation contain a microfauna of 119 species of Foraminifera, 22 of which are new. Of these 119 species of Foraminifera, 43 are agglutinated and 76 are calcareous. The agglutinated species are more abundant. The calcareous component of the microfauna is dominated by representatives of the family Nodosariidae.

This foraminiferal microfauna has been subdivided into three assemblages and two subassemblages. These assemblages are boreal in aspect; however, comparisons with other boreal microfaunas are difficult due to the endemic nature of the agglutinated component of the Mount Goodenough assemblages and to lithofacies changes between the Richardson Mountains and other areas from which Lower Cretaceous microfaunas have been described, such as the Sverdrup Basin of the Canadian Arctic Islands and western Siberia.

Assemblage 1 was recovered from the lower part of the informal lower member of the Mount Goodenough Formation from deposits of black, fissile shale with numerous horizons of clay-ironstone concretions. The rich foraminiferal assemblage recovered from this shale indicates deposition in a marine shelf environment. The assemblage was recovered from two sections: a 122 m (400 ft.) section of black shale at Martin Creek, which contains a rich and highly diversified foraminiferal microfauna (Section WB–9–72), and the lower 38.0 m (125.5 ft.) interval of predominantly grey shale beds with minor layers of siltstone at Goodenough Creek, which contains a foraminiferal microfauna of reduced diversity and numbers (Section WB–12–72). Although the foraminiferal microfauna recovered from both sections is indicative of an open-marine shelf environment, assemblage 1 from Martin Creek is indicative of greater depth such as in an outer shelf area, whereas assemblage 1 from Goodenough Creek is indicative of shallower water, such as in an inner shelf area.

Assemblage 2 was recovered from the upper part of the lower member of the Mount Goodenough Formation (Section WB–12–72) from deposits of grey-black shale with numerous clay-ironstone concretions and intervals of siltstone. Assemblage 2 lacks the species diversity and abundance of the deeper water biofacies of assemblage 1 from Martin Creek. This further reduction in foraminiferal species diversity together with the presence of silty layers indicates that although an open-marine shelf environment continued, assemblage 2 reflects a shallower water environment such as that of the inner shelf.

These concomitant trends of coarsening-upward grain size and decrease in foraminiferal species diversity and specimen numbers culminate in the sandstone-dominant upper member. Assemblage 3 from this member is an impoverished microfauna of greatly reduced species diversity and specimen numbers. The environment of deposition of this upper member is nearer shore than that of the lower deposits, possibly lowermost shoreface or offshore bars.

Data from the present study indicate a transgressive acme of late Hauterivian followed by a period of regression that spanned latest Hauterivian to late Barremain time for the depositional complex of the Mount Goodenough Formation. Comparison of this depositional complex (i.e., the transgression–regression cycle) from northern Canada with those recorded from western Canada shows that there is no record of a western Canadian transgression in the Late Hauterivian comparable to the Mount Goodenough depositional complex of northern Canada. If eustasy were

the controlling factor in sea level changes during the Early Cretaceous, then the transgressive peaks and regressive troughs of marine depositional complexes, as recorded in the sedimentary sequences of cratonic regions, should be synchronous within the limits of stratigraphic dating. The lack of synchroneity between northern and western Canada suggests that any record of eustatic oscillations of sea level in northern Yukon and adjacent Northwest Territories were overprinted by local and regional tectonic movements (i.e., folding, faulting, and widespread uplift), which occurred during late Hauterivian time in this area.

Sommaire

La Formation de Mount Goodenough dans le nord du Yukon et la portion nord-ouest des Territoires du Nord-Ouest est une importante succession clastique datant du Crétacé précoce. Dans le chaînon Aklavik des monts Richardson, cette formation se compose d'approximativement 300 m de shale et présente des quantités progressivement plus importantes de siltstone et de grès dans sa partie supérieure. Elle contient une mégafaune relativement peu abondante, mais heureusement, une riche microfaune à foraminifères comprenant de nombreuses espèces de la Province faunique boréale jusque-là inconnues y a été décrite.

La microfaune de la Formation de Mount Goodenough consiste en 119 espèces de foraminifères, dont 22 sont nouvelles. Sur ce total, 43 sont des foraminifères à test agglutiné et 76 des foraminifères à test calcaire. Les espèces à test agglutiné sont plus abondantes. Quant à celles à test calcaire, elles appartiennent surtout à la famille des Nodosariidés.

Cette microfaune à foraminifères a été subdivisée en trois assemblages et deux sous-assemblages. Les assemblages ont un aspect caractéristique de la région boréale; toutefois, il est difficile de les comparer avec d'autres microfaunes boréales en raison de la nature endémique de la composante «foraminifères à test agglutiné» des assemblages de Mount Goodenough et des variations de lithofaciès entre les monts Richardson et d'autres régions où des microfaunes du Crétacé inférieur ont été décrites, comme le bassin de Sverdrup de l'Archipel arctique canadien et la partie ouest de la Sibérie.

L'assemblage 1 provient de la partie inférieure du membre inférieur (informel) de la Formation de Mount Goodenough, qui présente des shales noirs fissiles contenant de nombreux horizons à concrétions argilo-ferrugineuses. Le riche assemblage à foraminifères extrait de ce shale indique une sédimentation dans un milieu épicontinental. L'assemblage a été décrit à partir de deux coupes : celle du ruisseau Martin mesurant 122 m (400 pi) d'épaisseur et composée de shale noir, qui contient une microfaune à foraminifères riche et très diversifiée (coupe WB-9-72), et celle du ruisseau Goodenough (inférieure) couvrant un intervalle de 38,0 m (125,5 pi) d'épaisseur, qui consiste essentiellement en des lits de shale gris mais aussi en des couches mineures de siltstone et qui présente une microfaune à foraminifères moins variée et moins abondante (coupe WB-12-72). Bien que la microfaune à foraminifères des deux coupes indique un milieu épicontinental à circulation libre, l'assemblage 1 du ruisseau Martin témoigne d'une plus grande profondeur marine, comme dans un secteur de plate-forme externe, tandis que l'assemblage 1 du ruisseau Goodenough est caractéristique d'un milieu marin moins profond, comme dans un secteur de plate-forme interne.

L'assemblage 2 provient de la partie supérieure du membre inférieur de la Formation de Mount Goodenough (coupe WB-12-72), qui présente des shales gris foncé contenant de nombreuses concrétions argilo-ferrugineuses et plusieurs intervalles de siltstone. Dans l'assemblage 2, les espèces sont moins variées et moins abondantes que dans les biofaciès d'eau plus profonde caractérisant l'assemblage 1 du ruisseau Martin. Cette réduction supplémentaire de la diversité des espèces de foraminifères ainsi que la présence de couches silteuses indique que l'assemblage 2, même s'il correspond à un milieu épicontinental à circulation libre, est caractéristique d'un milieu d'eau moins profonde, comme dans un secteur de plate-forme interne.

Ces tendances simultanées à un granoclassement inverse et à une réduction de la diversité et de l'abondance des espèces de foraminifères atteignent un maximum dans le membre supérieur, qui se compose surtout de grès. L'assemblage 3 provenant de ce membre est une microfaune appauvrie à la diversité d'espèces et au nombre d'individus très réduits. Le milieu sédimentaire de ce membre supérieur est de caractère plus littoral que celui des dépôts inférieurs; il correspond peut-être soit à des barres occupant la partie la plus basse de l'avant-plage, soit à des barres immergées.

Les données de la présente étude indiquent que dans le cas du complexe sédimentaire de la Formation de Mount Goodenough, une transgression maximale associée au tout début du Hauterivien tardif a été suivie d'une période de régression qui s'est échelonnée de la toute fin du Hauterivien tardif au Barrémien tardif. Une comparaison de ce complexe sédimentaire (c'est-à-dire du cycle transgression-régression) du Nord canadien avec ceux de l'Ouest canadien montre qu'aucune transgression survenue dans l'Ouest canadien au cours du Hauterivien tardif n'est comparable à celle qui a été décrite dans le cas du complexe de Mount Goodenough dans le Nord canadien. Si l'eustasie était le facteur déterminant du point de vue des variations du niveau de la mer au cours du Crétacé précoce, les pics transgressifs et les creux régressifs caractérisant les complexes sédimentaires marins, tels qu'enregistrés dans les séquences sédimentaires des régions cratoniques, devraient être synchrones avec les limites des datations stratigraphiques. L'absence de synchronisme entre le Nord et l'Ouest canadiens suggère que toute trace des oscillations eustatiques du niveau de la mer dans le nord du Yukon et dans les régions adjacentes des Territoires du Nord-Ouest a été effacée par des mouvements tectoniques locaux et régionaux (plis, failles et soulèvements de grande étendue), qui ont eu lieu pendant le Hauterivien tardif dans cette région.

INTRODUCTION

In the Yukon and northwestern Northwest Territories, Lower Cretaceous rocks outcrop extensively in the northern Richardson Mountains. In the subsurface, these Lower Cretaceous sequences underlie the adjacent Mackenzie Delta, parts of the Sverdrup Basin of the Canadian Arctic Islands, the Beaufort Sea, and the northern slope of Alaska.

The marine, Lower Cretaceous rocks of the Aklavik Range (situated in the northeastern Richardson Mountains) (Fig. 1) include many deposits of pre-Albian age. These deposits, however, contain a relatively scarce megafauna. The megafaunas are characterized by a high degree of endemism and a low level of diversity, and are very often dominated by a single species of mollusc. The rare ammonites, belemnites, and bivalves have been used for dating the Lower Cretaceous sequences of the Richardson Mountains and for establishing local and regional correlations.

The deposits of the upper Hauterivian to Barremian Mount Goodenough Formation contain one of the richest microfaunal assemblages of Foraminifera known from the Boreal Faunal Province. The present study was initiated to document this foraminiferal microfauna. Before this study, no comprehensive analysis of the microfauna of the entire formation had been attempted. Samples were collected by the authors in 1972 and 1979 from two outcrop sections located in the Aklavik Range of the Richardson Mountains immediately west of the Mackenzie Delta (Fig. 1). Sampling intervals varied depending upon ease of sampling; however, the sections were continuously trenched whenever possible. A total of 212 samples was utilized in this study, and 119 species of Foraminifera, including 22 new species, were recognized from the Mount Goodenough Formation.

These 119 species of Foraminifera were grouped into assemblages that were then evaluated for their biostratigraphic and paleoecological significance. The resulting biozones were compared with those schemes already established for other parts of the world where boreal 'Neocomian' microfaunas are known to occur. Finally, the foraminiferal assemblages of the Mount Goodenough Formation were used to reconstruct the depositional environment, geological history, and paleogeography of the area of the Richardson Mountains in Late Hauterivian to Barremian time.

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P.M. Swan of the Department of Modern Languages, University of Saskatchewan, assisted us with the naming of some of the "new" species of Foraminifera. His help with the more complex specific names is gratefully acknowledged.

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TECTONIC ELEMENTS

The tectonic elements that influenced Early Cretaceous sedimentation in northern Yukon and northwestern Northwest Territories are illustrated in Figure 2. During the Early Cretaceous, marine sediments accumulated in the eastern part of the Beaufort–Mackenzie Basin (i.e., the Blow Trough of Young et al., 1976) on a broad, continuous shelf with cratonic source areas to the south and east of the basin. Jeletzky (1971a, 1974, 1975), however, proposed that this area was a subsiding trough, which he named the Porcupine Plain–Richardson Mountain Trough. According to Jeletzky (op. cit.) this trough extended approximately north–south through northern Yukon and separated an eastern landmass, the Peel Landmass, from a western landmass, the Keele–Old Crow Landmass, the trough receiving sediments from both landmasses. Other authors (Poulton, 1982, 1984; Poulton et al., 1982; Dixon, 1986, 1991), however,

contend that there is no evidence of a westerly source of sediment during this time and that sediment was supplied only from southerly and easterly cratonic sources. Thus the Arctic seas of northern Yukon and northwestern Northwest Territories must have opened to the northwest onto the ancestral Pacific Ocean and to the northeast onto the Sverdrup Basin of the Canadian Arctic Islands (Balkwill et al., 1983).

A middle to late Hauterivian orogeny resulted in normal faulting and folding throughout this area (Dixon, 1982, 1986). Dixon (op. cit.) stated that a major period of uplift occurred during this phase of tectonic activity, resulting in a regionally extensive unconformity and the rejuvenation of many older tectonic elements of the area, such as the Eskimo Lakes Arch, the Cache Creek Uplift, the Eagle Arch, and the Tununuk High. These tectonic highs experienced more pronounced uplift to the extent that parts of them became subaerially eroded. Erosion of the rejuvenated tectonic elements resulted in sandy beds being deposited adjacent to and over these highs.

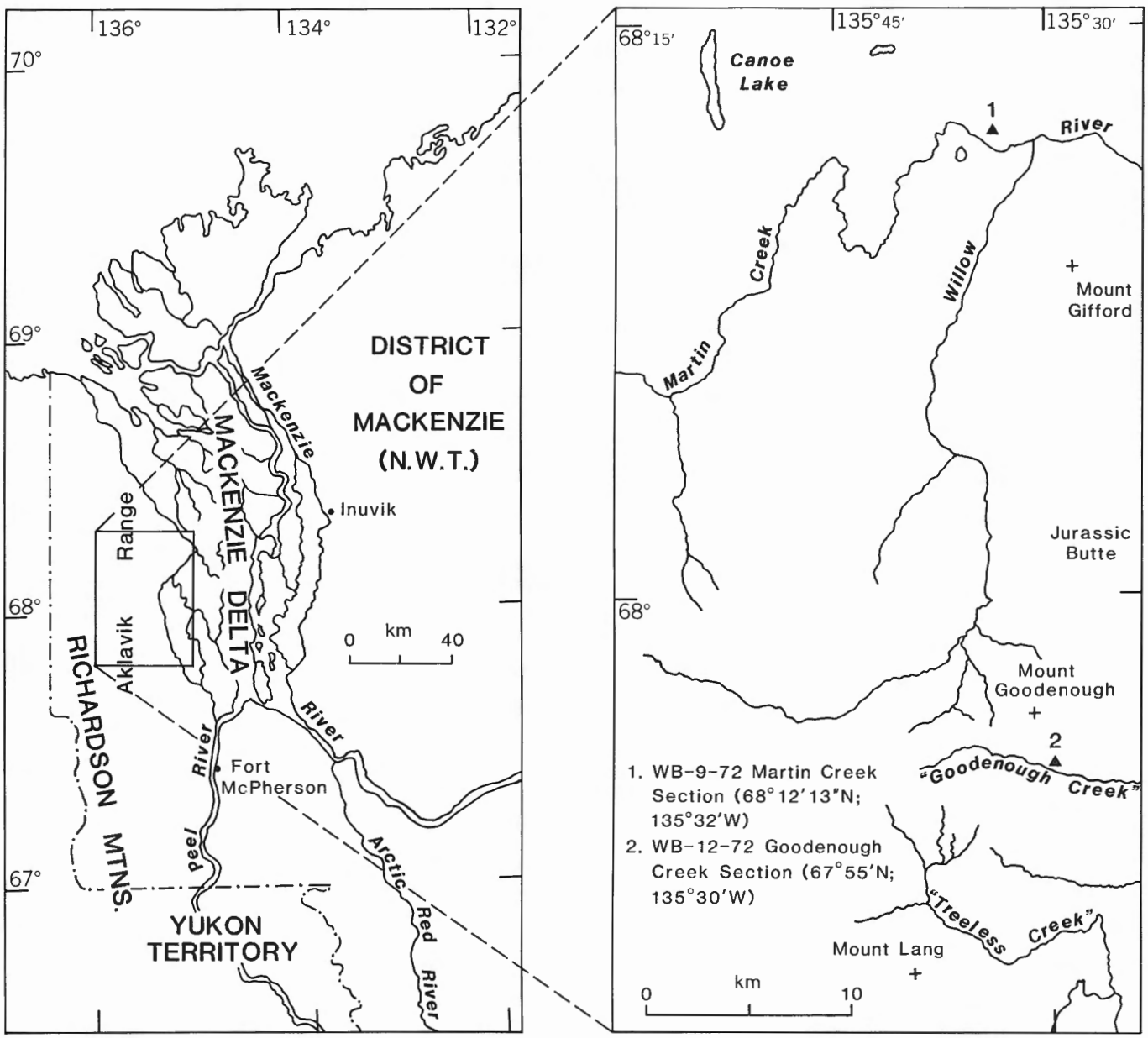

Figure 1. Index map, northwestern Northwest Territories.

The study area is located at the northern end of the Canoe Depression. The Canoe Depression and the Kugmallit Trough acted as depocentres throughout this time. The shoreline of the basin extended along the Eskimo Lakes Arch south-southwestward across the western edge of the Peel Plateau. The eastern part of this basin received a succession of deposits composed entirely of terrigenous clastics. The composition of the sandstone (quartz arenite) indicates a mature source terrane to the east; that is, the Peel Plateau. Dixon

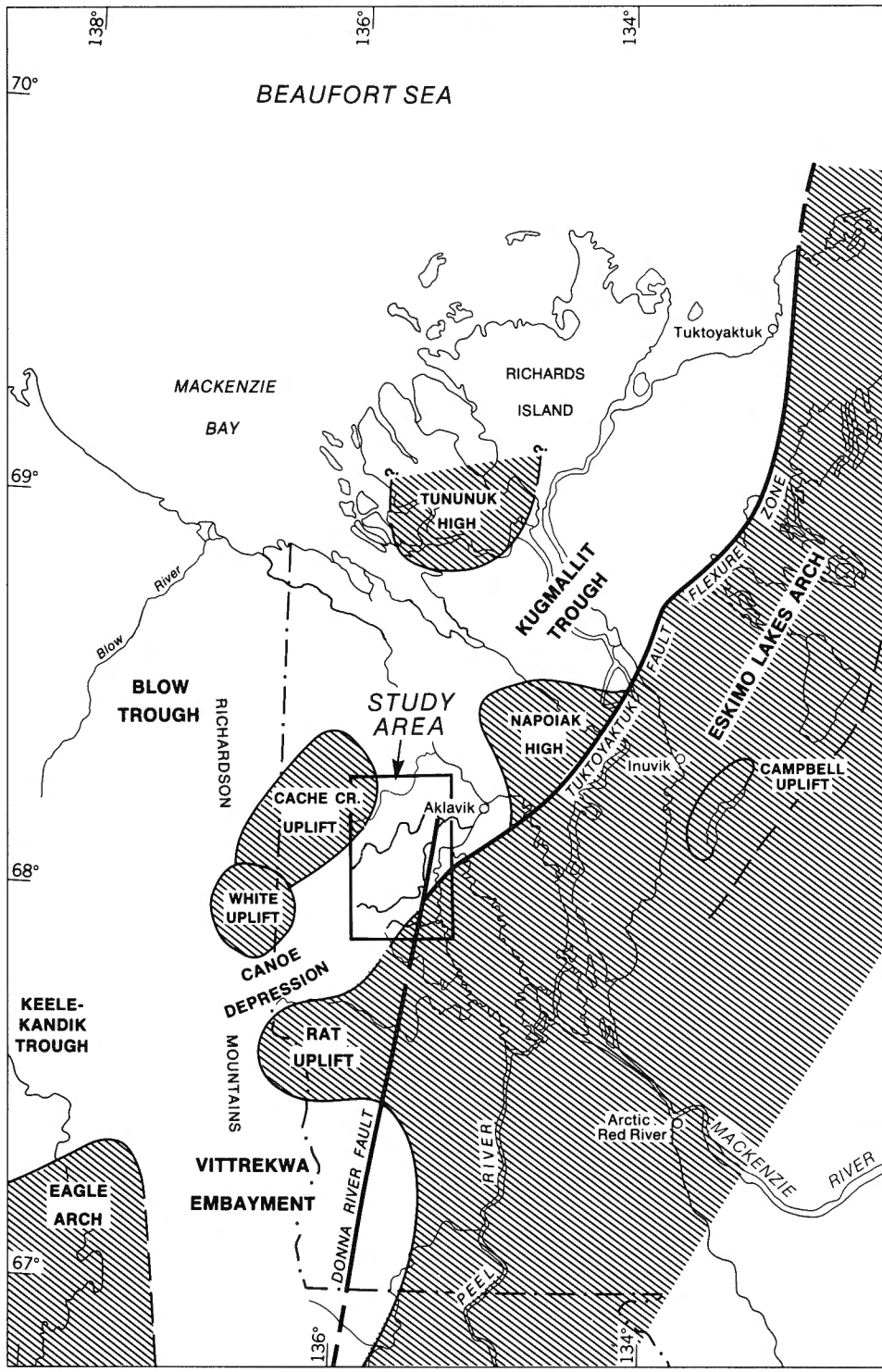

Figure 2. Tectonic elements of the study area. (From Young et al., 1976.)

(1991) notes that this part of the basin was under the influence of extensional tectonics related to the opening of what was to become the Canada Basin.

MOUNT GOODENOUGH FORMATION

The Mount Goodenough Formation was previously named the Upper Shale-Siltstone Division by Jeletzky (1958, 1960) and the Dark-Grey Siltstone Division (Jeletzky, 1961). The name Mount Goodenough Formation was used to replace this informal designation on several maps (Norris, 1981 a to g, 1982). Dixon (1982) first used the undefined name in a publication and applied it to a subsurface unit in the southern part of the Mackenzie Delta-Tuktoyaktuk Peninsula area.

The Mount Goodenough Formation was formally defined by Dixon and Jeletzky (1991). The type section is located on the east flank of the Mount Goodenough massif in the Aklavik Range of the northern Richardson Mountains (Geological Survey of Canada Section DFA89-6; 67°56′50″N, 135°24′30″W). In the Aklavik Range the type section can be divided into two informal members. The lower member consists of 228 m of black fissile shale with numerous bands of rusty weathering clay-ironstone concretions and several thin intervals of silty sandstone. Jeletzky previously reported a thin (0.15 m) layer of pebbles at the base of this formation; however, this layer was not seen by Dixon. A prominent cliff-forming sandstone interval found approximately two-thirds up the section is the first unit of the upper member. The upper member consists of 80 m of interbedded shale and sandstone. The sandstones are very fine grained, thin to thick bedded, with bioturbation and hummocky cross-stratification the most common sedimentary features. This twofold division in the Aklavik Range is not always discernible in other areas where Mount Goodenough strata are known to occur.

The contact of the Mount Goodenough Formation with the underlying Kamik Formation is usually abrupt and is recognized as a regional unconformity throughout most of the northern Richardson Mountains (Fig. 3). In the type section, Mount Goodenough strata abruptly and unconformably overlie the upper beds of the Jurassic Husky Formation with the intervening Martin Creek, McGuire, and Kamik formations being absent. In some areas adjacent to tectonic highs such as the Cache Creek Uplift and the Eskimo Lakes Arch, a sandstone

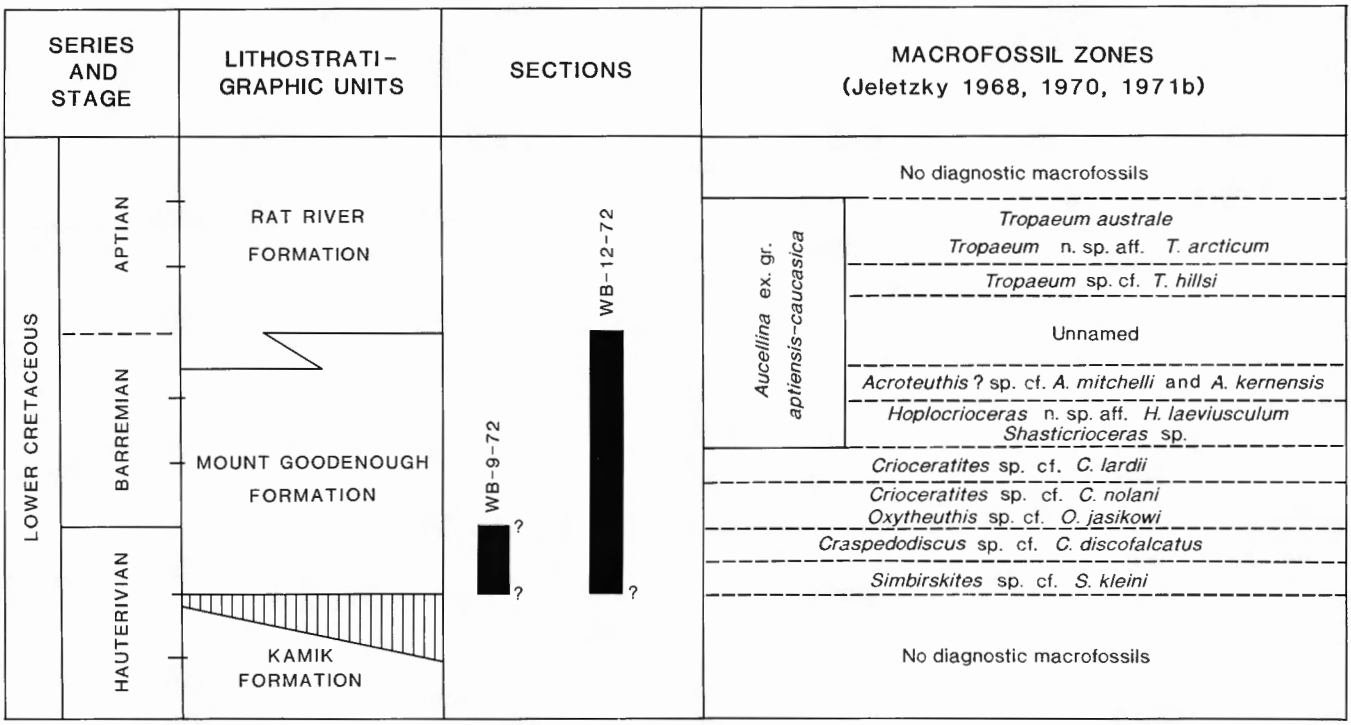

Figure 3. Relationship of measured sections to lithostratigraphic units and, approximately, to Boreal stages and local macrofossil zonation.

is present at the base of the Mount Goodenough succession. If a thick succession of Kamik strata underlies the Mount Goodenough Formation, this basal sandstone cannot be differentiated from the Kamik sandstone. However, in most areas, Mount Goodenough shale rests directly on older strata.

In the subsurface of the Mackenzie Delta and the Tuktoyaktuk Peninsula, Mount Goodenough strata consist of a locally developed basal sandstone of variable thickness overlain by a shale-dominant succession (Dixon et al., 1989). The Siku Formation was originally separated from the Mount Goodenough Formation (Dixon, 1982). However, later work indicated that the Siku shale was part of the Mount Goodenough succession and the Siku shale became the basal member of this formation (Dixon et al., 1989).

At the type section, the upper contact of the Mount Goodenough Formation with the Rat River Formation is abrupt. It is usually transitional elsewhere, as in the subsurface of the Canoe Depression where sandy Rat River beds are replaced laterally by a succession of shale, mudstone, and siltstone. Dixon (1982) has extended the Mount Goodenough Formation to include these shale and siltstone beds.

BIOSTRATIGRAPHIC FRAMEWORK

Megafaunas

The Early Cretaceous invertebrate megafaunas of the North American Boreal Faunal Province are characterized by a high degree of endemism and a low level of diversity. Very often invertebrate megafaunas are dominated by a single species of mollusc. The zonal framework (Fig. 3) established by Jeletzky (1968, 1970, 1971b) using ammonites, belemnites, and bivalves, is the basis for dating the Lower Cretaceous sequences of the Richardson Mountains and for establishing local and regional correlations.

Jeletzky established a late Hauterivian age for the "basal" beds of the Mount Goodenough Formation based on the occurrence of the ammonite *Simbirskites* (*Simbirskites*) sp. cf. *S.* (*S.*) *kleini* and the belemnites *Acroteuthis* sp. cf. *A. conoides* and *Oxyteuthis* sp. in the lower 9 to 12 m of this formation. In the northeastern Richardson Mountains, the beds immediately overlying these basal strata and the *kleini* Zone have yielded only poorly preserved ammonites, bivalves, and belemnites (Zone B of Jeletzky, 1968). Jeletzky claimed an early Barremian age for these beds based on a comparison of the poorly preserved belemnites to *Acroteuthis subquadratus*, *Oxyteuthis jasikowi*, and *O. pugio* var. *rimata*. Later, Jeletzky (1971b) amended this zonation. He established the *Craspedodiscus* sp. cf. *C. discofalcatus* Zone for the latest Hauterivian and changed his early Barremian Zone B to the *Crioceratites* sp. cf. *C. nolani*, *Oxyteuthis* sp. cf. *O. jasikowi* Zone.

The uppermost beds of the lower member and the beds of the upper member of the Mount Goodenough Formation fall within the *Crioceras* (*Hoplocrioceras*) sp. cf. *C.* (*H.*) *remondi* Zone (Jeletzky, 1968). Other diagnostic fossils of this zone include *Crioceras* (*Hoplocrioceras*) ex. gr. *remondi*, *Crioceras* (*Hoplocrioceras*) n. sp. aff. *laeviusculum*, *Ancyloceras* (*Acrioceras*) sp. aff. *A.* (*A.*) *starrkingi*, *Crioceras* (*Crioceras*) sp. cf. *C.* (*C.*) *latum*, *Crioceras* (*Shasticrioceras*?) sp., *Ancyloceras* (*Ancyloceras*) sp. cf. *A. durrelli*, *Aconeceras* sp., *Acroteuthis pseudopanderi*, *Acroteuthis* ex. aff. *conoides*, *Aucellina caucasica*, *A. caucasica* var. *stuckenbergi*, *Aucellina* sp. aff. *A. aptiensis*. This zone was considered by Jeletzky to span most of the Barremian with the exception of the latest Barremian. Later, Jeletzky (1971b) amended this zonation. He established the *Crioceratities* sp. cf. *C. lardii* Zone for the late early Barremian and earliest middle Barremian followed by the middle Barremian *Hoplocrioceras* n. sp. aff. *laeviusculum*, *Shasticrioceras* sp. Zone. Jeletzky also established an *Aucellina* ex. gr. *aptiensis–caucasica* Zone, which he claimed spanned the upper half of the Barremian and most of the Aptian. However, in the Russian Platform, Siberia, and northeast Asia, *Aucellina aptiensis* and *A. caucasica* both range from the late Aptian through the early Albian (Kauffman, 1979, Fig. 3F).

In the northeastern Richardson Mountains, the upper beds of the Mount Goodenough Formation are gradationally overlain by the Rat River Formation. The fauna from these basal Rat River beds (Zone C of Jeletzky, 1968) includes *Acroteuthis mitchelli*, *A.* sp. cf. *A. kernensis*, *A.* sp. cf. *A. pseudopanderi*, *Hibolithes* n. sp.?, nondiagnostic bivalves, and a species of starfish. According to Jeletzky, the belemnites indicate a late Barremian age and he later established the *Acroteuthis*? sp. cf. *A. mitchelli* and *A. kernensis* Zone for these beds (Jeletzky, 1971b). This basal sequence is gradationally overlain by 91.5–122 m (300–400 ft.) of sandstone of the Rat River Formation in which only *Aucellina aptiensis*, *A. caucasica*, and other nondiagnostic bivalves are found (Zone D of Jeletzky, 1968). However, Jeletzky (1968) dated beds from the upper part of the Rat River Formation as earliest late Aptian based on the occurrence of the

ammonite *Tropaeum australe*. He later (1971b) amended this zonation to include the *Tropaeum* sp. cf. *T. hillsi* Zone for the late early Aptian beds and the *T. australe* was renamed the *T. australe–T.* n. sp. aff. *T. arcticum* Zone and dated as middle Aptian. The uppermost beds of this formation lack diagnostic megafossils (Zone E of Jeletzky, 1968). As these siltstone beds gradationally overlie the sandstone of the *T. australe* Zone, Jeletzky assumed a late Aptian age for these deposits.

Microfaunas

To date, the only published studies of the Lower Cretaceous foraminiferal microfaunas of the Richardson Mountains are those of Chamney (1969, 1971a). In 1969, he described 28 agglutinated species recovered from 11 samples from a 33.5 m (110 ft.) section of the lower Mount Goodenough Formation exposed along Goodenough Creek. Chamney later (1971a) described seven new species from the family Ammodiscidae from Upper Jurassic–Lower Cretaceous sequences of the Richardson Mountains and the Canadian Arctic Islands.

Other Lower Cretaceous foraminiferal faunas described from the Boreal Faunal Province have been Albian or younger in age (Tappan, 1957, 1960, 1962; Bergquist, 1966; Chamney, 1978; Sliter, 1981). In the eastern Sverdrup Basin of the Canadian Arctic Islands, Wall (1983) described 11 foraminiferal assemblages ranging in age from Toarcian to Campanian, including four zones from Lower Cretaceous strata on Axel Heiberg Island and western Ellesmere Island. In the central part of this basin, Souaya (1976), using data from the Sun-Gulf-Global Linckens Island P-46 well, reported and illustrated 12 foraminiferal assemblage zones ranging in age from the Late Triassic (Norian) to the Early Cretaceous (Valanginian).

In the Commonwealth of Independent States (C.I.S.), studies by Dain and Kuznetsova (1971), Dain (1972), and Ivanova (1973) on the foraminiferal faunas of the Boreal Basin and western Siberia have concentrated on Upper Jurassic, particularly Volgian, sequences. Basov et al. (1973) listed foraminiferal faunas found in the Arctic region from sequences dated as middle and late Volgian and Berriasian. Saks (1972), in a taxonomic study, described and illustrated Foraminifera from upper Volgian–Berriasian beds from northern Siberia. He considered the Berriasian assemblages to be transitional between the boreal Volgian microfaunas of eastern Europe and the younger Neocomian (i.e., Valanginian) microfaunas of northwestern Europe. Sharovskaya (1968) included a stratigraphic chart with illustrations in a paper on the foraminiferal microfaunas from Jurassic and Lower Cretaceous deposits of western Siberia. Unfortunately, marine upper Hauterivian to lower Albian strata are absent in this depositional basin.

Lower Cretaceous foraminiferal assemblages have been reported in the subsurface from various Mackenzie Delta boreholes (Mountjoy and Chamney, 1969; Chamney, 1970a, b, 1971b, 1973a, b; Chamney *in* Barnes et al., 1974; Chamney *in* Brideaux et al., 1975; Dixon et al., 1989). However, species descriptions and photographs were not included in these reports.

FORAMINIFERAL ASSEMBLAGES

The rich and diverse foraminiferal microfauna of the Mount Goodenough Formation was recovered from a 122 m (400 ft.) section of uniform, soft, grey shale that outcrops along Martin Creek (Section WB-9-72) and a 510.5 m (1675 ft.) section of variably silty shale interbedded with siltstone and sandstone that outcrops at Goodenough Creek, near Mount Goodenough (Section WB-12-72) (Figs. 1, 4).

The Mount Goodenough foraminiferal microfauna has been subdivided into three assemblages and two subassemblages. This microfaunal succession is characterized by decreasing species diversity and abundance from lower to higher stratigraphic levels. Forty-three agglutinated and 76 calcareous species of Foraminifera were recovered, the agglutinated species forming the bulk of the specimens recovered.

Martin Creek section — assemblage 1 (deeper-water biofacies)

The Martin Creek section of the Mount Goodenough Formation is a 122 m (400 ft.) succession of grey shale exposed on the north side of Martin Creek (Fig. 1). Foraminifera were recovered from the lower 114 m (375 ft.) of the section, the top 8 m (25 ft.) being too steep to sample (Figs. 4, 5). These beds at Martin Creek are considered to be the deeper-water biofacies equivalent of the shallow-water biofacies represented by the lower 38 m (125.5 ft.) of the Mount Goodenough Formation at Goodenough Creek.

The Martin Creek assemblage (assemblage 1) contains a rich and diverse foraminiferal fauna of 38 agglutinated and 66 calcareous species. Innumerable

foraminiferal fragments and, more rarely, plant spores, fish teeth, gastropods, echinoderm spines, and bivalve shell fragments were noted.

In terms of abundance of specimens, the agglutinated component of this foraminiferal microfauna predominates. Specimens of *Bathysiphon brosgei*, *B.* sp. cf. *B. granulocoelia*, *Saccammina* sp. cf. *S. lathrami*, *Ammodiscus* sp. cf. *A. tenuissimus*, *A.* sp. cf. *A. cheradospirus*, *Glomospira variabilis*, *Glomospirella arctica*, *Reophax* sp. cf. *R. deckeri*, *R. friabilis*, *Labrospira goodenoughensis*, *Haplophragmoides* sp. cf. *H. concavus*, *Ammobaculites mountgoodenoughensis*, *A. validus*, *A. inelegans*, *Recurvoides* sp. cf. *R. sublustris*, *R.* ex. gr. *R. canningensis*, *Trochammina* ex. gr. *T. neocomiana*, *Gaudryina tailleuri*, and *Arenobulimina mcneili* occur in overwhelming numbers. Other important agglutinated species are *Hippocrepina* sp. cf. *H. barksdalei*, *H. rugosa*, *Saccammina* sp. cf. *S. alexanderi*, *Glomospira subarctica*, *Miliamina inornata*, *Haplophragmoides lobatoloculare*, *Ammobaculites*? *attenuatus*, and *Uvigerinammina laxa*.

Although the calcareous component of this foraminiferal fauna is highly diverse, specimen abundance never approaches that of the agglutinated component. Nodosariids such as *Nodosaria obscura*, *N.* sp. cf. *N. sceptrum*, *Dentalina communis*, *D.* sp. A, *D.* sp. B, *Geinitzinita arctocretacea*, *Pseudonodosaria* sp. cf. *P. netrona*, *P.* sp. A, *Lenticulina* sp. cf. *L. macrodisca*, *L.* sp. cf. *L. saxonica saxonica*, *Darbyella pseudolenticularis*, *Astacolus* sp. cf. *A. incrassatus*, *Frondicularia concinna*, *F.* sp., *Marginulina pyramidalis*, *M.* sp. A, *M.* sp. B, *M.* sp. C, *Marginulinopsis gracilissima*, *M. robusta*, *M. jonesi*, *M.* sp. cf. *M. reiseri*, *Saracenaria pravoslavlevi*, *S.* sp. cf. *S. porcupinensis*, *S. brookeae*, *S. compressa*, *Vaginulina* sp. cf. *V. calliopsis*, and *Vaginulinopsis* sp. cf. *V. pachynota* dominate the calcareous component. However, miliolids such as *Quinqueloculina opedentata*, polymorphinids such as *Globulina prisca*, *G.* sp. cf. *G. exserta*, and *G.* sp. cf. *G. lacrima*, and glandulinids such as *Oolina apiculata emaciata* and *O.* sp. cf. *O. globosa* commonly occur. More complex rotaliinids such as *Praebulimina*? *gravelliniformis*, *Quadrimorphina* sp., and *Conorboides walli* occur in assemblage 1 from the Martin Creek section; however, they reach their greatest abundance in the younger assemblages from the Goodenough Creek section.

Goodenough Creek section — assemblages 1, 2, 3

Foraminifera were recovered from the Mount Goodenough Formation from a 512.2 m (1680 ft.) thick section of shale, siltstone, and sandstone at Goodenough Creek (Fig. 1). This foraminiferal microfauna was divided into three assemblages and two subassemblages (assemblages 1, 2a, 2b, and 3) on the basis of the appearance and disappearance of selected species (Figs. 4, 6).

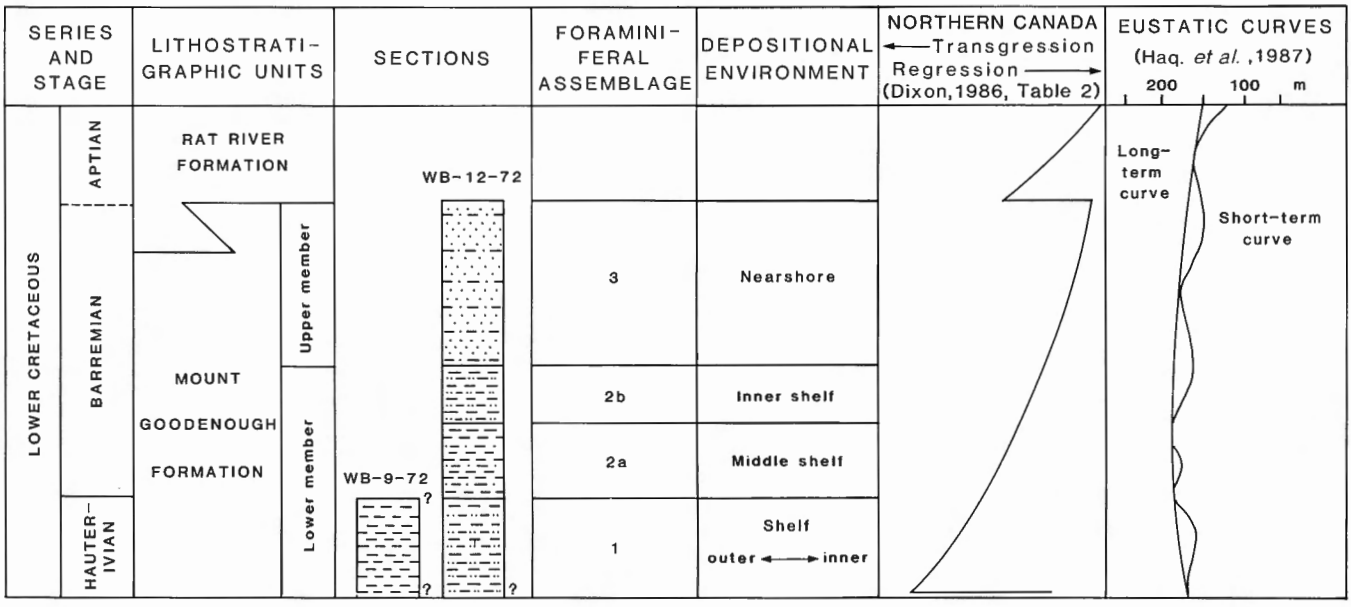

Figure 4. Relationship of measured sections and foraminiferal assemblages to depositional environments, transgressions, regressions, and global sea level changes.

Assemblage 1 — shallow-water biofacies

The oldest assemblage (assemblage 1) was recovered from the basal 38.0 m (125.5 ft.) of the Mount Goodenough succession at Goodenough Creek. Assemblage 1 consists of a foraminiferal microfauna of 18 agglutinated and 10 calcareous species. Of these 28 species, 23 were also recovered from the Martin Creek section and five are new species. Thus these assemblages are closely related and are part of a unified faunal unit. These lower beds at Goodenough Creek are therefore considered to be the shallow-water biofacies equivalent of the deeper-water biofacies represented by the 122 m (400 ft.) succession of grey shale at Martin Creek.

In terms of abundance of specimens, *Bathysiphon brosgei*, *B.* sp. cf. *B. granulocoelia*, *Glomospira variabilis*, *Glomospirella arctica*, *Labrospira goodenoughensis*, *Arenobulimina mcneili*, and *Lenticulina* sp. cf. *L. macrodisca* dominate. However, *Praebulimina*? *gravelliniformis* is at its most abundant in this assemblage. Also a new species, *Haplophragmoides euryraptum*, occurs abundantly. Four other new species are *Miliammina* sp., *Quinqueloculina* sp., *Bolivina* sp., and *Verneuilina caldwelli*, the first three species occurring only rarely in this assemblage and the latter species reaching greatest abundance in younger assemblages.

The upper boundary of assemblage 1 is marked by the disappearance of *Bathysiphon* sp. cf. *B. granulocoelia*, *Labrospira goodenoughensis*, *Ammobaculites validus*, *Recurvoides* ex. gr. *R. canningensis*, *Arenobulimina mcneili*, and *Praebulimina*? *gravelliniformis*.

Assemblage 2

Assemblage 2 was recovered from 360 m (1180.5 ft.) of silty shale and siltstone from the upper part of the lower member of the Mount Goodenough Formation at Goodenough Creek. This assemblage has been divided into two subassemblages: subassemblage 2a from the lower 135.5 m (443.5 ft.) of this interval and subassemblage 2b from the upper 224.5 m (737 ft.).

Subassemblage 2a consists of 15 agglutinated and 20 calcareous species. The agglutinated component of this microfauna once again dominates in terms of abundance of specimens. For example, *Saccammina* sp. cf. *S. lathrami*, *Glomospirella arctica*, *Recurvoides* sp. cf. *R. sublustris*, and *Gaudryina tailleuri* occur abundantly. Several species such as *Haplophragmoides lobatoloculare* and *Verneuilina caldwelli*, which first appeared in the older assemblage 1, reach their greatest abundance in this subassemblage. Other agglutinated species such as *Ammobaculites mountgoodenoughensis*, *A. inelegans*, and *Trochammina* ex. gr. *T. neocomiana*, which were present in the deeper-water biofacies of assemblage 1 at Martin Creek but not in the shallow-water biofacies at Goodenough Creek, occur in subassemblage 2a. As well, many calcareous species that were present in the deeper-water biofacies but absent in the shallow-water biofacies of assemblage 1 reappear in subassemblage 2a, e.g., *Dentalina* sp. A, *D.* sp. B, *Marginulina pyramidalis*, *Marginulinopsis robusta*, and *Oolina* sp. cf. *O. globosa*. The upper boundary of this subassemblage is drawn where the agglutinated species *Ammobaculites mountgoodenoughensis* and many of the calcareous nodosariid species disappear.

Subassemblage 2b is characterized by a meagre calcareous component with the nodosariids conspicuously absent. However, agglutinated species such as *Saccammina* sp. cf. *S. lathrami*, *Haplophragmoides lobatoloculare*, *Recurvoides* sp. cf. *R. sublustris*, and *Gaudryina tailleuri* are found abundantly. Other agglutinated species such as *Psamminosphaera asperata*, *Cribrostomoides cryptocameratum*, and *Ammobaculites inelegans*, which were present in the older assemblages, now reach their greatest abundance in this subassemblage. Two new introductions, *Recurvoides* ex. gr. *R. disputabilis* and *Verneuilinoides implexus*, occur abundantly, the former species being found only in this subassemblage, the latter continuing into assemblage 3.

The calcareous component of subassemblage 2b is relatively meagre, consisting of only nine species, six of which occur rarely. The remaining three are important stratigraphically. *Oolina hauteriviana hauteriviana*, a new introduction, is confined to this subassemblage. *Quadrimorphina* sp., occurring rarely in subassemblage 2a, reaches its greatest abundance in 2b and is not found at higher stratigraphic levels. In contrast, *Conorboides walli*, which is found rarely in assemblage 3, reaches its greatest abundance here. The upper boundary of this subassemblage is drawn where the *Quadrimorphina* sp. and the calcareous polymorphinid and glandulinid species disappear. The agglutinated species *Gaudryina tailleuri*, *Recurvoides* ex. gr. *R. disputabilis*, *Verneuilina caldwelli*, *Haplophragmoides euryraptum*, and *Trochammina* ex. gr. *T. neocomiana* also disappear at this boundary.

Assemblage 3

Assemblage 3, from 112.5 m (369 ft.) of the upper member of the Mount Goodenough beds, is characterized by an impoverished microfauna of 12 agglutinated and two calcareous species. With the exception of *Ammodiscus* sp. cf. *A. rotalarius*, the other species are also present in the older assemblages. *Saccammina* sp. cf. *S. lathrami*, *Cribrostomoides cryptocameratum*, *Haplophragmoides lobatoloculare*, *Ammobaculites inelegans*, and *Verneuilinoides implexus* continue to dominate the fauna. The two remaining calcareous species, *Conorboides walli* and *Marginulinopsis robusta*, occur only rarely.

BIOSTRATIGRAPHY

Environmental considerations

In assemblage 1 from Martin Creek, the species are the most diverse and the specimens are the most abundant of the assemblages studied. Thirty-eight species of agglutinated Foraminifera and 66 calcareous species make up this assemblage; however, specimens of agglutinated species are much more abundant than calcareous species and comprise the bulk of the microfauna recovered. Of the living agglutinated Foraminifera, species of the Lituolidae, Hormosinidae, and Ammodiscidae are found in nearshore or inshore environments of low salinity. But, as is common with stenohaline groups, certain species of these families are also found in marine waters of normal salinity and in greater depths. Of the calcareous component, living Nodosariidae populate the more open-marine waters of the shelf from middle to outer neritic depths and the upper reaches of the slope. Species of the Nodosariidae reach their greatest abundance and diversity in assemblage 1 at Martin Creek. Gordon (1970, p. 1697), in a discussion of Jurassic Foraminifera, noted that predominantly nodosariid fossil foraminiferal faunas are typical of shelf seas. Thus the probable environment of deposition indicated by the rich nodosariid component of this assemblage from Martin Creek would be the open-marine waters of the shelf of approximately the outer neritic zone.

The greater proportion of species found in assemblage 1 from the Martin Creek section were also found in assemblage 1 from the Goodenough Creek section, but there are fewer species and fewer individuals present. The Ammodiscidae, Lituolidae, and Ataxophragmiidae are represented most abundantly. The nodosariids are still the dominant calcareous element, although greatly reduced in diversity and abundance. More complex rotaliinids such as *Praebulimina? gravelliniformis* n. sp. are found in abundance. The general composition of this assemblage indicates a normal marine shelf environment; however, the reduced diversity of the fauna, the reduction in specimen abundance, and the occurrence of silty layers in a predominantly shale sequence suggest shallower water of approximately the inner neritic zone.

The composition of subassemblage 2a indicates a brief return to conditions approximating those of assemblage 1 from the Martin Creek section. However, the nodosariids and other calcareous species are not as abundant or diverse as the species from the Martin Creek section assemblage. The loss of most of this calcareous component in the succeeding subassemblage 2b signals a return to conditions of shallower water. Lithologically, the deposits from which assemblage 2 was recovered show a coarsening-upward trend from shale and silty-shale in the lower beds of the succession to predominantly siltstone beds with only minor shale units in the upper beds. Thus, the probable environment of deposition for the beds from which assemblage 2 was recovered is again the open-marine water of the shelf. However, middle neritic depths are indicated for the beds from which subassemblage 2a was recovered, succeeded by inner neritic depths for the beds from which subassemblage 2b was recovered.

This trend toward a shallowing of the region becomes even more obvious in the meagre microfauna of assemblage 3. Virtually the entire calcareous component has disappeared and agglutinated species of the Saccamminidae, Ataxophragmiidae and, particularly, Lituolidae dominate the assemblage. This faunal composition indicates nearshore conditions, culminating in the sandstone of the overlying Rat River Formation.

Biostratigraphic considerations

The Martin Creek section and the Goodenough Creek section are approximately 40 km apart in an area of extensive faulting. The top of the Martin Creek section is a present-day erosional surface and the bases of both sections are concealed under valley floor debris. The lithology of the sections is different, precluding any correlation on lithological criteria alone. However, the similarities of the foraminiferal microfauna from these sections indicate a relationship between the two areas. In particular, assemblage 1 microfaunas from these two sections are closely related and must be considered part of a unified faunal unit (Fig. 4).

Assemblage 1 from the Martin Creek section is considered to be a deeper-water biofacies approximating the outer neritic zone, whereas assemblage 1 from the Goodenough Creek section, represents a shallow-water biofacies approximating the inner neritic zone. Thus, assemblage 1 microfaunas from these two sections are contemporaneous. The shales on Martin Creek are the deep-water facies equivalent of the shallow-water sequences of the lower 38 m from the Goodenough Creek section.

Assemblages 1, 2, and 3 from Goodenough Creek were recovered in succession from the Mount Goodenough Formation and boundaries between the assemblages were drawn on breaks in the faunal succession (i.e., appearance and disappearance of species) rather than at lithological boundaries. The shift in the faunal spectrum in assemblages 1 to 3 from the Goodenough Creek section is far more gradual than the noticeable differences between the shallow-water and deeper-water biofacies of assemblage 1 from Martin Creek and Goodenough Creek sections.

Comparison with other foraminiferal assemblages

The Mount Goodenough assemblages are boreal in aspect; however, these assemblages, particularly the agglutinated Foraminifera, exhibit a certain degree of endemism, possibly as a result of restrictions between the Arctic regions and the world's major oceans. This endemism is reflected in the composition of the microfauna, with 22 "new" species making comparisons with foraminiferal assemblages from other parts of the world difficult.

Chamney (1969, 1971a) previously described a number of species from Lower Cretaceous sequences of the Richardson Mountains, particularly the beds of the Mount Goodenough Formation, from which assemblage 1 of this study was recovered. Although the similarities between assemblage 1 of this study and Chamney's microfauna are recognizable, differences exist in the taxonomy used by Chamney and this study.

The area of the Sverdrup Basin appears to hold some promise for regional correlations. Wall (1983) recognized four Lower Cretaceous assemblages from the eastern Sverdrup Basin; however, only one assemblage was recovered from upper Hauterivian to upper Barremian strata. His *Verneuilinoides neocomiensis* assemblage was recovered from a thin shale unit in the nonmarine uppermost Valanginian to Aptian Isachsen Formation. Unfortunately this microfauna lacks age-diagnostic components, as the only species identified, *V. neocomiensis*, has been reported to range from Berriasian to Aptian time in Europe.

Correlations with Europe are not possible because of pronounced faunal differences between the Arctic and European areas. More data from intervening areas such as western Siberia and northern Norway are needed. However, such links are again complicated by lithofacies changes between the northwestern Northwest Territories and western Siberia and northern Norway (Sharovskaya, 1968; Løfaldli and Thusu, 1979).

CONCLUSIONS

The Mount Goodenough Formation in the northwestern Northwest Territories contains a rich microfauna of 119 species of Foraminifera. This foraminiferal microfauna has been subdivided into three assemblages and two subassemblages and has been dated as late Hauterivian to late Barremian (Fig. 4). These dates are based on integration with the macrofossil zones (ammonites, belemnites, and bivalves) established for northern Yukon and northwestern Northwest Territories (Jeletzky 1968, 1970, 1971b). Of the 119 species of Foraminifera described in this paper, 22 are new species not previously described in the scientific literature.

The three foraminiferal assemblages recovered from the Mount Goodenough Formation are marked by a decrease in species diversity and individual numbers from older to younger assemblages. This trend is accompanied by a coarsening upward in grain size from the shale of the lower part of the informal lower member of this formation to the sandstone-dominant upper member. The environment of deposition for the strata of the Mount Goodenough Formation ranges from open-marine shelf (probably outer shelf) through inner-middle shelf to near shore deposits of probably lowermost shoreface or offshore sand bars.

Jeletzky (1974, 1978) proposed that a "profound and regional Late Hauterivian to Late Barremian subsidence" of the Richardson Mountain Trough (i.e., the Blow Trough) caused a "longlasting and widespread transgression which peaked in the late to latest Barremian." He further proposed that the greatest part of this trough continued as a littoral to neritic basin well into the late Aptian when a "strong orogenic phase" uplifted the southern part of the area, closing the southern outlet of the trough and restricting

deposition to the central part. Dixon (1982, 1986), however, proposed a marine shelf rather than a basinal model of deposition for this area. Dixon also proposed (1986, p. 67, Table 2) that a Late Hauterivian transgression inundated the area. This transgression was followed by a period of progradation that lasted until the latest Barremian (Fig. 4). Data from the present study also indicate a marine shelf depositional environment for the deposits of the Mount Goodenough Formation, with a transgressive acme of earliest Late Hauterivian, followed by a period of regression that spanned latest Late Hauterivian to Late Barremian time.

Various authors (e.g., Kauffman, 1977, 1979; Vail et al., 1977; Haq et al., 1987) have proposed that episodes of deposition and nondeposition of marine strata in different parts of the world were probably caused by eustatic (global) sea level changes. Haq et al. (1987) illustrate an almost continuous rise in sea level from Early to Middle Valanginian to latest Barremian time. If eustasy were the controlling factor in sea level changes during the Early Cretaceous, then the transgressive peaks and regressive troughs of marine depositional complexes, as recorded in the sedimentary sequences of cratonic regions, should be demonstrably synchronous within the limits of stratigraphic dating. Comparison of the depositional complex (i.e., the transgression–regression cycle) of the Mount Goodenough Formation from northern Canada with those depositional complexes recorded from western Canada (Caldwell, 1984; Stott, 1984) shows that there is no record of a western Canadian transgression in the Late Hauterivian comparable to the Mount Goodenough depositional complex of northern Yukon and northwestern Northwest Territories. This suggests that any record of eustatic oscillations of sea level in this area were overprinted by local and regional tectonic movements (i.e., folding, faulting, and widespread uplift), which occurred during the Late Hauterivian.

SYSTEMATIC PALEONTOLOGY

The classification of Foraminifera adopted in this study essentially follows that of Loeblich and Tappan in the *Treatise on Invertebrate Paleontology*, Part C, *Protista* 2, volumes 1 and 2 (1964). However, the irregularly coiled genus *Recurvoides* Earland, 1934 has been placed within the subfamily Recurvoidinae Alekseichik, 1973, in accordance with the proposals of Alekseichik-Mitskevich (1973). Also, the coiled calcareous nodosariids have been placed within the subfamily Lenticulininae Sigal, 1952, as recommended by Putrja (1970). We have not followed the new classification of the Foraminiferida as proposed by Loeblich and Tappan (1988) as the suprageneric classification of many of the genera studied in this paper remains unclear under Loeblich and Tappan's new scheme.

All types and figured specimens are deposited in the National Type Collection of Plant and Invertebrate Fossils of the Geological Survey of Canada, 601 Booth Street, Ottawa.

The following abbreviations of measurements of figured specimens have been used: L, length; W, width; H, height; T, thickness; D, diameter.

Note: "v" in front of an entry in the synonymy list indicates that the specimens were compared directly under the microscope. "*" denotes assemblage 1 from the Martin Creek section (deeper-water biofacies). "**" denotes assemblage 1 from the Goodenough Creek section (shallow-water biofacies). "Sample No." refers to the distribution charts (Figs. 5, 6), and denotes the sample from which the figured specimen was recovered.

Phylum PROTOZOA

Class SARCODINA

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, 1872

Bathysiphon brosgei Tappan, 1957

Plate 1, figures 5, 6

1957 *Bathysiphon brosgei* Tappan, p. 202, Pl. 65, figs. 1–5.
1962 *Bathysiphon brosgei* Tappan. Tappan, p. 128, Pl. 29, figs. 1–5.
v1976 *Bathysiphon brosgei* Tappan. Souaya, p. 263, Pl. 3, fig. 15.

1978 *Bathysiphon brosgei* Tappan. Chamney, p. 8, Pl. 1, figs. 1–3.
1981 *Bathysiphon brosgei* Tappan. Sliter, p. 52, Pl. 9, figs. 1, 2.

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, abundant. Subassemblages 2a and 2b, rare. Assemblage 3, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 93967	0.59	0.15	305
GSC 93968	0.88	0.27	335

Remarks. Tappan originally described *Bathysiphon brosgei* from Albian–Campanian rocks of the Arctic Slope of Alaska. This species has since been reported from Albian to Maastrichtian rocks of the Western Interior (Mello, 1969, 1971; Morris, 1971; Sutherland and Stelck, 1972; Stelck, 1975; North and Caldwell, 1970, 1975a, 1975b; McNeil and Caldwell, 1981; Koke and Stelck, 1985; Stelck and Koke, 1987), Campanian–Maastrichtian rocks of the Pacific Coast (Sliter, 1968), and Lower and Middle Albian rocks of the Yukon (Chamney, 1978) and the Arctic Islands (Sliter, 1981). In the Arctic, Souaya (1976), working from drillhole data from a well on Linckens Island, reported *B. brosgei* from Berriasian–lower Valanginian rocks of the Deer Bay Formation, thus extending the range of this species into the lowermost Cretaceous.

Bathysiphon brosgei is easily distinguished from associated species of *Bathysiphon* by its much smaller test size and more finely agglutinated wall.

Bathysiphon vitta Nauss, 1947

Plate 1, figures 7, 8

1947 *Bathysiphon vitta* Nauss, p. 334, Pl. 48, fig. 4.
1962 *Bathysiphon vitta* Nauss. Tappan, p. 128–129, Pl. 29, figs. 6–8.
v1976 *Bathysiphon vitta* Nauss. Souaya, p. 263, Pl. 3, fig. 16.
1981 *Bathysiphon vitta* Nauss. Sliter, p. 52, Pl. 9, figs. 3, 4.
v1983 *Bathysiphon vitta* Nauss. Wall, p. 262, Pl. 6, fig. 1.

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 93969	1.14	0.64	329
GSC 93970	1.00	0.61	323

Remarks. Nauss originally described *Bathysiphon vitta* from the Campanian Lea Park Formation of Alberta. In the Arctic, Tappan (1962) recorded this species from Albian rocks of the Arctic Slope of Alaska and Sliter (1981) from Albian rocks of the Canadian Arctic Islands. Souaya (1976) extended the range of this species by documenting it from the Kimmeridgian Awingak and the Berriasian–lower Valanginian Deer Bay formations of the Sverdrup Basin.

Bathysiphon vitta occurs relatively rarely in the Martin Creek section. In Assemblage 1, it is found with *B. brosgei* from which it differs by its larger size, compressed test, and generally smooth appearance and with *B.* sp. cf. *B. granulocoelia*, from which it differs by its smaller size, finely agglutinated wall, and smooth texture.

Bathysiphon sp. cf. *B. granulocoelia* Chamney, 1969

Plate 1, figures 3, 4

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, common.

Dimensions (mm).

	L	W	Sample no.
GSC 93971	1.46	0.45	308
GSC 93972	1.46	0.44	308

Remarks. The specimens recovered are similar to *Bathysiphon granulocoelia* Chamney, previously recorded from three samples taken from the lower 33.5 m (110 ft.) of the Mount Goodenough Formation about 3 km north of Goodenough Creek (Chamney, 1969). They differ, however, in that the specimen described by Chamney has a wall composed of small- to medium-sized quartz grains, whereas the present species is more coarsely agglutinated.

Bathysiphon sp.

Plate 1, figures 1, 2

Occurrence and distribution. Assemblage 1*, rare.

Description. Test large, elongate, flattened, straight to slightly bent tube open at both ends; wall thick, consisting of poorly sorted, medium to coarse quartz grains, surface roughly textured; aperture simple, rounded to elliptical, with slightly lipped appearance.

Dimensions (mm).

	L	W	Sample no.
GSC 93973	1.86	1.37	307
GSC 93974	1.25	1.18	307

Remarks. Only three specimens of this species were recovered, all from the Martin Creek section. As all of the specimens are broken, the maximum size of this very large species cannot be given. It is probable that this species occurred in larger numbers than were found and that specimens were lost due to the fragile nature of the extremely large tests.

Subfamily HIPPOCREPININAE Rhumbler, 1895

Genus *Hippocrepina* Parker, 1870

Hippocrepina rugosa n. sp.

Plate 1, figures 10–13

Diagnosis. Hippocrepina rugosa is characterized by a flattened test with well developed, irregularly spaced growth wrinkles or constrictions.

Etymology. The specific name refers to the wrinkled appearance of the test.

Occurrence and distribution. Assemblage 1*, abundant.

Description. Test flattened, elongate, tapering, consisting of undivided single chamber with irregularly spaced, prominent transverse growth wrinkles or constrictions; proloculus pointed or gently rounded; wall finely agglutinated, smoothly finished; apertural end of test broadly rounded; aperture small, terminal, central, rounded or elliptical, somewhat constricted.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 93976	0.69	0.24	308
Paratype GSC 93975	0.67	0.24	308
Paratype GSC 93977	0.64	0.16	308
Paratype GSC 93978	0.82	0.22	308

Remarks. Specimens of *Hippocrepina rugosa* display two test types: a pointed microspheric form (figs. 11–13) and a rounded megalospheric form (fig. 10). *Hippocrepina rugosa* compares favourably with the more elongate specimens of *H. barksdalei* (Tappan, 1962, Pl. 29, fig. 23; Sliter, 1981, Pl. 9, fig. 9). However, it differs in having more constricted and prominent transverse growth wrinkles.

Hippocrepina sp. cf. *H. barksdalei* (Tappan), 1957

Plate 1, figure 9

v1969 *Hippocrepina* cf. *H. barksdalei* Tappan. Chamney, p. 13, Pl. 1, figs. 7a, b.

Occurrence and distribution. Assemblage 1*, common. Assemblage 3, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 93979	0.62	0.45	549

Remarks. Hippocrepina sp. cf. *H. barksdalei* is similar to the shorter, broader specimens of *H. barksdalei* such as those reported by Tappan (1962, Pl. 29, figs. 21, 22, 25–27) from Albian rocks of the Arctic Slope of Alaska. The present species possesses a faintly lipped aperture, whereas Tappan describes the aperture of *H. barksdalei* as being "a rounded opening at the somewhat constricted end of the chamber."

The present species is identical to that reported by Chamney (1969) from the lowermost beds of the Mount Goodenough Formation 3 km north of Goodenough Creek. In the present study, only one specimen of this species was recovered from the Goodenough Creek section, whereas 27 specimens were recovered from the shale at Martin Creek.

Genus *Hyperammina* Brady, 1878

Hyperammina sp.

Plate 1, figures 14, 15

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, compressed, consisting of a large subround to ovate proloculus followed by long, tubular, parallel-sided second chamber smaller than proloculus in diameter; wall medium to finely agglutinated with rough surface texture; ovate aperture terminal at end of tubular second chamber.

Dimensions (mm).

	L	W	Sample no.
GSC 93980	1.10	0.40–0.22	325
GSC 93981	0.68	0.34–0.15	324

Remarks. Chamney (1969) previously recorded two species of *Hyperammina* from the Mount Goodenough Formation. The present species differs from his *Hyperammina* sp. cf. *H. acicula* (Parr) *fide* Crespin in possessing a large subrounded to ovate proloculus and a parallel-sided second chamber rather than a pointed proloculus and a flaring second chamber. It differs from his *Hyperammina* sp. cf. *H. aljutovica* Reitlinger in being much larger with a larger proloculus.

Family SACCAMMINIDAE Brady, 1884

Subfamily PSAMMOSPHAERINAE Haeckel, 1894

Genus *Psamminosphaera* Schulze, 1875

Psamminosphaera asperata n. sp.

Plate 1, figures 16–18

Diagnosis. *Psamminosphaera asperata* is characterized by the considerable amount of fine quartz matrix in its wall of small- to medium-sized quartz grains, giving the surface a roughly textured appearance.

Etymology. The specific name refers to the roughened appearance of the test.

Occurrence and distribution. Assemblage 1*, rare. Subassemblage 2a, rare. Subassemblage 2b, common. Assemblage 3, rare.

Description. Test single chamber, spherical to subspherical, slightly flattened; wall composed of small- to medium-sized quartz grains in fine quartz matrix; surface roughly textured; aperture indistinct.

Dimensions (mm).

	D	T	Sample no.
Holotype GSC 93984	0.69	0.47	507
Paratype GSC 93982	0.45	0.31	458
Paratype GSC 93983	0.56	0.44	493

Remarks. *Psamminosphaera asperata* occurs throughout the Mount Goodenough Formation. *Psamminosphaera asperata* differs from the associated species *Saccammina* sp. cf. *S. lathrami* (Tappan) in its spherical shape, rough texture, and lack of a distinct aperture.

Psamminosphaera asperata differs from *P. fusca* (Schulze), reported by Bartenstein and Brand (1951) from German Valanginian deposits, in its more spherical test shape and more finely agglutinated wall. It differs from *P. squalida* (Dain), reported by Dain (1972) from Volgian deposits of western Siberia, in its smaller size, rougher texture, and lack of spicules incorporated in its test wall.

Subfamily SACCAMMININAE Brady, 1884

Genus *Saccammina* M. Sars, 1869

Saccammina sp. cf. *S. alexanderi* (Loeblich and Tappan), 1950

Plate 1, figures 22, 23

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 93985	1.20	0.64–0.21	283
GSC 93986	1.21	0.53–0.20	333

Remarks. This species is very similar to *Saccammina alexanderi* (Loeblich and Tappan), which occurs widely in Albian–Campanian rocks of the Western Interior of

North America. However, the present species usually exhibits a more prominent (i.e., longer and narrower) neck.

Saccammina sp. cf. *S. lathrami* Tappan, 1960

Plate 1, figures 19–21

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, common. Subassemblages 2a and 2b, abundant.

Dimensions (mm).

	L	W	Sample no.
GSC 93987	0.36	0.33	289
GSC 93988	0.44	0.39	289
GSC 93989	0.61	0.59	289

Remarks. The tests recovered throughout the Mount Goodenough Formation differ from *Saccammina lathrami* Tappan, described from Albian–Cenomanian rocks of the Alaskan North Slope, in having poorly defined apertures that are usually flush with the test and only rarely having the short neck indicative of the Alaskan material. The present species is very similar to *S.* sp. cf. *S. lathrami* described by Brooke and Braun (1981) from the Upper Jurassic Fernie Formation of the Peace River area of northeastern British Columbia and adjacent Alberta. Similar saccamminids have been noted from Upper Cretaceous rocks of the Western Interior (Stelck et al., 1958, p. 31, Pl. 4, fig. 11; Morris, 1971, p. 265, Pl. 1, figs. 7–11; Sutherland and Stelck, 1972, p. 559–561, Pl. 1, figs. 5, 9; McNeil and Caldwell, 1981, p. 134, Pl. 9, fig. 10).

Genus *Pelosina* Brady, 1879

Pelosina? sp.

Plate 1, figures 24, 25

Occurrence and distribution. Assemblage 1*, rare.

Description. Test medium sized, uniserial, subcylindrical; wall thin, finely agglutinated with roughened surface texture; test with constricted tubular extensions at either end, extensions not equally distant from centre of test; aperture at open ends of tubular extensions.

Dimensions (mm).

	L	W	T	Sample no.
GSC 93990	0.66	0.29	0.30	301
GSC 93991	0.36	0.26	0.22	301

Remarks. Only four specimens of *Pelosina*? sp. were recovered from the Martin Creek section. These specimens are tentatively referred to *Pelosina*, although the extensions on either end of the test are not equidistant from the centre of the test.

Family AMMODISCIDAE Reuss, 1862

Subfamily AMMODISCINAE Reuss, 1862

Genus *Ammodiscus* Reuss, 1862

Ammodiscus sp. cf. *A. cheradospirus* Loeblich and Tappan, 1950

Plate 1, figures 33–35

Occurrence and distribution. Assemblage 1*, very abundant.

Dimensions (mm).

	D	T	Sample no.
GSC 93992	1.38–0.95	0.15	298
GSC 93993	1.11	0.15	298
GSC 93994	2.00	0.19	298

Remarks. Ammodiscus cheradospirus Loeblich and Tappan was first described from the Jurassic Rierdon Formation of Montana. The specimens found at Martin Creek are very similar to those specimens of *A. cheradospirus* subsequently described and figured by Tappan (1955, p. 38, Pl. 8, fig. 9) from Upper Jurassic rocks of the Alaskan North Slope. They differ, however, in that the present species is larger, more coarsely arenaceous, the spiral suture is less distinct than that shown by Tappan, and the tests are commonly ovate in outline. In these characteristics, the present species resembles *A.* sp. cf. *A. cheradospirus* described by Brooke and Braun (1981) from the Upper Jurassic Fernie Formation of northeastern British Columbia and adjacent Alberta, differing only in the more distinct spiral suture of the present species.

Ammodiscus sp. cf. *A. mangusi* (Tappan), 1957

Plate 1, figures 31, 32

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	D	T	Sample no.
GSC 93995	0.74–0.47	0.19	318
GSC 93996	0.74–0.45	0.15	318

Remarks. Only a few specimens of *Ammodiscus* sp. cf. *A. manugsi* (Tappan) have been recovered from the Martin Creek section. This species compares favourably to *A. mangusi* originally described by Tappan (1957) from Albian formations of the Alaskan North Slope. *Ammodiscus mangusi* is described as having a discoidal test and a thick, evolute second chamber that forms only a few whorls. Tests of the present species exhibit an ovate shape and a second chamber which, although planispirally evolute with a few chambers, is more irregularly planispiral than Tappan's species. This feature, however, could be a product of distortion due to compaction of the tests.

Ammodiscus sp. cf. *A. rotalarius* Loeblich and Tappan, 1949

Plate 1, figure 30

Occurrence and distribution. Assemblage 3, rare.

Dimensions (mm).

	D	T	Sample no.
GSC 93997	0.60–0.52	0.14	548

Remarks. The present species displays the overlap between whorls that is characteristic of *Ammodiscus rotalarius* Loeblich and Tappan. However, as only a single, badly distorted specimen was recovered from the upper Mount Goodenough Formation, it was felt that the specific designation should be tentative. *Ammodiscus rotalarius* was originally described by Loeblich and Tappan (1949) from the Albian Walnut Clay of Oklahoma. Tappan (1962) later recorded it from the Albian Torok Formation and the Albian–Cenomanian Nanushuk Group of the Arctic Slope of Alaska, Chamney (1978) from the Albian Arctic Red Formation of the Snake River–Peel River area of the Yukon, and Sliter (1981) from the Albian Christopher Formation of the Canadian Arctic Islands.

Ammodiscus sp. cf. *A. tenuissimus* (Gümbel), 1862

Plate 1, figures 26–29

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, common. Subassemblage 2a, rare.

Dimensions (mm).

	D	T	Sample no.
GSC 93998	0.49–0.33	0.08	318
GSC 93999	0.56	0.06	318
GSC 94000	0.56–0.40	0.11	298
GSC 94001	0.42–0.37	0.07	298

Remarks. Specimens of the present species compare favourably to *Ammodiscus tenuissimus*, originally described as *Spirillina tenuissima* by Gümbel (1862) from Oxfordian strata in Germany. This species has subsequently been widely reported from other Middle and Upper Jurassic strata in Europe. The range of *A. tenuissimus* has been extended into the Lower Cretaceous both in Germany (Bartenstein and Brand, 1951; Michael, 1967) and the C.I.S. (Myatliuk, 1939).

Genus *Glomospira* Rzehak, 1885

Glomospira subarctica Chamney, 1969

Plate 2, figures 1–4

v1969 *Glomospira subarctica* Chamney, p. 16, 17, Pl. 2, figs. 7–9.

v1983 *Glomospira subarctica* Chamney. Wall, p. 261, Pl. 5, fig. 12.

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, rare. Subassemblage 2a, rare.

Dimensions (mm).

	D	H	Sample no.
GSC 94002	0.50–0.33	0.40	430
GSC 94003	0.34–0.28	0.29	333
GSC 94004	0.24	0.26	269
GSC 94005	0.26	0.31	269

Remarks. Glomospira subarctica was first described by Chamney (1969) from the lowermost beds of the Mount Goodenough Formation north of Goodenough Creek. This species has also been reported by Wall (1983) from his *Uvigerinammina* sp. 1 Assemblage from the upper Deer Bay Formation of the eastern Sverdrup Basin, Canadian Arctic Islands, from strata of Berriasian–Valanginian age.

Glomospira variabilis (Kübler and Zwingli), 1870

Plate 2, figures 5, 6

1870 *Cornuspira variabilis* Kübler and Zwingli, p. 33, Pl. 4(I), fig. 4.
1955 *Glomospira pattoni* Tappan, p. 40, Pl. 8, figs. 15–17.
1960 *Glomospira variabilis* (Kübler and Zwingli). Seibold and Seibold, p. 324, figs. 2q–s.
v1969 *Glomospira subarctica saturna* Chamney, p. 17–18, Pl. II, figs. 10–12.

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, common. Subassemblage 2a, rare. Subassemblage 2b, rare.

Dimensions (mm).

	D	H	Sample no.
GSC 94006	0.70	0.27	318
GSC 94007	0.65–0.56	0.34	318

Remarks. Glomospira variabilis (Kübler and Zwingli) was recovered from both sections studied. It differs from the associated species *Glomospirella arctica* Chamney in that the early portion of the tubular second chamber forms a conical spiral rather than a streptospiral coil.

Glomospira variabilis was first described from Oxfordian beds of Germany. In North America, Tappan (1955) reported a similar species, *G. pattoni*, from Upper Jurassic rocks of the Alaskan North Slope. Seibold and Seibold (1960) first recognized the conspecificity of these two species. *Glomospira subarctica saturna* Chamney, originally described from the lower beds of the Mount Goodenough Formation as it outcrops along Goodenough Creek, is identical to the smaller specimens of *G. variabilis* of this study.

Genus *Glomospirella* Plummer, 1945

Glomospirella arctica Chamney, 1969

Plate 2, figures 7, 8

v1969 *Glomospirella arctica* Chamney, p. 18–20, Pl. II, figs. 13, 14; Pl. III, figs. 1–4.

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, common. Subassemblages 2a and 2b, common.

Dimensions (mm).

	D	H	Sample no.
GSC 94008	0.65–0.45	0.15	308
GSC 94009	0.69–0.51	0.19	308

Remarks. Glomospirella arctica Chamney was originally described from the lower beds of the Mount Goodenough Formation north of Goodenough Creek.

Subfamily TOLYPAMMININAE Cushman, 1928

Genus *Lituotuba* Rhumbler, 1895

Lituotuba tortuosa n. sp.

Plate 2, figures 9–11

Diagnosis. Lituotuba tortuosa is characterized by its initial coiling, which is planispiral and regular with only the later whorls becoming uncoiled and irregular in growth.

Etymology. The specific name refers to this irregular (i.e., full of crooks or turns) growth habit.

Occurrence and distribution. Assemblage 1*, common.

Description. Test composed of proloculus and long, undivided tubular second chamber, early stage loosely planispirally coiled resembling *Ammodiscus*, later stage uncoiled and irregular; wall finely agglutinated, surface smooth; aperture at open end of tubular second chamber.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94010	0.61	0.56	278
Paratype GSC 94011	0.60	0.44	277
Paratype GSC 94012	0.53	0.45–0.10	277

Remarks. Lituotuba tortuosa differs from *L. irregularis*, reported by Tappan (1955) from Lower Jurassic deposits of the Alaskan North Slope, in having a more regular coil with more whorls and in lacking a well developed later uncoiled stage. *Lituotuba gallupi*, reported by Chamney (1971a) from Berriasian–Valanginian deposits from the northern flank of the Richardson Mountains, differs from the present species in developing this later uncoiled, rectilinear stage.

Superfamily LITUOLACEA de Blainville, 1825

Family HORMOSINIDAE Haeckel, 1894

Subfamily HORMOSININAE Haeckel, 1894

Genus *Reophax* Montfort, 1808

Reophax friabilis n. sp.

Plate 2, figures 17, 18

Diagnosis. Rephax friabilis is characterized by its very large and coarsely agglutinated test with large, spherical chambers and a large, rounded proloculus.

Etymology. The specific name refers to the extremely fragile test that is only rarely found intact.

Occurrence and distribution. Assemblage 1*, abundant.

Description. Test very large, elongate, uniserial, consisting of two to (?)four very large, compressed, spherical, strongly overlapping chambers; chambers high and wide, increasing gradually in size from very large, rounded proloculus; sutures very distinct, depressed, arcuate; wall coarsely agglutinated, surface rough; aperture rounded, terminal on short neck; specimens usually broken.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94013	2.30	1.44	311
Paratype GSC 94014	2.31	1.29	311

Remarks. Reophax friabilis is very similar to *R. pilulifera* Brady as illustrated by Bartenstein et al. (1957) from the Barremian Cuche and Toco formations of Trinidad, British West Indies, but it differs in that the present species is much larger.

Reophax friabilis differs from the similar species *R. troyeri* Tappan in being much larger, more coarsely agglutinated, and having fewer and more strongly overlapping chambers. It differs from *R. texanus* Cushman and Waters in being much larger, with more strongly overlapping chambers, and in having an apertural neck.

Reophax sp. cf. *R. deckeri* Tappan, 1940

Plate 2, figures 12–14

Occurrence and distribution. Assemblage 1*, very abundant. Subassemblage 2b, rare. Assemblage 3, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94015	1.71	0.41	301
GSC 94016	1.42	0.56	308
GSC 94017	0.85	0.45	308

Remarks. Specimens of the present species compare favourably to *Reophax deckeri* Tappan, originally described from the Lower Cretaceous Grayson Formation of northern Texas (Tappan, 1940). The present species differs from *R. deckeri*, however, in its shorter apertural neck and more constricted sutures. It is not comparable to *R. tundraensis* described previously from the Mount Goodenough Formation by Chamney (1969).

Reophax sp. A

Plate 2, figures 15, 16

Occurrence and distribution. Assemblage 1*, rare.

Description. Test large, elongate, uniserial and rectilinear, slightly flaring but with nearly parallel sides, consisting of four to six subcylindrical, overlapping chambers of greater height than width; chambers increase more rapidly in height than in width from ovate proloculus; final chamber large, narrow, twice as long as wide, forming approximately one half of test length; sutures distinct, horizontal, slightly depressed; wall medium to coarsely agglutinated; aperture terminal, rounded, at end of short neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94018	2.00	0.50	335
GSC 94019	1.20	0.37	334

Remarks. This distinctive species was found only in the Martin Creek section of the Mount Goodenough Formation.

Reophax sp. B

Plate 2, figure 19

Occurrence and distribution. Assemblage 1*, rare.

Description. Test medium to large sized, elongate, uniserial, consisting of two to four (?or five) large, spherical chambers; chambers higher than wide, increasing gradually in size as added; proloculus not seen as all specimens broken; sutures distinct, horizontal, constricted; wall coarsely agglutinated with rough surface texture; aperture terminal, rounded, slightly produced.

Dimensions (mm).

	L	W	Sample no.
GSC 94020	1.55	0.96	298

Remarks. Only a few broken specimens of this species were recovered from the Martin Creek section.

Family RZEHAKINIDAE Cushman, 1933

Genus *Miliammina* Heron-Allen and Earland, 1930

Miliammina inornata n. sp.

Plate 2, figures 20–22

Diagnosis. *Miliammina inornata* is characterized by its narrow and elongate test with a simple aperture.

Etymology. The specific name refers to the simple, unadorned nature of the test.

Occurrence and distribution. Assemblage 1*, common.

Description. Test medium sized, narrow, elongate, sides subparallel; chambers indistinct, tubular, narrow, elongate, quinqueloculine in plan, each half a coil in length; sutures depressed, sometimes indistinct due to poor preservation; aperture a simple opening at the end of the final chamber.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94023	0.53	0.25	273
Paratype GSC 94021	0.66	0.29	273
Paratype GSC 94022	0.63	0.26	273

Remarks. *Miliammina inornata* differs from *M. valendis*, described from Valanginian deposits of Germany (Bartenstein and Brand, 1951), in being narrower with a simple aperture. It differs from *M. manitobensis* Wickenden in being smaller, narrower, and lacking an apertural neck, and from *M. awunensis* Tappan in being larger, comparatively narrower and more elongate, with a more ovate outline.

Miliammina sp. cf. *M. awunensis* Tappan, 1957

Plate 2, figure 23

Occurrence and distribution. Subassemblage 2a, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94024	0.56	0.33	454

Remarks. *Miliammina awunensis* was originally described by Tappan (1957) from Albian formations of the Alaskan North Slope. Only one specimen of the present species was recovered from the upper Mount Goodenough Formation. However, this specimen compares favourably to those figured by Tappan.

Miliammina sp.

Plate 2, figure 24

Occurrence and distribution. Assemblage 1**, rare.

Description. Test small, narrow, elongate, sides subparallel, ovate in outline; chambers very narrow, elongate, quinqueloculine in plan, each half a coil in length; sutures distinct, depressed; wall finely agglutinated; aperture simple opening at end of final chamber, slightly produced on short neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94025	0.47	0.16	431

Remarks. Only a single specimen of this species was recovered from the section on Goodenough Creek. This single specimen compares favourably to *Miliammina ischnia* Tappan recovered from Albian formations of the Alaskan North Slope (Tappan, 1957), differing in that Tappan's species lacks the short-necked aperture of the present species.

Family LITUOLIDAE de Blainville, 1825

Subfamily HAPLOPHRAGMOIDINAE Maync, 1952

Genus *Haplophragmoides* Cushman, 1910

Haplophragmoides lobatoloculare n. sp.

Plate 3, figures 7–10

Diagnosis. *Haplophragmoides lobatoloculare* is characterized by the periphery of its test, which is narrowly rounded and lobulate, and by its chambers, which show a tendency toward an umbilical lobe.

Etymology. The specific name refers to the lobulate periphery.

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, rare. Subassemblage 2a, very abundant. Subassemblage 2b, very abundant. Assemblage 3, common.

Description. Test small to medium sized, planispiral and involute, compressed, periphery narrowly rounded and lobulate; seven or eight chambers visible, with tendency toward an umbilical lobe; sutures distinct, slightly depressed, somewhat sigmoidal; wall finely agglutinated with smooth finish; aperture obscure but appears to be a basal slit or low arch.

Dimensions (mm).

	D	T	Sample no.
Holotype GSC 94037	0.74–0.61	0.29	273
Paratype GSC 94035	0.60–0.53	0.24	279
Paratype GSC 94036	0.59–0.51	0.24	273
Paratype GSC 94038	0.67–0.57	0.25	273

Remarks. *Haplophragmoides lobatoloculare* bears some resemblance to *H. gigas*, a species common in Albian formations of the Western Interior. They differ, however, in that *H. lobatoloculare* has fewer chambers, a lobulate periphery, and usually does not show the inner ends of the chambers of the preceding coil in the umbilical area.

Haplophragmoides euryraptum n. sp.

Plate 3, figures 11–13

Diagnosis. *Haplophragmoides euryraptum* is characterized by its large, partly evolute, biumbilicate test with eight to ten chambers in the final whorl, and its distinct, thickened sutures.

Etymology. The specific name refers to the strongly developed, wide sutures.

Occurrence and distribution. Assemblage 1**, very abundant. Assemblage 2b, rare.

Description. Test medium sized, rare specimens very large, planispiral and partly evolute, biumbilicate with tendency to show inner ends of chambers of preceding coil in umbilical area, slightly compressed with rounded periphery; eight to ten chambers in final whorl, increasing gradually in size as added, slightly inflated; sutures distinct, slightly curved, thick,

moderately depressed; wall finely agglutinated; aperture an elongate slit at base of apertural face.

Dimensions (mm).

	D	T	Sample no.
Holotype GSC 94039	0.80–0.69	0.30	512
Paratype GSC 94040	0.74–0.56	0.29	508
Paratype GSC 94041	1.41–1.16	0.59	430

Remarks. Haplophragmoides euryraptum was recorded only from the Goodenough Creek section of the Mount Goodenough Formation. The tests of this species are usually crushed or flattened and opaque, and only a few specimens are well preserved.

The slightly asymmetrical coiling of the test, which results in the inner ends of the chambers of the preceding coil being visible in the umbilical area of the test, and the presence of thickened sutures distinguish *Haplophragmoides euryraptum* from *H. nonionoides* Reuss of Myatliuk (1939, p. 40, Pl. 1, figs. 1–3), a species that is common in Neocomian strata of the Volga region of the C.I.S. *Haplophragmoides*(?) *canuiformis* Dain, described from Lower Kimmeridgian deposits of western Siberia (Dain, 1972, Pl. VIII, figs. 2, 3, Pl. XIX, fig. 2), exhibits similar asymmetric coiling of the tests. However, *H. euryraptum* differs from the latter species in having fewer chambers, and distinct, thickened sutures.

Haplophragmoides sp. cf. *H. concavus* (Chapman), 1910

Plate 3, figures 14–17

Occurrence and distribution. Assemblage 1*, very abundant.

Dimensions (mm).

	D	T	Sample no.
GSC 94042	0.38	0.09	301
GSC 94043	0.33	0.05	301
GSC 94044	0.36	0.04	321
GSC 94045	0.38	0.05	321

Remarks. The present species compares favourably to *Haplophragmoides concavus*, originally described from the Gault of England (Chapman, 1892). *Haplophragmoides concavus* has subsequently been found to range from the Valanginian to the Albian, occurring most frequently in Valanginian deposits (Bartenstein and Brand, 1951; Michael, 1967).

Genus *Cribrostomoides* Cushman, 1910

Cribrostomoides cryptocameratum n. sp.

Plate 3, figures 1–6

Diagnosis. Cribrostomoides cryptocameratum is characterized by its indistinct features when the tests are dry; however, when the tests are wet, many chambers (up to 12) and sigmoidal sutures can be seen.

Etymology. The specific name refers to the indistinct (i.e., hidden) nature of these chambers.

Occurrence and distribution. Assemblage 1*, rare. Assemblage 1**, rare. Subassemblage 2b, very abundant. Assemblage 3, abundant.

Description. Test medium sized, planispirally involute, compressed, with narrowly rounded to subacute periphery, usually opaque with rare specimens displaying distinct features; chambers indistinct but visible when immersed in water, up to 12 in number, gradually enlarging in size as added; sutures indistinct, somewhat sigmoidal; wall agglutinated with fine- to medium-sized quartz grains, roughly finished; aperture obscure but probably areal as indicated by sigmoidal trend in sutures.

Dimensions (mm).

	D	T	Sample no.
Holotype GSC 94029	0.55–0.44	0.19	506
Paratype GSC 94030	0.74–0.55	0.24	549
Paratype GSC 94031	0.65–0.54	0.15	549
Paratype GSC 94032	0.54–0.41	0.17	552
Paratype GSC 94033	0.76–0.68	0.32	512
Paratype GSC 94034	0.75–0.61	0.29	512

Remarks. Only four specimens of *Cribrostomoides cryptocameratum* were recovered from the Martin Creek section. However, specimens of this species gradually increase in number until they form a major component of subassemblage 2b and assemblage 3 of the Goodenough Creek section. *Cribrostomoides cryptocameratum* was not previously recorded by Chamney (1969) in his work on the Mount

Goodenough Formation, as this species occurred very rarely within the unit studied by Chamney.

Genus *Labrospira* Höglund, 1947

Labrospira goodenoughensis (Chamney), 1969

Plate 2, figures 25–27

v1969 *Haplophragmoides goodenoughensis* Chamney, p. 23, 24, Pl. IV, figs. 5, 6.
v1969 *Haplophragmoides coronis* Chamney, p. 25, Pl. V, fig. 4 (not 5).
v1976 *Haplophragmoides goodenoughensis* Chamney. Souaya, p. 267, Pl. 2, fig. 6.
v1976 *Haplophragmoides topagorukensis* Tappan. Souaya, p. 267, Pl. 1, fig. 2.
1979 *Cribrostomoides goodenoughensis* (Chamney). Hedinger, Pl. 9, figs. 1–14, Pl. 10, figs. 1, 2.
v1983 *Cribrostomoides goodenoughensis* (Chamney). Wall, p. 259, Pl. 4, figs. 34, 35.

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, common.

Dimensions (mm).

	D	T	Sample no.
GSC 94026	1.01–0.91	0.36	341
GSC 94027	1.25–1.16	0.56	301
GSC 94028	1.06–1.00	0.54	301

Remarks. Labrospira goodenoughensis was originally described from the lowermost beds of the Mount Goodenough Formation north of Goodenough Creek (Chamney, 1969) as *Haplophragmoides goodenoughensis*. However, as the specimens of this species are characterized by the relatively compressed (from lateral sides) tests and the slit-like (or oval) areal apertures above the base of the apertural face, the specimens should be referred to the genus *Labrospira* rather than *Haplophragmoides*.

Chamney (1969) described another new species, *H. coronis*, from the beds from which specimens of *L. goodenoughensis* were recovered. However, the specimen figured by Chamney (1969, Pl. V, fig. 4) as the holotype (GSC 19796) of *H. coronis* is considered by the authors to be a juvenile specimen of *Labrospira goodenoughensis*. The paratype (GSC 19797) of *H. coronis* figured by Chamney (1969, Pl. V, fig. 5) is very badly deformed so that a firm identification is difficult. However, the specimen probably is *L. goodenoughensis*.

In the eastern part of the Sverdrup Basin, Wall (1983) recorded *L. goodenoughensis* from upper Volgian beds of the Deer Bay Formation as *Cribrostomoides goodenoughensis*. Toward mid-basin, *L. goodenoughensis* has been recorded from the Awingak, Deer Bay, and Isachsen formations ranging from late Volgian to Valanginian in age (Souaya, 1976). Souaya also recorded *H. topagorukensis* Tappan, a common Albian species, from the same samples as *L. goodenoughensis*. However, the specimens identified and figured by Souaya as *H. topagorukensis* are considered by the authors to be juvenile forms of *L. goodenoughensis*.

Subfamily LITUOLINAE de Blainville, 1825

Genus *Ammobaculites* Cushman, 1910

Ammobaculites inelegans n. sp.

Plate 3, figures 26–33

v1969 *Ammobaculites erectus* Crespin. Chamney, p. 29, 30, Pl. VI, figs. 4–6.

Diagnosis. Ammobaculites inelegans is characterized by its compressed test with an indistinct, small coil and indistinct chambers.

Etymology. The specific name refers to the simple and unadorned nature of the test.

Occurrence and distribution. Assemblage 1*, very abundant. Subassemblage 2a, common. Subassemblage 2b, abundant. Assemblage 3, common.

Description. Test elongate, medium sized, very compressed, slightly flaring; early portion close coiled with up to (?)four indistinct chambers, coil usually of lesser diameter than, or more rarely equal to, width of first uniserial chamber; later portion of up to five uniserial chambers of greater width than height, gradually increasing in size until height and width are approximately equal in final chamber; sutures indistinct in coil, usually indistinct in uniserial portion of test except when test is wet, horizontal, and slightly depressed; wall medium to coarsely agglutinated with rough surface texture; aperture terminal, central, elongate slit.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94048	0.94	0.31–0.25	302
Paratype GSC 94046	1.01	0.40–0.26	305
Paratype GSC 94047	0.88	0.29–0.25	302
Paratype GSC 94049	0.79	0.27–0.20	302
Paratype GSC 94050	0.79	0.29–0.22	508
Paratype GSC 94051	0.77	0.31–0.25	508
Paratype GSC 94052	0.81	0.26–0.21	508
Paratype GSC 94053	0.88	0.32–0.25	548

Remarks. Ammobaculites inelegans is a very long-ranging species found throughout the Mount Goodenough Formation. This species was previously recorded from the Mount Goodenough Formation by Chamney (1969) as *A. erectus*, a species originally described from Lower Cretaceous deposits of Australia (Crespin, 1963). The Mount Goodenough specimens are different from *A. erectus* in that the latter species has a distinct, three-chambered coil of greater diameter than the uniserial portion of the test, a narrow-elongate uniserial portion of the test with distinct, constricted sutures, inflated chambers, and a pyriform final chamber.

Ammobaculites mountgoodenoughensis n. sp.

Plate 3, figures 18–21

v1969 *Ammobaculites reophacoides* Bartenstein. Chamney, p. 28, 29, Pl. VI, figs. 1–3.

Diagnosis. Ammobaculites mountgoodenoughensis is characterized by its small, compressed, finely agglutinated test with a distinct coil of four chambers, and a parallel-sided uncoiled portion.

Etymology. The specific name refers to Mount Goodenough.

Occurrence and distribution. Assemblage 1*, abundant. Subassemblage 2a, common.

Description. Test elongate, small to medium sized, compressed, ovate in section; consisting of a close coil of four chambers, coil diameter equal to or greater than width of uniserial portion of test; later portion parallel-sided, consisting of three to five chambers increasing very gradually in height and width as added; many tests twisted at coil-uniserial juncture; sutures indistinct, flush to slightly depressed, horizontal in uniserial portion; wall agglutinated with fine- to medium-sized grains, surface rough; aperture central, rounded and flush with chamber periphery.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94055	0.60	0.19–0.18	267
Paratype GSC 94054	0.59	0.20–0.18	267
Paratype GSC 94056	0.84	0.19	267
Paratype GSC 94057	0.61	0.27–0.19	267

Remarks. Specimens of *Ammobaculites mountgoodenoughensis* are identical to *A. reophacoides* Bartenstein recorded by Chamney (1969) from the lowermost beds of the Mount Goodenough Formation north of Goodenough Creek. However, these specimens differ from *A. reophacoides* as originally described by Bartenstein (1952) from Barremian deposits of Germany in possessing larger, more well defined coils with four chambers, and uniserial chambers that do not increase as rapidly in height, resulting in a terminal chamber that is less elongate and strongly tapered. Also, Chamney observed that the initial coil of his specimens was asymmetric. Tests of this species are often twisted at the coil-uniserial juncture (e.g., Pl. 3, fig. 20), and it is probable that this feature was mistaken by Chamney for asymmetric coiling.

The species recorded by Souaya (1976) from the Upper Jurassic Awingak Formation of the Sverdrup Basin as *A. reophacoides* Bartenstein is distinct from *Ammobaculites mountgoodenoughensis* of this study.

Ammobaculites validus n. sp.

Plate 4, figures 6–9

Diagnosis. Ammobaculites validus is characterized by its large, robust, coarsely agglutinated test with a large, biumbilicate coil.

Etymology. The specific name refers to the sturdy nature of the test.

Occurrence and distribution. Assemblage 1*, very abundant. Assemblage 1**, common.

Description. Test elongate, medium to large sized, robust, slightly compressed; early portion consisting of large biumbilicate close coil of four or five chambers,

coil of greater diameter than first uniserial chamber; later portion consisting of up to five uniserial chambers, low and broad, which increase gradually in size as added until final chamber, which is of markedly greater height than width; sutures indistinct, horizontal, and slightly depressed; wall coarsely to very coarsely agglutinated with very rough surface often masking other features such as sutures; aperture terminal, central, rounded to oval, although more ovate apertures may be due to compression.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94058	1.69	0.56–0.50	297
Paratype GSC 94059	0.92	0.46	297
Paratype GSC 94060	1.16	0.62–0.54	297
Paratype GSC 94061	3.00	1.50–0.66	301

Remarks. With its large size, large coil, and coarsely agglutinated walls, *Ammobaculites validus* is a very distinctive species. Very large specimens such as the one shown in Plate 4, figure 9 (paratype GSC 94061) often have the initial coil missing and could be mistaken for *Reophax*. However, on closer examination, the break can usually be seen.

Ammobaculites validus is distinguished from other large, coarsely agglutinated species such as *A. subaequalis* Myatliuk, described from lower Volgian deposits of the Middle Volga region of the C.I.S. (Myatliuk, 1939) and *A. alaskensis* Tappan, described from Jurassic deposits of northern Alaska (Tappan, 1955), by its distinct planispiral coil of four or five chambers.

Ammobaculites? *attenuatus* n. sp.

Plate 3, figures 22–25

Diagnosis. Ammobaculites? *attenuatus* is characterized by its narrow and elongate test with a small, indistinct coil, chambers of greater height than width, and pyriform final chamber.

Etymology. The specific name refers to the narrow and elongate (i.e., attenuated) nature of the test.

Occurrence and distribution. Assemblage 1*, common.

Description. Test medium sized, elongate; early portion a small, indistinct coil of three or four chambers; diameter of coil approximately equal to width of uniserial portion; later portion gently tapering with four or five slightly inflated chambers of greater height than width that increase more in height than width as added; final chamber pyriform in shape; sutures indistinct in coil, distinct and constricted in uniserial portion; wall medium to coarsely agglutinated with rough surface texture; aperture terminal, central, rounded.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94063	1.01	0.22	300
Paratype GSC 94062	1.34	0.27	300
Paratype GSC 94064	0.67	0.17	300
Paratype GSC 94065	0.94	0.25	300

Remarks. The generic designation of this species has been queried as it is possible that the initial early portion of the test is streptospirally coiled as in *Haplophragmium*. Many tests of this species have been broken, usually at the juncture of the coil and the uniserial portion of the test such as is shown in Plate 3, figure 22 (paratype GSC 94062).

Ammobaculites? *attenuatus* differs from *A. dentonensis*, first described by Tappan (1940) as *A. variabilis* from the Upper Albian Grayson Formation of northern Texas and southern Oklahoma, in its indistinct chambers and sutures in the coiled portion of the test, and its more coarsely agglutinated test. *Ammobaculites vetusta* (Terquem and Berthelin), described by Tappan (1955) from Lower Jurassic strata of northern Alaska, differs in that it has a well developed coil and a more finely agglutinated test.

Subfamily RECURVOIDINAE Alekseichik, 1973

Genus *Recurvoides* Earland, 1934

Recurvoides sp. cf. *R. sublustris* Dain, 1972

Plate 4, figures 1–5

v1969 *Trochammina squamata* (Jones and Parker) subsp. *limbata* Chapman. Chamney, p. 32, Pl. IV, figs. 13, 14.

v1976 *Recurvoides limbatus* (Chapman). Souaya, p. 268, Pl. 1, fig. 7.

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, rare. Subassemblage 2a, abundant. Subassemblage 2b, common. Assemblage 3, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94066	0.44	0.375	475
GSC 94067	0.375	0.30	321
GSC 94068	0.53	0.35	267
GSC 94069	0.44	0.31	324
GSC 94070	0.56	0.41	323

Remarks. *Recurvoides sublustris* was originally described by Dain (1972, Pl. XII, figs. 3–6) from Lower Kimmeridgian deposits of western Siberia. *Recurvoides* sp. cf. *R. sublustris* of this study differs from *R. sublustris* Dain in having eight or nine chambers in the final whorl compared to ten to twelve chambers for the original species; however, all other characteristics appear similar.

In 1969, Chamney identified *Trochammina squamata* (Jones and Parker) subsp. *limbata* Chapman from a 33.5 m (110 ft.) interval of the lower Mount Goodenough beds north of Goodenough Creek. Chamney recognized that the aperture of this species was confined to the "inner margin of the last-formed chamber on the ventral side". However, he considered the specimens to be those of *Trochammina* rather than *Recurvoides* or *Thalmannammina*. Later Souaya (1976) recorded *Recurvoides limbatus* (Chapman) from beds of the Deer Bay Formation of the Sverdrup Basin, which he had dated as Berriasian–Valanginian in age. Souaya reported that *Recurvoides limbatus* (Chapman) corresponded with Chamney's *Trochammina squamata* (Jones and Parker) subsp. *limbata*. However, as originally proposed by Chapman, this species is very compressed with an angular periphery, curved septal sutures, lobulate outline, and only six chambers in the final whorl. As the specimens of Chamney and Souaya are identical to those of the present species, both species are considered to be conspecific with *Recurvoides* sp. cf. *R. sublustris* of this study.

Recurvoides ex. gr. *R. stschekuriensis* Dain, 1972

Plate 4, figures 10–12

Occurrence and distribution. Assemblage 1*, common.

Description. Test medium to large sized, ovate to circular in outline with narrowly rounded to compressed peripheries; coiling asymmetrical, evolute on one side with one and a half to two and a half coils visible, involute on reverse side; plane of coiling varies at slight angle to previous whorl, resulting in comparatively flat test; 12 subrectangular gradually enlarging chambers visible in final whorl; spiral and septal sutures indistinct when tests dry, slightly depressed, thin; when tests wet, sutures distinct, thick; wall agglutinated, finely grained; aperture small, ovate, areal.

Dimensions (mm).

	L	W	Sample no.
GSC 94071	1.33	0.82	266
GSC 94072	0.80	0.65	268
GSC 94073	1.11	0.96	266

Remarks. Although larger, the present species appears to belong to *Recurvoides* ex. gr. *R. stschekuriensis* Dain (1972, Pl. XIII, figs. 5–7) first described from Volgian deposits of western Siberia. This group is distinguished by the large number (from 10 to 20) of chambers visible in the one and a half to two and a half coils on the spiral side of the test; however, the chambers are usually only clearly seen when wet. The angle of rotation of the axis of coiling is slight, resulting in a comparatively flat test approaching that of the genus *Haplophragmoides*. Dain stated that later Valanginian species of *Recurvoides* originated with *R. stschekuriensis*.

Recurvoides ex. gr. *R. stschekuriensis* of this study is not similar to *R.* sp. cf. *R. stschekuriensis* as reported by Souaya (1976) from beds of the Sʻavik and Awingak formations that range in age from Bajocian to Early Tithonian (Early Volgian) according to the palynostratigraphic dates used in Souaya's study. This reported occurrence is in older strata than that reported by Dain.

Recurvoides ex. gr. *R. disputabilis* Dain

Plate 4, figures 13–16

Occurrence and distribution. Subassemblage 2b, very abundant.

Description. Test small to medium sized, planispirally partly evolute, coiling asymmetrical with angle of

rotation of final whorl at 50° to 90° to previous whorl, penultimate whorl forming broad knob in centre of spiral side of test; periphery broadly rounded; six to eight chambers in final whorl, increasing gradually in size as added, inflated; sutures distinct, straight, depressed, and slightly thickened; wall agglutinated with fine- to medium-sized grains; rough surface texture; aperture obscure but appears to be an elongate slit or low arch above base of apertural face.

Dimensions (mm).

	D	T	Sample no.
GSC 94074	0.62–0.55	0.27	509
GSC 94075	0.55–0.44	0.25	506
GSC 94076	0.43	0.21	506
GSC 94077	0.65	0.33	512

Remarks. The present species appears to belong to *Recurvoides* ex. gr. *R. disputabilis* first described by Dain (1972) from Upper Oxfordian strata of western Siberia. This group of *Recurvoides* is characterized by the angle of coiling of the whorls that results in the penultimate whorl forming a knob-like feature in the centre of the spiral side of the test.

Recurvoides ex. gr. *R. disputabilis* was recovered only from the upper beds of the Goodenough Creek section. In this species, coiling may vary from slightly to more strongly asymmetrical. This species was not previously recorded by Chamney (1969) in his work on the Mount Goodenough Formation, as it occurs stratigraphically above the unit studied by Chamney.

Recurvoides ex. gr. *R. canningensis* (Tappan), 1955

Plate 4, figures 22–26

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, rare.

Dimensions (mm).

	D	T	Sample no.
GSC 94078	0.325	0.25	321
GSC 94079	0.26	0.20	321
GSC 94080	0.275	0.20	321
GSC 94081	0.345–0.385	0.21	335
GSC 94082	0.260–0.335	0.26	335

Remarks. The present species is very similar to those specimens of *Trochammina canningensis* figured by Tappan (1955, p. 49, Pl. 14, figs. 15, 17–19) that have between five and seven chambers visible on the dorsal side of the test. Tappan, however states that from five to twelve chambers may be visible dorsally for *T. canningensis*. Thus, the present species differs from Tappan's species in having fewer chambers visible on the dorsal side. However, all other features appear to be identical.

Tappan originally described *T. canningensis* from Lower and Upper Jurassic strata of the Alaskan North Slope. This species has subsequently been reported in strata ranging in age from Middle Jurassic to Early Cretaceous (Souaya, 1976; Hedinger, 1979; Brooke and Braun, 1981).

In Europe, a very similar species, *T. globigeriniformis*, has been recorded from the Gault of Folkestone, England (Chapman, 1892) and Neocomian deposits in Germany (Hecht, 1938; Bartenstein, 1952; Michael, 1967). *Trochammina globigeriniformis* (Parker and Jones) was originally described from Recent sediments of the North Atlantic Ocean. The specimens described from Recent sediments appear to have more numerous (up to ten) chambers visible on the dorsal side of the test, whereas the Lower Cretaceous specimens have between four and eight chambers visible dorsally. It is the authors' opinion that the Lower Cretaceous specimens should be referred to *Recurvoides* ex. gr. *R. canningensis*.

Family TROCHAMMINIDAE Schwager, 1877

Subfamily TROCHAMMININAE Schwager, 1877

Genus *Trochammina* Parker and Jones, 1859

Trochammina ex. gr. *T. neocomiana* Myatliuk, 1939

Plate 4, figures 17–21

Occurrence and distribution. Assemblage 1*, very abundant. Subassemblage 2a, common. Subassemblage 2b, rare.

Description. Test trochoid, low spired, compressed, with shallow umbilicus on umbilical side, periphery lobulate and rounded; chambers few in number, increasing rapidly in size as added; two and a half whorls visible on spiral side with five chambers visible in ultimate and penultimate whorls, rarely six

chambers visible in ultimate whorl; sutures distinct, depressed, radial; wall finely to coarsely agglutinated, roughly finished; aperture an extraumbilical-umbilical slit at base of final chamber.

Dimensions (mm).

	D	T	Sample no.
GSC 94083	0.39	0.14	321
GSC 94084	0.33–0.38	0.11	321
GSC 94085	0.33–0.28	0.14	334
GSC 94086	0.43–0.45	0.11	336
GSC 94087	0.45	0.12	336

Remarks. All of the specimens recovered are compressed and distorted to some degree. However, these specimens appear to be similar to *Trochammina neocomiana*, originally described by Myatliuk (1939) from upper Neocomian deposits of the middle Volga region, C.I.S. Similar species with compressed, low-spired tests and five chambers in the ultimate whorl have been reported by Romanova (1960) from Cretaceous deposits of the western Siberian lowland and by Dain (1972) from Upper Jurassic deposits of western Siberia.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Subfamily VERNEUILININAE Cushman, 1911

Genus *Verneuilina* d'Orbigny, 1839

Verneuilina caldwelli n. sp.

Plate 5, figures 1–5

Diagnosis. Verneuilina caldwelli is characterized by its rapidly flaring test with rounded peripheral angles and slightly excavated sides.

Etymology. The specific name is patronymic in honour of W.G.E. Caldwell, head of the Department of Geological Sciences, University of Saskatchewan, from 1972 to 1988.

Occurrence and distribution. Assemblage 1**, rare. Subassemblage 2a, abundant. Subassemblage 2b, rare.

Description. Test small, triserial, pyramidal in shape, flaring rapidly from an angular base, periphery rounded, sides slightly excavated; chambers indistinct, appear to increase gradually in size as added; sutures indistinct, slightly depressed; wall medium to coarsely agglutinated with rough surface texture; aperture a high basal arch.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94089	0.425	0.275	476
Paratype GSC 94088	0.45	0.25	476
Paratype GSC 94090	0.45	0.29	476
Paratype GSC 94091	0.45	0.25	476
Paratype GSC 94092	0.46	0.26	476

Remarks. Verneuilina caldwelli, found only in the Goodenough Creek section, differs from the older but similar species *V. anglica* Cushman as reported by Souaya (1976) from the Upper Jurassic Awingak Formation, and by Wall (1983) from Upper Volgian deposits of the Deer Bay Formation from the Sverdrup Basin, in its larger test size, more rounded peripheral angles, and less excavated sides. *Verneuilina caldwelli* also differs from the younger *V. canadensis* Cushman, a species common in Albian–Cenomanian strata of the Western Interior of North America, in being smaller and broader with uninflated, indistinct chambers.

Genus *Gaudryina* d'Orbigny, 1839

Gaudryina tailleuri (Tappan), 1957

Plate 5, figures 6–12

1957 *Verneuilinoides tailleuri* Tappan, p. 208, Pl. 66, figs. 19–22.
1957 *Dorothia chandlerensis* Tappan, p. 209, Pl. 66, figs. 29, 30.
1962 *Gaudryina tailleuri* (Tappan). Tappan, p. 149, 150, Pl. 35, figs. 8–16.
v1969 *Gaudryina tappanae* Chamney, p. 31, Pl. VI, figs. 9–12.

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, common. Subassemblage 2a, common. Subassemblage 2b, abundant.

Dimensions (mm).

	L	W	Sample no.
GSC 94093	0.825	0.21	266
GSC 94094	0.775	0.23	267
GSC 94095	0.70	0.24	267

GSC 94096	0.74	0.23	267
GSC 94097	0.80	0.225	269
GSC 94098	0.65	0.20	269
GSC 94099	0.70	0.20	272

Remarks. Specimens of *Gaudryina tailleuri* display two test types: a completely triserial test that is subtriangular in section (e.g., Pl. 5, figs. 6, 10–12), previously considered to be *Dorothia chandlerensis* Tappan; and a test that is initially triserial and triangular in section but becomes biserial and compressed, the initial triserial portion forming only about one third of the length of the test (Pl. 5, figs. 7–9), previously considered to be *Verneuilinoides tailleuri* Tappan. Tappan (1962) later considered the two species to be conspecific, possibly representing the megalospheric and microspheric generations of the species.

Chamney (1969) described *Gaudryina tappanae* (p. 31, Pl. VI, figs. 9–12) from the lowermost Mount Goodenough Formation north of Goodenough Creek. *Gaudryina tappanae* of Chamney's study is identical to the triserial–biserial forms of *G. tailleuri*. Chamney states that a distinctive axial twist between the triserial and biserial portions of the test distinguishes *G. tappanae* from other similar species. However, both the specimens figured by Tappan (1962, Pl. 35, figs. 10, 11, 13, 15) and those of this study (Pl. 5, figs. 7–9) that have triserial–biserial tests display this "distinctive" axial twist.

In northern Alaska, *G. tailleuri* has been described from the Lower Cretaceous Torok and Fortress Mountain formations. An Early Albian age was assigned to these deposits based on association with the ammonites *Grantziceras* (= *Beaudanticeras*) and *Colvilla* (Imlay, 1961). Similarly, in the eastern Sverdrup Basin, *G. tailleuri* has been reported from Lower Albian strata of the Christopher Formation (Sliter, 1981). However, additional work has extended the range of *G. tailleuri* into the Neocomian and Upper Jurassic (Ramsay, 1970; Souaya, 1976).

Genus *Uvigerinammina* Majzon, 1943

Uvigerinammina laxa n. sp.

Plate 5, figures 13–16

Diagnosis. *Uvigerinammina laxa* is characterized by the very loose, trochospiral arrangement of coiling of its chambers, the low number of chambers, and the necked aperture.

Etymology. The specific name refers to this loose (i.e., lax) arrangement of the chambers.

Occurrence and distribution. Assemblage 1*, abundant.

Description. Test small, flaring very little from the rounded base; chambers few in number, distinct, slightly inflated, increasing rapidly in size as added, in loose triserial arrangement with earlier chambers more closely appressed; sutures distinct, depressed; wall finely agglutinated; surface relatively smoothly finished; aperture terminal, rounded, at end of short neck.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94100	0.51	0.29	289
Paratype GSC 94101	0.51	0.29	302
Paratype GSC 94102	0.55	0.26	308
Paratype GSC 94103	0.61	0.30	308

Remarks. Forty-two specimens of *Uvigerinammina laxa* were recovered from the Martin Creek section. In a few specimens (Pl. 5, fig. 15), the trochospiral arrangement of coiling becomes so extended that the final chambers appear to be biserially or even uniserially arranged.

Uvigerinammina laxa differs from the younger *U. athabascensis* (Mellon and Wall) in its smaller and less robust test with chambers that are less inflated, and its shorter apertural neck.

Genus *Verneuilinoides* Loeblich and Tappan, 1949

Verneuilinoides implexus n. sp.

Plate 5, figures 17–19

Diagnosis. *Verneuilinoides implexus* is characterized by the rapid increase in the size of its chambers and the triserial arrangement of coiling that may become extended so the final chambers appear to be biserially arranged.

Etymology. The specific name refers to the interlaced or intertwined arrangement of the chambers.

Occurrence and distribution. Subassemblage 2b, common. Assemblage 3, common.

Description. Test medium sized, elongate, triserial, rounded in section, flaring rapidly from angular base; initial chambers closely appressed, indistinct, increasing slowly in size as added; final chambers distinct, inflated, loosely appressed, increasing rapidly in size as added, triserial arrangement of coiling becoming extended so that final chambers appear to be biserial; sutures flush to slightly depressed; wall agglutinated with fine- to medium-sized particles; surface rough; aperture obscure.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94105	0.71	0.36	523
Paratype GSC 94104	0.775	0.49	527
Paratype GSC 94106	0.49	0.31	523

Remarks. Twenty-six specimens of *Verneuilinoides implexus* were recovered from the upper Mount Goodenough Formation. All specimens recovered are relatively poorly preserved with dark brown, opaque tests.

Verneuilinoides implexus is differentiated from *Uvigerinammina laxa* by its tighter, trochospiral coiling and lack of an apertural neck. It differs from *V. gracious* and *V. postgracious*, both described from Kimmeridgian deposits in western Siberia (Dain, 1972), in its larger size, rounded cross-section, and rapidly flaring test.

Subfamily GLOBOTEXTULARIINAE Cushman, 1927

Genus *Arenobulimina* Cushman, 1927

Arenobulimina mcneili n. sp.

Plate 5, figures 20–23

Diagnosis. *Arenobulimina mcneili* is characterized by its large test with numerous, inflated chambers arranged five chambers in a whorl.

Etymology. The specific name is patronymic in honour of D.H. McNeil of the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada.

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, common.

Description. Test medium to large size, gently flaring from rounded base, rounded to ovate in cross-section although ovate tests probably distorted; chambers numerous, trochospiral with five chambers in a whorl, occasional specimens with four chambers in final whorl, inflated, increasing rapidly in size; sutures distinct, constricted; wall medium to coarsely agglutinated with rough surface texture; aperture a low basal arch.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94107	1.04	0.72	294
Paratype GSC 94108	1.08	0.70	324
Paratype GSC 94109	0.95	0.73	324
Paratype GSC 94110	1.06	0.64	301

Remarks. *Arenobulimina mcneili* differs from *Arenobulimina* sp. 2 of Wall (1983) and *Arenobulimina* sp. cf. *A. torula* Tappan (Souaya, 1976), both from the Deer Bay Formation of the Sverdrup Basin, in being much larger with fewer and less inflated chambers in a whorl. This species occurs abundantly in the lower beds of the Mount Goodenough Formation.

Suborder MILIOLINA Delage and Hérouard, 1896

Superfamily MILIOLACEA Ehrenberg, 1839

Family MILIOLIDAE Ehrenberg, 1839

Subfamily QUINQUELOCULININAE Cushman, 1917

Genus *Quinqueloculina* d'Orbigny, 1826

Quinqueloculina opedentata n. sp.

Plate 5, figures 24–26

Diagnosis. *Quinqueloculina opedentata* is characterized by its robust test, inflated chambers, and aperture that is toothed but lacks a distinct neck.

Etymology. The specific name refers to the toothed aperture.

Occurrence and distribution. Assemblage 1*, abundant.

Description. Test small to medium sized, robust, ovate in outline, wedge shaped in section; chambers slightly inflated, quinqueloculine in plan, half a coil in length, of equal diameter throughout; on four chambered side, third from last chamber is more inflated than either ultimate or penultimate chambers; sutures distinct, depressed; wall porcelaneous-calcareous with smooth surface; aperture at end of final chamber, rounded with tooth.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94113	0.45	0.30	305
Paratype GSC 94111	0.475	0.325	305
Paratype GSC 94112	0.40	0.31	305

Remarks. *Quinqueloculina opedentata*, recovered only from the Martin Creek section, differs from *Q. infravalanginiana* Bartenstein, described from Berriasian deposits of Germany (Bartenstein, 1962), in its shorter, more robust test, thicker, inflated chambers, and aperture that lacks a distinct neck. *Quinqueloculina minima* Tappan, a species reported from Albian formations in Texas and Oklahoma, is much smaller, lacks a toothed aperture, and the ultimate and penultimate chambers greatly overlap the previously formed chambers.

There is a similarity between the present species and *Q. mitchurini* Dain as figured by Dain and Kuznetsova (1971) from Middle Volgian deposits of the stratotype section of the Volgian Stage in the C.I.S. Unfortunately, it has been difficult to evaluate this similarity due to the poor quality of the figures in the Russian publication.

Quinqueloculina sp.

Plate 5, figure 27

Occurrence and distribution. Assemblage 1**, rare.

Description. Test small, ovate in outline, flattened in cross-section; chambers quinqueloculine in plan, each half a coil in length, narrow and of equal diameter throughout; sutures distinct, depressed; wall porcelaneous-calcareous with smooth surface; aperture at end of final chamber, rounded with no tooth visible.

Dimensions (mm).

	L	W	Sample no.
GSC 94114	0.31	0.19	428

Remarks. A single specimen of this species was recovered from the Goodenough Creek section. This specimen differs from the older *Quinqueloculina opedentata* n. sp. in its smaller, more delicate test, less inflated and narrower chambers, and simple aperture.

Suborder ROTALIINA Delage and Hérouard, 1896

Superfamily NODOSARIACEA Ehrenberg, 1838

Family NODOSARIIDAE Ehrenberg, 1838

Subfamily NODOSARIINAE Ehrenberg, 1838

Genus *Nodosaria* Lamarck, 1812

Nodosaria obscura Reuss, 1845

Plate 5, figures 28–31

1845 *Nodosaria obscura* Reuss, p. 26, Pl. 13, figs. 7–9.

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94115	0.81	0.41	308
GSC 94116	1.06	0.42	312
GSC 94117	0.54	0.30	309
GSC 94118	0.66	0.30	327

Remarks. *Nodosaria obscura* Reuss has been recorded from Lower Cretaceous deposits in Germany, France, and England. In North America, this species is common in the Del Rio and Grayson formations and ranges throughout the Washita Group, in Texas and Oklahoma. A similar species, *Nodosaria nana* Reuss, has been recorded from Albian formations in northern Alaska and the Yukon (Tappan, 1962; Chamney, 1978). This species differs from *N. obscura* of this study in having more numerous but less prominent ribs, and a weakly developed apical spine and apertural neck.

Nodosaria sp. cf. *N. sceptrum* Reuss, 1863

Plate 5, figures 32–34

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94119	1.39	0.375	288
GSC 94120	0.60	0.225	313
GSC 94121	0.55	0.225	312

Remarks. The specimens of this species, recovered only from the Martin Creek section, compare closely to *Nodosaria sceptrum*, originally described by Reuss from the Hils und Gault of northern Germany. However, the chambers of the present species are more inflated and globose than those of *N. sceptrum*. Also, the final chamber is very globose with a small neck, whereas that of *N. sceptrum* is less inflated and more pyriform in shape and is produced at the apertural end.

Nodosaria sceptrum has been reported from strata in central Europe ranging in age from Middle Valanginian to Albian, and is most common in strata of Middle Valanginian, Hauterivian, and Barremian age. In the Boreal Realm, Myatliuk (1939) reported this species from Volgian deposits of the middle Volga region of the C.I.S. Fursenko and Polenova (1950), in their work on the Foraminifera of the Lower Volgian substage of Emba Province of the C.I.S., described a similar species as *N. tubifera* Reuss var. *scythicis*. Saks (1972) reported *N. sceptrum* from Middle Berriasian and Lower Valanginian deposits of central Siberia.

Nodosaria sp. A

Plate 5, figure 35

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, rectilinear, rounded in cross-section, uniserial throughout; chambers long and narrow, final chamber inflated; sutures indistinct, horizontal; wall calcareous, ornamented with six, low, continuous, longitudinal costae; aperture terminal, central, radiate, slightly produced.

Dimensions (mm).

	L	W	Sample no.
GSC 94122	0.80	0.225	325

Remarks. A single specimen was recovered from the Martin Creek section with only the final three chambers preserved. *Nodosaria* sp. A bears some resemblance to *Nodosaria orthopleura* Reuss as figured by Bartenstein (1956, Pl. 1, fig. 19) from Hauterivian strata of eastern England, but differs in having more numerous but less strongly developed ribs and an inflated final chamber.

Nodosaria sp. B

Plate 5, figure 36

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, rectilinear, rounded in cross-section, uniserial throughout; initial chambers missing, later chambers inflated, rounded, and globose; sutures distinct, horizontal, thickened, constricted; wall calcareous with smooth surface; aperture terminal, rounded, central on a distinct neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94123	0.56	0.25–0.07	283

Remarks. One specimen of *Nodosaria* sp. B was recovered from the Martin Creek section. Only the final few chambers are preserved in the recovered specimen, but the straight axis of the test and the centrally placed aperture indicate that the specimen belongs to the genus *Nodosaria*.

Nodosaria sp. B is very similar to *N. concinna* Reuss as figured by Sliter (1981) from the lower Christopher Formation of Amund Ringnes Island. As originally described from the Upper Cretaceous of Germany, *N. concinna* has an apical proloculus and a more elongate final chamber than the present species.

Genus *Dentalina* Risso, 1826

Dentalina communis d'Orbigny, 1826

Plate 5, figures 37–39

1826 *Nodosaria* (*Dentalina*) *communis* d'Orbigny, p. 254, no. 35.
1951 *Dentalina communis* d'Orbigny. Bartenstein and Brand, p. 308, Pl. 9, figs. 230, 231 (non 228, 229).
1967 *Dentalina communis* d'Orbigny. Michael, p. 61, Pl. V, figs. 1, 2.

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, rare. Subassemblage 2a, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94124	2.875	0.49	299
GSC 94125	0.75	0.21	299
GSC 94126	0.80	0.19	299

Remarks. Dentalina communis is a morphologically simple species with a wide geographic and long geological range. This species commonly occurs throughout Lower Cretaceous deposits of Europe and Albian deposits of the United States. The present species most closely resembles *D. communis* of Bartenstein and Brand (1951) from Valanginian–Lower Hauterivian deposits of northwestern Germany and of Michael (1967) from Upper Hauterivian–Barremian deposits, also of northwestern Germany.

Dentalina sp. A

Plate 5, figures 40–42

Occurrence and distribution. Assemblage 1*, abundant. Subassemblage 2a, common.

Description. Test elongate, uniserial, arcuate, rounded in section; large, globular, inflated proloculus followed by one to eight large, globular, inflated chambers increasing gradually in size as added; initial chambers wider than high, in ultimate chamber height approximately equals width; sutures distinct, horizontal, constricted; wall calcareous with smooth surface; aperture terminal, radiate, slightly produced.

Dimensions (mm).

	L	W	Sample no.
GSC 94127	1.225	0.325	281
GSC 94128	0.94	0.25	281
GSC 94129	0.725	0.325	283

Remarks. Dentalina sp. A occurs throughout the Martin Creek section and in part of the Goodenough Creek section. Unfortunately, larger specimens are usually broken, and were recovered only as disarticulated single chambers.

Dentalina sp. A bears some similarity to *Dentalina soluta* (Reuss) reported throughout the Lower Cretaceous of Germany, England, and the Netherlands. They differ, however, in that the present species has lower, broader, and more globose chambers, and an ultimate chamber that is globose rather than pyriform in shape. *Dentalina* sp. A differs from *D. distincta* Reuss as figured by Tappan (1962, Pl. 45, fig. 18) from the Albian Topagoruk Formation of the Alaskan North Slope in its much larger test, more globose chambers, and rounded proloculus. It differs from *D. duplexa* Chamney (1978, p. 29, Pl. 9, figs. 3–5), reported from the Albian Arctic Red Formation of the Yukon, in its more globose chambers and smooth surface.

Dentalina sp. B

Plate 5, figures 43–45

Occurrence and distribution. Assemblage 1*, common. Subassemblage 2a, rare.

Description. Test elongate, uniserial, arcuate, rounded in section; consists of three to five cylindrical chambers of greater height than width that increase very little in diameter and only slightly more in height as added; proloculus large, initial end pointed; final chamber increases more markedly in height; sutures distinct, horizontal, flush; wall calcareous, surface smooth; aperture terminal, radiate.

Dimensions (mm).

	L	W	Sample no.
GSC 94130	0.91	0.225	296
GSC 94131	1.11	0.275	311
GSC 94132	0.76	0.21	332

Remarks. Dentalina sp. B is very similar to *D. cylindroides* Reuss (1863, Pl. II, fig. 16) from the Hils und Gault of northwestern Germany. Specimens of this species described later by other authors (Tappan, 1940, p. 102, Pl. 16, fig. 2; 1943, p. 495, 496, Pl. 79, figs. 30, 31) had a more blunt initial end and many more (up to 13) chambers. The material recovered in the present study was insufficient to evaluate this type of variability within the species.

Dentalina linearis (Roemer), a similar species from Valanginian and Hauterivian deposits of Germany (Eichenberg, 1934, p. 164, Pl. 10, fig. 13; Bartenstein and Brand, 1951, Pl. 9, figs. 234–237), differs in having a more rounded proloculus and more numerous and inflated chambers.

Dentalina sp. C

Plate 5, figures 51–53

Occurrence and distribution. Assemblage 1*, rare.

Description. Test rounded to ovate in cross-section, composed of two elongate, slightly inflated, approximately equal-sized chambers; chambers twice as long as wide; initial end of first chamber acute to apiculate but usually broken; sutures distinct, constricted, horizontal; aperture terminal, radiate, produced at dorsal angle.

Dimensions (mm).

	L	W	Sample no.
GSC 94133	0.575	0.19	282
GSC 94134	0.71	0.225	282
GSC 94135	0.60	0.25	299

Remarks. Dentalina sp. C bears some resemblance to *Nodosaria cylindracea* Reuss described from the Upper Cretaceous of Europe and North America. The present species, however, has constricted sutures, a more acute or even apiculate proloculus, and an eccentric terminal aperture.

Dentalina sp. D

Plate 5, figure 46

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, uniserial, tapering, slightly arcuate, rounded in section; proloculus small, apiculate with eccentric basal spine nearest inner margin of test followed by nine chambers initially low, broad, and uninflated, later higher with ultimate and penultimate chambers inflated; sutures distinct, flush to slightly constricted, horizontal or very slightly oblique; wall calcareous, surface smooth; aperture terminal, radiate on short neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94136	1.05	0.25–0.075	284

Remarks. Only a single specimen of this species was recovered from the Martin Creek section. *Dentalina* sp. D differs from the associated *D. communis* in its eccentric basal spine, horizontal sutures, and inflated ultimate and penultimate chambers.

Dentalina? sp.

Plate 5, figures 47–50

Occurrence and distribution. Assemblage 1*, rare.

Description. Test consisting of inflated, ovate chambers, very constricted to a slender tubular neck at end of chamber; necks usually broken; chambers may be slightly asymmetrical with eccentric necks; specimens consist of one single chamber broken at the constricted necks; wall calcareous with smooth surface; aperture at end of tubular neck, rounded.

Dimensions (mm).

	L	W	Sample no.
GSC 94137	0.30	0.24	329
GSC 94138	0.375	0.24	321
GSC 94139	0.31	0.21	320
GSC 94140	0.30	0.24	320

Remarks. As no complete tests were found and only single disarticulated chambers were recovered from the Martin Creek section, the generic assignment of these specimens is tentative. The presence of a broken neck at either end of the inflated chambers, however, suggests that these chambers represent an elongate, fragile species of *Dentalina* with chambers probably arranged in a uniserial, arcuate series such as was proposed by Tappan (1962, p. 175, Pl. 45, figs. 9–12, 22) for *Dentalina*? *dettermani*, a much larger Albian species from the Alaskan North Slope.

Genus *Geinitzinita* Sellier de Civrieaux and Dessauvagie, 1965

Geinitzinita arctocretacea (Gerke), 1969

Plate 6, figures 1–4

1969 *Paralingulina arctocretacea* Gerke, p. 26–31, Pl. II, figs. 7–11; Pl. III, figs. 1–7.
v1976 *Lingulina* sp. cf. *L. hybrida* Frentzen. Souaya, p. 280, Pl. 3, figs. 4a, b.

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94141	0.575	0.24	284
GSC 94142	0.475	0.20	287
GSC 94143	0.60	0.21	308
GSC 94144	0.66	0.20	308

Remarks. *Geinitzinita arctocretacea* (Gerke) was originally described from the Nordvik region of north-central Siberia. In an addendum to the paper, Gerke (1969, p. 11) recognized that *Paralingulina* was a junior synonym of *Geinitzinita* as proposed by Sellier de Civrieaux and Dessauvagie (1965) in their reclassification of the Nodosariidae.

Gerke recognized two subspecies of this species. *Geinitzinita arctocretacea* of this study appears to be closer in morphology to his subspecies *G. arctocretacea arctocretacea*. Gerke states that occurrences of this species appear to be concentrated in Valanginian deposits, specifically the zone of *Surites spasskensis* excluding the lower two subzones. This zone, according to Gerke, encompasses most of the Valanginian and possibly the lowest of the Hauterivian.

Souaya (1976) recorded *Lingulina* sp. cf. *L. hybrida* Frentzen, a species identical to the present species, from Berriasian–Valanginian deposits of the Deer Bay Formation from Linckens Island in the Sverdrup Basin. Other species of *Geinitzinita* have been reported from the Jurassic Fernie Formation (Brooke and Braun, 1981) and lower Deer Bay Formation (Wall, 1983).

Genus *Pseudonodosaria* Boomgaart, 1949

Pseudonodosaria sp. cf. *P. netrona* (Tappan), 1960

Plate 6, figures 8–10

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94145	0.44	0.21	266
GSC 94146	0.475	0.25	300
GSC 94147	0.56	0.325	302

Remarks. Ten specimens of *Pseudonodosaria* sp. cf. *P. netrona* (Tappan) were recovered from the Martin Creek section. The specimens differ from *P. netrona* (Tappan, 1960, p. 293, Pl. 2, figs. 11, 12) from the Albian Topagoruk and Grandstand formations of the Alaskan North Slope in having proximally acute proloculi and indistinct sutures. All other features appear to be identical.

Pseudonodosaria sp. A

Plate 6, figures 11–13

Occurrence and distribution. Assemblage 1*, common.

Description. Test elongate, uniserial, small to medium sized, rounded to ovate in cross-section; composed of three to five strongly embracing chambers that enlarge more in width than height from a rounded proloculus; final chamber large, approximately one third of test length; sutures indistinct, horizontal, and flush; wall calcareous, smoothly finished; aperture terminal, central, radiate.

Dimensions (mm).

	L	W	Sample no.
GSC 94148 (megalospheric)	0.44	0.175	309
GSC 94149 (megalospheric)	0.375	0.15	312
GSC 94150 (microspheric)	0.59	0.26	313

Remarks. Pseudonodosaria sp. A bears some similarity to *P. humilis* (Reuss) first described from the "Hilsthone" of northern Germany. In North America, Tappan (1962) reported *P. humilis* from the Albian Topagoruk, Grandstand, and Fortress Mountain formations. The present species differs from *P. humilis*, however, in being much smaller in overall size and having a larger terminal chamber.

Pseudonodosaria sp. B

Plate 6, figures 5–7

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, uniserial, small in size, rounded in section; composed of four or five slightly inflated, overlapping chambers that enlarge rapidly; proloculus small, globose; sutures distinct, horizontal, and flush to slightly constricted; wall calcareous and ornamented with eight longitudinal costae not extending onto proloculus or apertural face of final chamber; aperture terminal, central, rounded.

Dimensions (mm).

	L	W	Sample no.
GSC 94151	0.61	0.225	274
GSC 94152	0.56	0.24	298
GSC 94153	0.39	0.19	304

Remarks. Only three specimens of this species, all of which are figured, were recovered from the Martin Creek section. This species bears some resemblance to *P. tenuis* (Bornemann), reported widely from Jurassic and Lower Cretaceous deposits of Germany. The sutures of the present species, however, are not as constricted as those of *P. tenuis* and the test is ornamented with eight longitudinal costae. *Pseudonodosaria sexcostata* (Bornemann) [= *P. quinquecostata* (Bornemann) of Tappan, 1955], reported from Jurassic deposits of the Alaskan North Slope, differs in having an apiculate proloculus, arched sutures, and five to nine sharply developed longitudinal costae.

Pseudonodosaria? sp.

Plate 6, figure 14

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, uniserial, small, compressed in cross-section; composed of three, rapidly enlarging, overlapping chambers; proloculus large, rounded; final chamber slightly inflated and produced; sutures distinct, horizontal, depressed; wall calcareous, ornamented with very fine, discontinuous costae terminating at sutures; aperture central, terminal, (?)radiate, and with a neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94154	0.45	0.21	300

Remarks. Only a single specimen of this species was recovered from the Martin Creek section. Its generic placement is questionable, as the chambers are not as strongly embracing as would be expected of *Pseudonodosaria.*

Subfamily LENTICULININAE Sigal, 1952

Genus *Lenticulina* Lamarck, 1804

Lenticulina sp. cf. *L. macrodisca* (Reuss), 1863

Plate 6, figures 15–18

Occurrence and distribution. Assemblage 1*, abundant. Assemblage 1**, abundant. Subassemblage 2a, common.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94155	0.80	0.65	0.44	282
GSC 94156	0.81	0.675	0.475	282
GSC 94157	0.69	0.575	0.375	282
GSC 94158	0.55	0.475	0.29	282

Remarks. *Lenticulina macrodisca* (Reuss) was originally described from the Hils und Gault of northern Germany. In North America, *L. macrodisca* has been reported from Albian formations of Arctic Canada (Tappan, 1962; Chamney, 1978; Sliter, 1981). The oldest occurrence of this species in North America has been from Berriasian beds of the Deer Bay Formation of the Sverdrup Basin (Souaya, 1976).

Lenticulina sp. cf. *L. macrodisca* of this study differs from *L. macrodisca*, as originally figured by Reuss, in possessing nine or ten rather than seven or eight chambers in the final whorl and a relatively smaller proloculus. The present species, however, does appear to fall within the range of variation allowed by some workers for this species. For example, all reported occurrences of *L. macrodisca* in North America show specimens with relatively smaller proloculi than that shown by the specimens originally figured by Reuss. Tappan (1962) reports seven to nine chambers in the final whorl and a neck-like apertural extension. Souaya (1976) figures a keeled specimen with ten chambers in the final whorl. Chamney (1978) described seven to nine chambers in the final whorl, a keel, and possibly a short neck-like aperture. Sliter (1981) describes six to seven chambers in the final whorl, slightly depressed sutures, and slightly inflated chambers. Until this range of variation for *L. macrodisca* is better understood, the authors feel that the specific assignment of the present species should remain tentative.

Lenticulina sp. cf. *L. saxonica saxonica*
Bartenstein and Brand, 1951

Plate 6, figures 19–21

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94159	1.19	0.85	0.55	276
GSC 94160	0.74	0.525	0.25	302
GSC 94161	0.74	0.51	0.24	275

Remarks. The present species, recovered only from the Martin Creek section, compares favourably to *Lenticulina saxonica saxonica* Bartenstein and Brand (1951) originally described from Middle Valanginian–Lower Hauterivian deposits of northwestern Germany. The present species differs, however, in having occasional specimens that exhibit asymmetrical coiling (Pl. 6, fig. 21), a less well developed peripheral keel, and raised sutures.

Souaya (1976) reported *L.* sp. cf. *L. saxonica saxonica* from Berriasian deposits of the Deer Bay Formation of the Sverdrup Basin. The specimen figured by Souaya is broken. However, it appears to be similar to the present species.

Lenticulina sp.

Plate 6, figure 27

Occurrence and distribution. Assemblage 1*, rare.

Description. Test large, lenticular, planispirally involute, periphery keeled; nine chambers visible in the final whorl around a depressed umbilicus, increasing gradually in size as added; sutures distinct, curved, raised, thickened, thickest toward umbilical area, forming broad ridge near umbilical depression; wall calcareous, surface smooth; aperture radiate, at peripheral angle.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94162	1.525	1.30	0.725	309

Remarks. Only a single specimen of this very large species of *Lenticulina* was recovered from the Martin Creek section. This species shows some similarity to *L. ouachensis wisselmanni* (Bettenstaedt), described from Hauterivian–Barremian rocks of Europe (Bettenstaedt, 1952; Michael, 1967). However, the raised sutures and peripheral keel of the present species are not as well developed as those of the latter species. Also, *L. ouachensis wisselmanni* has a well developed, distinct ring around its umbilical depression.

Genus *Darbyella* Howe and Wallace, 1932

Darbyella pseudolenticularis n. sp.

Plate 6, figures 22–25

Diagnosis. *Darbyella pseudolenticularis* is characterized by trochospiral coiling and numerous chambers with the chambers of the inner whorl being visible in the umbilical region of the spiral side of the test.

Etymology. The specific name refers to the overall appearance of the test that upon cursory examination, would appear to be a *Lenticulina*.

Occurrence and distribution. Assemblage 1*, abundant.

Description. Test medium to large sized, lenticular, biumbonate, periphery keeled, coiling trochoid; chambers numerous, nine to eleven in final whorl, up to nine in inner whorl, increasing very gradually in size as added from small proloculus, chambers of inner whorl visible in umbilical region of spiral side of test; sutures curved, thickened, and raised although this last feature may be lost on less well preserved specimens; wall calcareous; aperture radiate, at peripheral angle.

Dimensions (mm).

	D	T	Sample no.
Holotype GSC 94164	0.56–0.69	0.31	268
Paratype GSC 94163	0.81–0.94	0.44	268
(aperture broken during photography)			
Paratype GSC 94165	0.375–0.475	0.20	269
Paratype GSC 94166	0.31–0.375	0.175	269

Remarks. *Darbyella pseudolenticularis* is distinguished by the trochospiral coiling of its numerous chambers. The genus *Darbyella* was considered by Loeblich and Tappan (1964) to be a synonym of *Lenticulina*, representing an abnormal asymmetrical form of this genus. Loeblich and Tappan stated that in large assemblages of any species of *Lenticulina*, random asymmetrical, twinned, or even partially uncoiled specimens may be found, such as seen in the species *L. bayrocki* Mellon and Wall (1956), originally described from the Lower Albian basal Clearwater Formation of Alberta. However, in the present species, trochospiral coiling is not exhibited by random specimens but by every specimen recovered. *Darbyella pseudolenticularis* occurs abundantly in the Martin Creek section. Furthermore, these specimens cannot be assigned as mere variants to any other species of *Lenticulina* recovered from this section. Therefore, as the trochoid mode of coiling is demonstrably not merely random, the authors have assigned the specimens to the genus *Darbyella*.

Darbyella? sp.

Plate 6, figure 26

Occurrence and distribution. Assemblage 1*, rare.

Description. Test medium sized, lenticular, with excavated umbilical areas, trochospirally coiled with final whorl becoming uncoiled, dorsal periphery and margins of apertural face with large keel; nine chambers in final whorl, increasing gradually in size as added, of greater width than height, inflated just above each suture producing basal chamber ridge; sutures distinct, strongly curved, depressed, thickened; wall calcareous with surface ornamented by raised ridges above each suture; aperture radiate at end of short, stout neck, at dorsal angle.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94167	0.80	0.56	0.26	283

Remarks. A single specimen of this very distinctive species was recovered from the Martin Creek section. This specimen has been tentatively assigned to the genus *Darbyella* because of the trochoid coiling of the test. However, this specimen could also be an asymmetrical variant of a species of *Lenticulina*.

The present species shows some similarity to *Saracenaria topagorukensis* Tappan, described from Upper Jurassic rocks of the Alaskan North Slope (Tappan, 1955, p. 65, Pl. 26, fig. 26), differing in its slightly greater size, trochoid coiling, and inflation of the chambers, which in Tappan's species remains as a ridge just below, rather than above, each suture.

Genus *Astacolus* de Montfort, 1808

Astacolus strombecki (Reuss), 1863

Plate 7, figures 5–8

1863 *Cristellaria strombecki* Reuss, p. 68, Pl. VII, fig. 7.

1962 *Astacolus strombecki* (Reuss). Tappan, p. 178, Pl. 46, figs. 14, 15.

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94168	0.625	0.25	296
GSC 94169	0.61	0.25	313

GSC 94170	0.66	0.29	299
GSC 94171	0.44	0.19	299

Remarks. The thin, flattened tests of *Astacolus strombecki* are extremely fragile and complete tests such as the one shown in Plate 7, figure 8 are rare. This species was first described by Reuss from the Hils und Gault of northwestern Germany. The present species is most similar to those specimens figured by Tappan from the Albian Grandstand and Torok formations of the Alaskan North Slope.

Astacolus sp. cf. *A. incrassatus* (Reuss), 1863

Plate 7, figures 9–11

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94172	0.65	0.46	301
GSC 94173	0.76	0.45	301
GSC 94174	0.56	0.325	311

Remarks. The present species, recovered only from the Martin Creek section, compares favourably to *A. incrassatus* (Reuss) as figured by Tappan (1962, Pl. 46, figs. 8, 9a, b, not 10a, b) from the Albian Topagoruk, Torok, and Grandstand formations of the Alaskan North Slope. *Astacolus* sp. cf. *A. incrassatus* of this study differs in having a less distinct coil, and a surface ornamented with seven or eight continuous and discontinuous longitudinal costae rather than the four reported by Tappan. The number of costae of the present species more closely resembles that of *Vaginulina incrassata* as originally described and figured by Reuss (1863, Pl. IV, figs. 9a, b) from the Hils und Gault of northwestern Germany. The specimen figured by Reuss, however, has a bulbous proloculus and straighter costae than those of the present species.

Astacolus sp.

Plate 7, figure 12

Occurrence and distribution. Subassemblage 2a, rare.

Description. Test small, broken, elongate to ovate in outline, compressed; five low chambers visible in partially coiled arrangement; chambers increase rapidly in width as added and extend toward proloculus on inner margin of test; sutures indistinct, flush to slightly depressed, curved, strongly oblique; wall calcareous with smooth surface; aperture unknown.

Dimensions (mm).

	L	W	Sample no.
GSC 94175	0.51	0.36	483

Remarks. Only two broken specimens of *Astacolus* sp. were recovered from the Mount Goodenough section. These broken specimens cannot be attributed to any other species of *Astacolus* recovered from this section.

Genus *Citharina* d'Orbigny, 1839

Citharina sp.

Plate 7, figure 17

Occurrence and distribution. Assemblage 1*, rare.

Description. Test flattened, elongate, subtriangular in outline with keeled margins, tapering to narrow base; seven broad, low, oblique chambers increasing gradually in size from small, ellipsoidal proloculus; base with a short, stout spine; sutures flush, straight, strongly oblique, obscured by surface ornamentation; wall calcareous; surface ornamented with eight longitudinal costae on a side, three of which are limited to upper third of test; aperture radiate, at dorsal angle, on short neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94176	1.15	0.325	283

Remarks. A single specimen of this species was recovered from the Martin Creek section. Many compressed, triangular species of *Citharina* with longitudinal costae have been recorded from Jurassic and Cretaceous deposits, both in Europe and North America, and many of these species are similar to the present species. For example, *Citharina* sp. cf. *C. accuminata* (Reuss), recorded from Albian deposits of the Alaskan North Slope and the Yukon (Tappan, 1962; Chamney, 1978), differs in having continuous costae as does *C. rudocostata* Bartenstein and Brand,

originally described from German Valanginian deposits (Bartenstein and Brand, 1951). *Citharina orthonota* (Reuss), first described from strata of Hauterivian age and later from Valanginian deposits in Germany (Reuss, 1863; Barentstein and Brand, 1951), has much finer, more numerous and branching costae. *Citharina paucicostata* (Reuss), first described from the Hils und Gault of Germany (Reuss, 1863), has shortened costae that originate from both the apertural and prolocular ends of the test. *Citharina pseudostriatula* Bartenstein and Brand, from Upper Valanginian–Lower Hauterivian deposits of Germany (Bartenstein and Brand, 1951), possesses twelve costae.

Bartenstein (1976) states that *C. pseudostriatula* and related species of *Citharina* with triangular, compressed tests and longitudinal costae are confined to Upper Valanginian–Lower Hauterivian deposits and can be used in correlating these strata.

Genus *Frondicularia* Defrance, 1826

Frondicularia concinna Koch, 1851

Plate 7, figures 1–4

1851 *Frondicularia concinna* Koch, p. 172, Pl. 24, fig. 5.
1951 *Frondicularia concinna* Koch. Bartenstein and Brand, p. 305, Pl. 8, figs. 209, 210.

Occurrence and distribution. Assemblage 1*, abundant.

Dimensions (mm).

	L	W	Sample no.
GSC 94177	1.89	1.04	269
GSC 94178	0.96	0.56	299
GSC 94179	1.10	0.65	298
GSC 94180	0.96	0.64	301

Remarks. Frondicularia concinna Koch was originally described from the "Hilsthone" of Germany. It has subsequently been recorded from strata in Europe ranging in age from Late Valanginian to Late Barremian. This species is more common in Upper Valanginian to Hauterivian deposits and is used in Europe as an index species for these deposits (Bartenstein and Brand, 1951).

Frondicularia sp.

Plate 7, figures 13–15

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, compressed, with faces flattened to slightly concave, gently tapering with greatest width at last chamber; chambers distinct, chevron-shaped, three to five in number increasing gradually in size from large, globular proloculus; base with short, stout spine; sutures flush to slightly depressed, strongly arched toward centre of test; wall calcareous; surface ornamented by 10 to 12 raised, longitudinal, discontinuous costae that are more strongly developed near prolocular end of test; aperture terminal, radiate, produced on short neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94181	1.26	0.39	266
GSC 94182	0.96	0.25	282
GSC 94183	0.575	0.21	288

Remarks. Eight specimens of *Frondicularia* sp. were recovered from the Martin Creek section. This species does not appear to be similar to any other *Frondicularia* species previously reported from Lower Cretaceous strata. However, many narrow, elongate species of this genus are found in Upper Cretaceous strata, some of which are similar to the present species. For example, *F. linearis* Franke, originally described from northern Germany (Franke, 1928), differs in having costae on the proloculus only. *Frondicularia linguiformis* Marsson, also originally described from Europe but subsequently reported from Texas (Cushman, 1946), has very fine and numerous costae that are confined to the chambers between the sutures. *Frondicularia striatula* Reuss, first described from Bohemia (Reuss, 1845) and also subsequently reported from Texas (Cushman, 1946), is the most similar to the present species but differs in having continuous costae.

Frondicularia? sp.

Plate 7, figure 16

Occurrence and distribution. Subassemblage 2a, rare.

Description. Test broken, compressed with flattened faces, (?)palmate; chambers distinct, chevron-shaped, only four preserved but appear to increase rapidly in width and overlap laterally; sutures flush to slightly depressed, strongly arched toward centre of test; wall calcareous with smooth surface; aperture unknown.

Dimensions (mm).

	L	W	Sample no.
GSC 94184	0.55	0.84	456

Remarks. As only a single broken fragment of *Frondicularia*? sp. was recovered from the Goodenough Creek section, a specific designation was not attempted and the generic designation is tentative.

Genus *Marginulina* d'Orbigny, 1826

Marginulina pyramidalis (Koch), 1851

Plate 7, figures 18, 19

1851 *Nodosaria pyramidalis* Koch, p. 173, Pl. 24, fig. 8.
1951 *Marginulina pyramidalis* (Koch). Bartenstein and Brand, p. 307, Pl. 9, figs. 221–223.
1967 *Marginulina pyramidalis* (Koch). Basov, p. 61, Pl. III, figs. 1–3.
1968 *Marginulina pyramidalis* (Koch). Basov, Table 1.
1972 *Marginulina pyramidalis* (Koch). Saks, p. 252, 253.

Occurrence and distribution. Assemblage 1*, abundant. Subassemblage 2a, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94185	1.16	0.40	308
GSC 94186	0.775	0.275	476

Remarks. *Marginulina pyramidalis* (Koch) was first described from the "Hilsthone" of northern Germany from strata of Hauterivian age. This species has subsequently been reported in Europe from deposits ranging throughout the Lower Cretaceous; however, *M. pyramidalis* is most commonly recovered from Middle Valanginian to Upper Barremian deposits. In the Boreal Realm, Basov (1967, 1968) reported *M. pyramidalis* from Volgian–Berriasian deposits of the Kheta River Basin in central Siberia. Later, Saks (1972) recorded this species from Berriasian–Valanginian deposits of the Paks-Peninsula, also in central Siberia.

Marginulina sp. cf. *M. pinguicula* Tappan, 1955

Plate 7, figures 27, 28

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94187	0.44	0.375	0.35	304
GSC 94188	0.59	0.45	0.40	310

Remarks. Seven specimens were recovered from the Martin Creek section. When the tests of these specimens are dry, this very globose species resembles a polymorphinid. However, when the tests are wet, an incomplete coil can be seen in the early portion of the test. *Marginulina* sp. cf. *M. pinguicula* of this study compares favourably to *M. pinguicula* Tappan, originally described from Upper Jurassic rocks of the Alaskan North Slope, in its overall general shape, chamber morphology and arrangement, and suture type. They differ, however, in that the present species has a smaller test with distinct and slightly depressed sutures.

Marginulina sp. A

Plate 7, figures 20–23

Occurrence and distribution. Assemblage 1*, common.

Description. Test elongate to ovate, uniserial, rounded in section with slightly arcuate axis and rounded periphery; proloculus small, apiculate, followed by three to six low and broad chambers that increase rapidly in size as added; final chamber inflated and very large forming approximately one third to one half of test length; sutures distinct, flush, oblique; wall calcareous with smooth surface; aperture terminal, radiate, produced at dorsal angle.

Dimensions (mm).

	L	W	Sample no.
GSC 94189	0.75	0.25	305
GSC 94190	0.60	0.20	305
GSC 94191	0.49	0.21	305
GSC 94192	0.34	0.15	305

Remarks. Marginulina sp. A differs from *M. brevis* Paalzow as reported from Upper Jurassic deposits of the Alaskan North Slope by Tappan (1955) and from the Husky Formation of the northern Yukon and northwestern Northwest Territories by Hedinger (1979) in its more elongate shape, rounded cross-section, less strongly oblique sutures, and apiculate proloculus. It differs from *M. breviformis* (Terquem and Berthelin) as reported by Tappan (1955) from Lower Jurassic rocks of the Alaskan North Slope in its less strongly oblique sutures and rounded cross-section.

Marginulina sp. B

Plate 7, figures 24–26

Occurrence and distribution. Assemblage 1*, common.

Description. Test elongate, rounded in cross-section; small globular proloculus followed by five or six obliquely oriented, uncoiled, rectilinear chambers that increase gradually in size as added; sutures indistinct, oblique, and flush in early portion of test, becoming more distinct, less oblique, and slightly constricted in later portion; wall calcareous with smooth surface; aperture terminal, radiate, produced at dorsal angle.

Dimensions (mm).

	L	W	Sample no.
GSC 94193	0.69	0.175	283
GSC 94194	0.69	0.19	284
GSC 94195	0.65	0.19	325

Remarks. Marginulina sp. B is similar to the less arcuate forms of *Dentalina* such as *D. nana* Reuss or the more loosely coiled forms of *Marginulina* such as *M. linearis* Reuss, both species originally described from the Hils und Gault of northwestern Germany (Reuss, 1863). *Marginulina* sp. B of the Martin Creek section differs morphologically, however, from these species in having a small proloculus and second chamber that are slightly coiled but not completely enrolled, and in having sutures that become less, rather than more, oblique in the later portion of the test.

Marginulina sp. C

Plate 7, figures 29–32

Occurrence and distribution. Assemblage 1*, common.

Description. Test small to medium sized, compressed, ovate in cross-section with sharply angled dorsal margin and broadly rounded ventral margin; five or six low and broad chambers in slightly coiled arrangement, increasing gradually in height, more rapidly in width, as added; final chamber increasing more markedly in height being two to two and a half times as high as penultimate chamber; sutures flush, straight, becoming strongly oblique in later portion of test; wall calcareous with smooth surface; aperture radiate, somewhat produced, at peripheral angle.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94196	0.60	0.35	0.30	282
GSC 94197	0.61	0.425	0.29	297
GSC 94198	0.49	0.325	0.24	307
GSC 94199	0.40	0.31	0.25	292

Remarks. Marginulina sp. C is similar to *Marginulina planuiscula* (Reuss) as figured by Tappan (1962) and Sliter (1981) from Albian formations of the Alaskan North Slope and the Sverdrup Basin. However, *M.* sp. C has a more compressed, shorter test with straight rather than curved sutures. In the general shape of the test, *M.* sp. C is comparable to *Lenticulina* sp. aff. *L. ovalis* (Reuss) as figured by Løfaldli and Thusu (1979) from the Valanginian–Hauterivian Nybrua Formation of northern Norway. Unfortunately, the chamber arrangement is not clearly shown in the specimen figured by Løfaldli and Thusu.

Marginulina sp.

Plate 7, figure 33

Occurrence and distribution. Assemblage 1*, rare.

Description. Test medium sized, elongate, rounded in section, axis slightly curved; consisting of inflated

proloculus followed by four broad and low chambers that increase very little in height and gradually in width as added; final chamber slightly inflated; sutures distinct, straight, flush to slightly depressed; wall calcareous with smooth surface; aperture terminal, radiate, on short but distinct neck, at dorsal angle.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94200	0.69	0.325–0.19	0.29	311

Remarks. As only two specimens of *Marginulina* sp. were recovered from the Martin Creek section, the material was insufficient for evaluations and comparisons to be made.

Marginulina? sp. A

Plate 7, figure 34

Occurrence and distribution. Subassemblage 2a, rare.

Description. Test small, short, broad, compressed, periphery gently angled; six low and broad chambers increasing gradually in size as added from small, globose proloculus forming an incomplete coil; final chamber extends toward proloculus on inner margin of test; sutures distinct, depressed, straight, radiate; wall calcareous; aperture terminal, at dorsal angle, type unknown.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94201	0.39	0.26	0.17	484

Remarks. A single steinkern of *Marginulina*? sp. A was recovered from upper strata of the Goodenough Creek section.

Marginulina? sp. B

Plate 7, figure 35

Occurrence and distribution. Assemblage 1*, rare.

Description. Test small, short, broad, robust, periphery broadly rounded; chambers few in number (five), early chambers very low and broad, increasing gradually in size from a large, globular proloculus forming an incomplete coil; final chamber much higher, inflated, forming over one half of test length; sutures distinct, depressed, gently curved in early portion of test, later straight; wall calcareous; aperture terminal, rounded, at dorsal angle.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94202	0.44	0.31	0.31	330

Remarks. The one steinkern of this species recovered from the Martin Creek section appears to be that of a loosely coiled nodosariid species such as *Marginulina*.

Genus *Marginulinopsis* Silvestri, 1904

Marginulinopsis gracilissima (Reuss), 1863

Plate 7, figures 36–39

1863 *Cristellaria gracilissima* Reuss, p. 64, Pl. 6, figs. 9, 10.
1939 *Marginulina gracilissima* (Reuss). Myatliuk, p. 61, Pl. 4, fig. 50.
1951 *Lenticulina* (*Marginulinopsis*) *gracilissima* (Reuss). Bartenstein and Brand, p. 288, Pl. 6, fig. 139.
v1976 *Marginulina* sp. cf. *M. cephalotes* (Reuss). Souaya, p. 280, Pl. 4, fig. 15.

Occurrence and distribution. Assemblage 1*, abundant.

Dimensions (mm).

	L	W	Sample no.
GSC 94203	0.925	0.275	301
GSC 94204	0.86	0.24	301
GSC 94205	0.625	0.24	301
GSC 94206	0.56	0.21	301

Remarks. Marginulinopsis gracilissima (Reuss) was first described from the Hils und Gault of northwestern Germany. It has subsequently been widely reported throughout Neocomian deposits of Europe. In the C.I.S., the range of this species extends into Middle Volgian deposits.

In the Sverdrup Basin, Souaya (1976) reported *Marginulina* sp. cf. *M. cephalotes* (Reuss) from the Lower Deer Bay and Upper Savik formations, which were dated as Berriasian and Callovian, respectively. The specimen figured by Souaya from the Deer Bay Formation appears to be identical to the specimens of *Marginulinopsis gracilissima* recovered from the Martin Creek section.

Marginulinopsis jonesi (Reuss), 1863

Plate 8, figures 1–3

1863 *Marginulina jonesi* Reuss, p. 61, Pl. 5, fig. 19.
1951 *Lenticulina* (*Marginulinopsis*) *jonesi* (Reuss). Bartenstein and Brand, p. 289, Pl. 6, fig. 334.
1962 *Marginulinopsis jonesi* (Reuss). Tappan, p. 167, Pl. 42, figs. 1–6.
1978 *Marginulinopsis jonesi* (Reuss). Chamney, p. 29, Pl. 7, figs. 7–9.

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94207	0.70	0.29	299
GSC 94208	0.65	0.24	296
GSC 94209	0.59	0.20	296

Remarks. Only eight specimens of *Marginulinopsis jonesi* were recovered from a 23 m interval of the Martin Creek section. *Marginulinopsis jonesi* has been reported throughout Lower Cretaceous deposits of Europe, particularly Germany. In North America, this species has been reported from the Albian Grandstand and Topagoruk formations of the Alaskan North Slope and the Arctic Red Formation of the Yukon. Souaya (1976) reported *M. jonesi* from Berriasian–lower Valanginian deposits of the Deer Bay Formation of the Sverdrup Basin. The specimen figured by Souaya, however, does not show the numerous low, longitudinal ribs characteristic of this species.

Marginulinopsis robusta (Reuss), 1863

Plate 8, figures 4–8

1863 *Marginulina robusta* Reuss, p. 63, Pl. 6, figs. 5, 6.
1951 *Lenticulina* (*Marginulinopsis*) *robusta* (Reuss). Bartenstein and Brand, p. 289, Pl. 6, figs. 142, 143.
v1983 *Marginulinopsis robusta* (Reuss). Wall, p. 261, Pl. 5, figs. 28, 29.

Occurrence and distribution. Assemblage 1*, abundant. Subassemblage 2a, common. Assemblage 3, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94210	0.50	0.19	299
GSC 94211	0.64	0.20	299
GSC 94212	0.575	0.29	480
GSC 94213	0.91	0.26	283
GSC 94214	1.06	0.375	310

Remarks. Marginulinopsis robusta (Reuss) was originally described from the Hils und Gault of northwestern Germany. This species has subsequently been reported throughout Neocomian deposits of Europe. In North America, Wall (1983) reported *M. robusta* from the upper Deer Bay Formation of the Sverdrup Basin, dated as Berriasian–Valanginian in age by Jeletzky (1973) and Kemper (1975), using megafossils.

Marginulinopsis sp. cf. *M. reiseri* Tappan, 1960

Plate 8, figure 9

1960 *Marginulinopsis reiseri* Tappan, p. 293, Pl. 2, figs. 1, 2.

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94215	0.775	0.29	0.25	268

Remarks. Marginulinopsis reiseri Tappan was originally described from the Albian Topagoruk, Torok, and Grandstand formations of the Alaskan North Slope. The greatest length of the specimens from the present study is smaller than that attained by the Alaskan specimens. All other characteristics appear identical.

Marginulinopsis sp.

Plate 8, figures 10–12

Occurrence and distribution. Assemblage 1*, rare.

Description. Test small, robust, with gently angled dorsal periphery, broadly rounded ventral periphery, and umbilical depressions; chambers few in number, early portion of four to six chambers in close coil, final chamber with tendency to uncoil; early chambers low and broad, increasing gradually in size as added from large globular proloculus; final chamber inflated; sutures distinct, depressed, strongly curved; wall calcareous with smooth surface; aperture terminal, rounded, with neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94216	0.29	0.19	269
GSC 94217	0.30	0.19	269
GSC 94218	0.30	0.19	269

Remarks. Marginulinopsis sp. was recovered only from the lowermost beds of the Martin Creek section. This very small species somewhat resembles the juvenile specimens of *Marginulinopsis gracilissima* (Reuss) that were recorded from the same strata. They differ, however, in that *M. gracilissima* has straight, horizontal sutures and a straight dorsal margin with the aperture at the dorsal angle and lacks an umbilical depression in the coiled portion of the test. With the exception of the position of the apertural neck, the present species more closely resembles the juvenile specimens of *Marginulina zaspelovae* Romanova reported from Volgian and Neocomian deposits of western, central, and northern Siberia (Romanova, 1960; Basov, 1967, 1968; Saks, 1972). However, *M. zaspelovae* also has a larger form with an elongate, uncoiled, uniserial portion of the test.

Genus *Saracenaria* Defrance, 1824

Saracenaria brookeae n. sp.

Plate 8, figures 19–21

v1976 *Saracenaria triangularis* (d'Orbigny). Souaya, p. 280, Pl. 4, fig. 3.

Diagnosis. Saracenaria brookeae is characterized by small test size, a small initial coil with a widely flaring uncoiled section, keeled dorsal periphery, and sharply angled ventral peripheries.

Etymology. The specific name is patronymic in honour of M.M. Brooke, formerly with the University of Saskatchewan, who studied the Jurassic microfaunas of the Western Interior Basin.

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, common. Subassemblage 2b, rare.

Description. Test small, robust with triangular cross-section, keeled dorsal periphery, and sharply angled ventral peripheries, consisting of small, close coil of four or five chambers followed by a widely flaring, uncoiled section of two or three chambers; chambers increase rapidly in width and more rapidly in height dorsally than ventrally; terminal chamber inflated, extending to proloculus on inner margin of test with broad, triangular terminal face; sutures indistinct and flush, final suture distinct, depressed, arcuate; wall calcareous with smooth surface; aperture radiate, at dorsal angle, slightly produced.

Dimensions (mm).

	L	W	T	Sample no.
Holotype GSC 94219	0.425	0.31	0.29	281
Paratype GSC 94220	0.36	0.275	0.175	281
Paratype GSC 94221	0.35	0.26	0.275	281

Remarks. Saracenaria brookeae is identical to *S. triangularis* (d'Orbigny) as figured by Souaya (1976) from Upper Tithonian (Upper Volgian) beds of the Awingak Formation and Berriasian–Lower Valanginian beds of the Deer Bay Formation of the Sverdrup Basin. As originally described by d'Orbigny, however, *S. triangularis* is a fairly large species that has been widely recorded from Upper Cretaceous deposits in both Europe and the Gulf Coast region of the United States. The authors consider specimens of the present species and those reported by Souaya to constitute a new and distinct species of *Saracenaria.*

Saracenaria brookeae differs from similar, younger species such as *Saracenaria* sp. A of Stelck et al. (1956, p. 51, Figs. 26, 27) and *S. dutroi* Tappan (1962, Pl. 41, figs. 17a, b, not figs. 15a, b, 16) in its keeled dorsal periphery, sharply angled ventral peripheries enclosing a triangular terminal face, and more numerous chambers. The present species is comparable to the shorter, broader specimens of *Saracenaria* sp. 176 as described and figured by Brooke and Braun (1981, Pl. 7, figs. 45, 55, 62–69, not figs. 56–61) from the

Upper Jurassic Fernie Formation of northeastern British Columbia and adjacent Alberta. The specimens recovered by Brooke and Braun, however, differ from the present species in that the coiled portion of the tests are strongly compressed.

Saracenaria compressa n. sp.

Plate 8, figures 22–25

Diagnosis. Saracenaria compressa is characterized by a compressed test, acute periphery, and gently rounded ventral margins enclosing the apertural face.

Etymology. The specific name refers to the compressed test.

Occurrence and distribution. Assemblage 1*, common.

Description. Test elongate, compressed with acute periphery; early portion consisting of close coil of five or six chambers; later portion uncoiled, of three to five chambers with triangular cross-section; chambers low and broad, increasing gradually in size from a small proloculus; sutures flush to slightly depressed, strongly curved; wall calcareous with smooth surface; aperture radiate, at dorsal angle, slightly produced.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 94222	0.89	0.44	296
Paratype GSC 94223	0.74	0.45	306
Paratype GSC 94224	0.56	0.375	267
Paratype GSC 94225	0.46	0.275	296

Remarks. Saracenaria compressa is similar to *S. oxfordiana* Tappan, originally described from Upper Jurassic deposits of the Alaskan North Slope (Tappan, 1955, p. 64, Pl. 26, fig. 27). However, the present species has an acute rather than a keeled dorsal margin and more gently rounded ventral margins enclosing the apertural face.

Saracenaria pravoslavlevi Fursenko and Polenova, 1950

Plate 8, figures 13–15

1950 *Saracenaria pravoslavlevi* Fursenko and Polenova, p. 45, Pl. IV, figs. 13–15.

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94226	0.70	0.375	0.31	301
GSC 94227	0.60	0.31	0.30	268
GSC 94228	0.475	0.24	0.25	282

Remarks. Saracenaria pravoslavlevi Fursenko and Polenova was originally described from Volgian deposits of the Emba region of the central C.I.S. Subsequent workers extended the range of this species into the Neocomian.

Saracenaria pravoslavlevi is characterized by its keeled ventral and dorsal margins, distinct sutures that coalesce with the ventral margins, and large initial coil. These features serve to distinguish it from similar species such as *S. italica* Defrance and *S. frankei* Dam, both of which have been described from Lower Cretaceous deposits of Europe (Eichenberg, 1934; Dam, 1946, 1948; Bartenstein and Brand, 1951; Michael, 1967).

Saracenaria sp. cf. *S. porcupinensis* Chamney, 1978

Plate 8, figures 16–18

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, rare. Subassemblage 2a, rare. Subassemblage 2b, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94229	0.69	0.40	312
GSC 94230	0.45	0.31	283
GSC 94231	0.45	0.30	311

Remarks. Saracenaria sp. cf. *S. porcupinensis* of this study compares favourably to *S. porcupinensis* Chamney, originally described from the Albian Martin House Formation of the Yukon. The present species differs in having more chambers in the initial coil. However, all other characteristics appear identical.

Genus *Vaginulina* d'Orbigny, 1826

Vaginulina kochii Roemer, 1841

Plate 8, figure 26

1841 *Vaginulina kochii* Roemer, p. 96, Pl. 15, fig. 10.
1951 *Vaginulina kochii* Roemer. Bartenstein and Brand, p. 293, Pl. 6, figs. 158, 159.

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94232	1.30	0.45	277

Remarks. A single specimen of *Vaginulina kochii* was recovered from the Martin Creek section. This specimen appears identical to the specimens figured by Bartenstein and Brand (1951) from Upper Valanginian deposits of northwestern Germany. Other workers have extended the range of this species from Upper Valanginian to Upper Barremian deposits.

Vaginulina sp. cf. *V. calliopsis* (Reuss), 1863

Plate 8, figures 28, 29

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94233	0.85	0.30	0.25	302
GSC 94234	0.69	0.19	0.15	320

Remarks. Vaginulina sp. cf. *V. calliopsis* (Reuss) compares favourably to *Marginulina calliopsis* as originally figured by Reuss from the Hils und Gault of Germany, differing only in the final chamber, which is inflated in the present species. The few specimens recovered from the Martin Creek section, however, are not similar to *Lenticulina* (*Astacolus*) *calliopsis* (Reuss) of Bartenstein and Brand (1951) from Valanginian deposits of northwestern Germany. This latter species is shown as having a well developed coil and straight rather than curved sutures.

Vaginulina sp. A

Plate 8, figures 31–33

Occurrence and distribution. Subassemblage 2a, rare.

Description. Test small, ovate in outline, compressed with narrowly rounded periphery; five or six chambers in slightly coiled arrangement; initial chambers very low and broad, increasing very little in size as added; final chamber large, increasing greatly in height, occupying one half to two thirds of test length; sutures distinct, depressed, straight, oblique; wall calcareous with smooth surface; aperture slightly produced, at peripheral angle, type unknown.

Dimensions (mm).

	L	W	Sample no.
GSC 94235	0.40	0.19	480
GSC 94236	0.39	0.20	485
GSC 94237	0.30	0.225	485

Remarks. Five specimens of *Vaginulina* sp. A were recovered from the Goodenough Creek section. The poor preservation of these specimens precluded any further comparison and identification.

Vaginulina sp. B

Plate 8, figure 30

Occurrence and distribution. Subassemblage 2a, rare.

Description. Test elongate, medium sized, ovate in cross-section with rounded ventral periphery and angled dorsal periphery; chambers numerous, low and broad, three or four chambers in slightly coiled but not completely enrolled arrangement followed by parallel-sided uncoiled section of five chambers; chambers increase gradually in size as added; sutures indistinct, flush, strongly oblique; wall calcareous; surface ornamented with ten very low, longitudinal ribs that disappear at last suture; aperture radiate, at dorsal angle, slightly produced.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94238	0.66	0.225	0.175	477

Remarks. A single specimen of *Vaginulina* sp. B was recovered from the Goodenough Creek section.

Vaginulina sp. C

Plate 8, figure 34

Occurrence and distribution. Assemblage 1*, rare.

Description. Test medium sized, elongate, ovate in cross-section with rounded ventral and angled dorsal peripheries; chambers low and broad, first four slightly coiled, but not completely enrolled, followed by parallel-sided uncoiled section of four chambers; chambers increase gradually in width, more markedly in height as added, final three chambers inflated; initial sutures indistinct, flush, curved, last three sutures distinct, depressed, gently curved, oblique; wall calcareous; surface ornamented by series (approximately five) of indistinct, fine, longitudinal costae of unequal length confined to ventral portion of test extending from proloculus, none reaching terminal chamber; aperture distinct, at peripheral angle, with neck, radiate.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94239	0.64	0.19	0.16	324

Remarks. *Vaginulina* sp. C differs from the similar, associated species *V*. sp. cf. *V. calliopsis* (Reuss) in its surface ornamentation. A single specimen was recovered from the Martin Creek section.

Vaginulina sp. D

Plate 8, figure 27

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, medium sized, ovate in cross-section with broadly rounded peripheries; ovate proloculus followed by six low chambers that increase gradually in size as added; final chamber relatively high and slightly inflated; sutures flush to slightly depressed, becoming oblique in later portion of test; wall calcareous with smooth surface; aperture radiate at dorsal angle, produced.

Dimensions (mm).

	L	W	T	Sample no.
GSC 94240	0.59	0.26	0.24	281

Remarks. The few specimens recovered from the Martin Creek section are very similar to *Cristellaria scitula* Berthelin as figured by Chapman (1894) from the Gault of Folkestone. The material recovered was insufficient to verify a specific designation.

Vaginulina? sp.

Plate 8, figure 35

Occurrence and distribution. Assemblage 1*, rare.

Description. Test small, compressed, semitriangular in outline, periphery flattened and truncated; consisting of large, globular proloculus followed by small, subtriangular second chamber; chamber arrangement faintly suggestive of coil; sutures distinct, thickened, raised; wall calcareous with smooth surface; aperture terminal, radiate, at outer margin.

Dimensions (mm).

	L	W	Sample no.
GSC 94241	0.36	0.24	332

Remarks. A single juvenile specimen of *Vaginulina*? sp. was recovered from the Martin Creek section. This juvenile specimen is probably that of a *Vaginulina*, but it cannot be attributed to any other species of *Vaginulina* recovered from this section.

Genus *Vaginulinopsis* Silvestri, 1904

Vaginulinopsis sp. cf. *V. pachynota* Dam, 1946

Plate 8, figures 36–38

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94242	0.54	0.30	289
GSC 94243	0.56	0.30	287
GSC 94244	0.53	0.26	282

Remarks. *Vaginulinopsis* sp. cf. *V. pachynota* Dam compares favourably to *V. pachynota* Dam as described and figured by Tappan (1962, p. 180, Pl. 47, fig. 6) from the Lower Albian Torok and Fortress Mountain formations of the Alaskan North Slope. This species was originally described from Hauterivian deposits of the Netherlands. Both the present species and the Alaskan species differ from the original species, however, in having smaller tests with flush to slightly depressed rather than thickened and elevated sutures.

Vaginulinopsis sp.

Plate 8, figures 39, 40

Occurrence and distribution. Assemblage 1**, rare. Subassemblages 2a and 2b, rare.

Description. Test small, compressed, ovate in outline with angled periphery; chambers few, low and broad, early three chambers forming incomplete coil followed by three or four uncoiled chambers that reach back toward proloculus on inner margin of test; chambers increase more rapidly in width than in height; sutures indistinct, flush, gently curved and oblique; wall calcareous with smooth surface; aperture at peripheral angle, type unknown.

Dimensions (mm).

	L	W	Sample no.
GSC 94245	0.39	0.25	530
GSC 94246	0.425	0.275	480

Remarks. Eight specimens of *Vaginulinopsis* sp. were recovered from the Goodenough Creek section. This species bears some similarity to the older *V.* sp. cf. *V. pachynota* Dam recovered from the Martin Creek section; however, the eight tests recovered are so badly preserved that a more precise comparison is not possible.

Subfamily LINGULININAE
Loeblich and Tappan, 1961

Genus *Lingulina* d'Orbigny, 1826

Lingulina? sp.

Plate 9, figure 1

Occurrence and distribution. Assemblage 1*, rare.

Description. Test flattened, elongate to ovate in outline with rounded margins and slightly concave lateral faces; globular, inflated proloculus followed by six strongly arched, uniserial chambers that increase gradually in size as added and that overlap each preceding chamber; chambers slightly inflated along margins of test forming two longitudinal ridges that extend from proloculus to terminal chamber; sutures distinct, flush to slightly depressed, thickened, strongly arched at centre of test; wall calcareous with smooth surface; terminal aperture unknown as final chamber broken, but preceding apertural necks seen between chambers (when wet) appear to have elongate apertural slits.

Dimensions (mm).

	L	W	Sample no.
GSC 94247	0.975	0.44	328

Remarks. A single specimen of *Lingulina*? sp. was recovered from the Martin Creek section. The specimen bears some resemblance to *Frondicularia.* However, as the aperture does not appear to be radiate, the specimen is tentatively assigned to *Lingulina.*

Genus *Lingulonodosaria* Silvestri, 1903

Lingulonodosaria? sp.

Plate 9, figure 2

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate, medium sized, uniserial, compressed, parallel-sided with narrowly rounded margins; very large, inflated, globular proloculus followed by two inflated, low and broad chambers that increase very little in width and gradually in height as

added; chambers are not strongly overlapping; sutures distinct, depressed, constricted, straight, horizontal; wall calcareous with smooth surface; aperture a terminal elongate slit in plane of compression.

Dimensions (mm).

	L	W	Sample no.
GSC 94248	0.69	0.275	276

Remarks. As the terminal chamber of *Lingulonodosaria*? sp. is crushed, it is possible that the slit-type aperture is a result of distortion. The specimen would then be assigned to the genus *Nodosaria*.

Family POLYMORPHINIDAE d'Orbigny, 1839

Subfamily POLYMORPHININAE d'Orbigny, 1839

Genus *Eoguttulina* Cushman and Ozawa, 1930

Eoguttulina? sp.

Plate 9, figure 3

Occurrence and distribution. Assemblage 1*, rare.

Description. Test elongate with rounded cross-section; chambers few, large, inflated, embracing, four in number, increasing rapidly in size from large, globular proloculus; chambers appear to be arranged in extended, elongate, spiral series but could also be loosely biserial and extended; terminal chamber high and conical; sutures distinct, depressed, constricted, gently curved; wall calcareous with smooth surface; aperture terminal, central, radiate.

Dimensions (mm).

	L	W	Sample no.
GSC 94249	0.80	0.31	297

Remarks. A single specimen of *Eoguttulina*? sp. was recovered from the Martin Creek section. As there is some question about the arrangement of the chambers, the generic designation of this specimen is tentative.

Genus *Globulina* d'Orbigny, 1839

Globulina prisca Reuss, 1863

Plate 9, figures 8–10

1863 *Globulina prisca* Reuss, p. 79, Pl. 9, fig. 8.
1951 *Globulina prisca* Reuss. Bartenstein and Brand, p. 320, Pl. 10, fig. 286.
1962 *Globulina prisca* Reuss. Tappan, p. 184, Pl. 47, figs. 25, 26.

Occurrence and distribution. Assemblage 1*, common. Subassemblages 2a and 2b, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94250	0.50	0.24	312
GSC 94251	0.525	0.26	530
GSC 94252	0.475	0.175	307

Remarks. Specimens of *Globulina prisca* Reuss of this study range from acutely to gently angled at the proximal end of the test, possibly representing the microspheric and megalospheric generations of the species.

Globulina prisca has been widely recorded from Lower Cretaceous deposits of Germany, the Netherlands, England, Poland, France, Alaska, and Norway. *Globulina* sp. cf. *G. prisca* as recorded by Souaya (1976) from the Deer Bay Formation of the Sverdrup Basin differs in being a much smaller species.

Globulina sp. cf. *G. exserta* (Berthelin), 1880

Plate 9, figures 6, 7

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, rare. Subassemblages 2a and 2b, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94253	0.36	0.24	303
GSC 94254	0.34	0.21	282

Remarks. The specimens recovered compare favourably to *Globulina exserta* (Berthelin) as described and figured by Tappan (1962, p. 183, Pl. 47, figs. 20, 21, not figs. 22, 23) from the Albian Grandstand Formation of the Alaskan North Slope. Tappan, however, included in her description specimens recovered from the Topagoruk Formation (Pl. 47, figs. 22, 23) that have an apiculate basal end. No specimens were recovered in the present study that compare to the specimens from the Topagoruk Formation.

Globulina exserta has been widely recorded throughout Lower Cretaceous deposits in Europe and the Gulf Coast region of the United States.

Globulina sp. cf. *G. lacrima* Reuss, 1845

Plate 9, figures 4, 5

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, rare. Subassemblages 2a and 2b, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94255	0.81	0.51	310
GSC 94256	0.30	0.24	300

Remarks. The present species is very similar to *G. lacrima* Reuss, a species widely distributed in Cretaceous deposits of Europe and the Gulf Coast region of the United States. Mellon and Wall (1956) described a subspecies, *G. lacrima canadensis*, from Albian formations of northern British Columbia and Alberta based upon its consistently smaller size, about one third the size of the specimens originally described from Germany. Specimens of the present species vary in size from very large, as for *G. lacrima* as originally described, to very small, as for *G. lacrima canadensis*.

Genus *Pyrulinoides* Marie, 1941

Pyrulinoides sp. cf. *P. thurrelli* Tappan, 1957

Plate 9, figures 11–13

Occurrence and distribution. Assemblage 1*, rare. Subassemblages 2a and 2b, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94257	0.66	0.35	305
GSC 94258	0.81	0.425	306
GSC 94259	0.80	0.375	312

Remarks. *Pyrulinoides* sp. cf. *P. thurrelli* Tappan compares favourably to *P. thurrelli*, originally described by Tappan (1957) from the Albian Grandstand and Topagoruk formations of the Alaskan North Slope. The present species differs from Tappan's figured specimens, however, in having one additional chamber, a slightly smaller terminal chamber, and an ovate rather than a circular cross-section, although this last feature could be a result of distortion.

Family GLANDULINIDAE Reuss, 1860

Subfamily GLANDULININAE Reuss, 1860

Genus *Tristix* Macfadyen, 1941

Tristix sp. cf. *T. acutangulus* (Reuss), 1863

Plate 9, figure 14

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94260	0.54	0.19	312

Remarks. The single specimen of this species recovered from the Martin Creek section compares favourably to *Tristix acutangulus* (Reuss), originally described from the Hils und Gault of northwestern Germany. Except for being approximately one half the size, the present species is very similar if not identical to *T. acutangulus* as figured by Bartenstein and Brand (1951, p. 314, Pl. 10, fig. 257) from Middle Valanginian–Lower Hauterivian deposits of Germany. However, as only a single specimen was recovered, the specific identification of this specimen is tentative.

Subfamily OOLININAE Loeblich and Tappan, 1961

Genus *Oolina* d'Orbigny, 1839

Oolina apiculata emaciata (Reuss), 1862

Plate 9, figures 17–19

1862 *Lagena apiculata* var. *emaciata* Reuss, p. 319, Pl. 1, fig. 9.
1967 *Lagena apiculata emaciata* Reuss. Michael, p. 74, Pl. IV, figs. 37, 38.

Occurrence and distribution. Assemblage 1*, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94261	0.70	0.325	311
GSC 94262	0.525	0.24	321
GSC 94263	0.34	0.16	313

Remarks. The present species, recovered only from the Martin Creek section, is identical to *Lagena apiculata emaciata* Reuss as figured by Michael (1967) from Barremian deposits of northwestern Germany. However, the size range of the specimens recovered in this study is greater than that documented for the German specimens.

Oolina hauteriviana hauteriviana (Bartenstein and Brand), 1951

Plate 9, figures 22–24

1934 *Lagena* sp.(?) Eichenberg, p. 182, Pl. 12, fig. 13.
1951 *Lagena hauteriviana hauteriviana* Bartenstein and Brand, p. 317, Pl. 10, figs. 227, 228.
1967 *Lagena hauteriviana hauteriviana* Bartenstein and Brand. Michael, p. 75, Pl. IV, figs. 34, 35.

Occurrence and distribution. Subassemblage 2b, common.

Dimensions (mm).

	L	W	Sample no.
GSC 94264	0.44	0.30	506
GSC 94265	0.395	0.35	525
GSC 94266	0.39	0.34	525

Remarks. Oolina hauteriviana hauteriviana has been reported from German deposits ranging in age from Late Hauterivian to Middle Barremian. Specimens of this species are distinguished from specimens of the older species *Dentalina*? sp. by their larger tests, symmetrical, globose shape, and apiculate base. The basal spine is broken on many specimens. However, a remnant of the spine or a scar is usually visible.

Oolina sp. cf. *O. globosa* (Montagu), 1803

Plate 9, figures 20, 21

Occurrence and distribution. Assemblage 1*, common. Subassemblage 2a, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94267	0.56	0.40	301
GSC 94268	0.55	0.36	305

Remarks. Oolina globosa (Montagu) has been widely recorded from Lower Cretaceous deposits of Europe. The present species differs from *O. globosa* in its larger, more elongate test; all other characteristics appear identical.

Oolina sp. cf. *O. sulcata* (Walker and Jacob), 1798

Plate 9, figures 15, 16

Occurrence and distribution. Assemblage 1*, rare.

Dimensions (mm).

	L	W	Sample no.
GSC 94269	0.34	0.30	283
GSC 94270	0.31	0.25	298

Remarks. Only two specimens of *Oolina* sp. cf. *O. sulcata* (Walker and Jacob), both of which are shown, were recovered from the Martin Creek section. These specimens differ from *Serpula* (*Lagena*) *sulcata* Walker and Jacob in having seven or eight, rather than ten to twelve, longitudinal ribs. The present species is very similar to *Lagena* sp. cf. *L. sulcata* as figured by Bartenstein and Brand (1951, p. 319, Pl. 10, fig. 281) from Upper Valanginian deposits of Germany. The specimen figured by Bartenstein and Brand has nine

longitudinal ribs. However, all other characteristics appear identical.

Oolina sp.

Plate 9, figure 25

Occurrence and distribution. Assemblage 1*, rare.

Description. Test tiny, unilocular, ovate; wall calcareous; surface ornamented by numerous very fine, low, indistinct, longitudinal ribs that merge posteriorly to form short, stout, basal spine; aperture terminal, simple, at end of short, broad neck.

Dimensions (mm).

	L	W	Sample no.
GSC 94271	0.275	0.175	300

Remarks. Three specimens of *Oolina* sp. were recovered from the Martin Creek section. This species is similar to *O. striatifera* Tappan, reported from the Duck Creek and Grayson formations of Texas and Oklahoma (Tappan, 1940, 1943). However, the specimens figured by Tappan are flask-shaped with more prominent longitudinal ribs.

Superfamily BULIMINACEA Jones, 1875

Family TURRILINIDAE Cushman, 1927

Subfamily TURRILININAE Cushman, 1927

Genus *Praebulimina* Hofker, 1953

Praebulimina? *gravelliniformis* n. sp.

Plate 9, figures 26–33

Diagnosis. Praebulimina? *gravelliniformis* is characterized by its tiny test with four, rather than three, chambers to each whorl and its large, loop-shaped aperture.

Etymology. The specific name refers to this quadriserial chamber arrangement as in the genus *Gravellina*.

Occurrence and distribution. Assemblage 1*, common. Assemblage 1**, abundant.

Description. Test tiny, flaring rapidly from bluntly rounded base; chambers low and broad, four to each whorl, increasing gradually in size as added; chambers of final whorl inflated, increasing markedly in size with final whorl forming approximately one half of test length; sutures distinct, depressed; wall calcareous with smooth surface; aperture large, distinct, loop-shaped, extending up apertural face, surrounding area depressed.

Dimensions (mm).

	L	W	Sample no.
Holotype GSC 98065	0.26	0.175	308
Paratype GSC 98066	0.24	0.175	308
Paratype GSC 98067	0.31	0.20	308
Paratype GSC 98068	0.24	0.16	308
Paratype GSC 98069	0.275	0.21	428
Paratype GSC 98070	0.25	0.26	428
Paratype GSC 98071	0.275	0.20	428
Paratype GSC 98072	0.30	0.175	428

Remarks. The generic designation of *Praebulimina*? *gravelliniformis* is tentative as the recovered specimens differ from the definition of the genus *Praebulimina* given by Loeblich and Tappan (1964), in having four chambers to a whorl throughout the length of the test rather than a triserial arrangement of the chambers. In this feature, the present species resembles *Buliminella* =(*Praebulimina*) *loeblichi*, originally described by Bartenstein and Brand (1951) from Upper Valanginian deposits of Germany. They differ, however, in that the German species has an indistinct, small, half-moon shaped aperture.

Family BOLIVINITIDAE Cushman, 1927

Genus *Bolivina* d'Orbigny, 1839

Bolivina sp.

Plate 9, figure 34

Occurrence and distribution. Assemblage 1**, rare.

Description. Test tiny, elongate, gradually tapering, compressed with rounded periphery; chambers distinct, numerous (16), overlapping, of uniform shape, low and broad, biserially arranged throughout and increasing gradually in size as added; sutures distinct, depressed, arcuate; wall calcareous with smooth surface; aperture a wide, elongate loop in terminal face.

Dimensions (mm).

	L	W	Sample no.
GSC 94272	0.50	0.16	430

Remarks. As only a single specimen of *Bolivina* sp. was recovered from the Goodenough Creek section, a specific designation was not attempted.

The test was clearly biserial throughout, so this specimen was assigned to *Bolivina* and not to similar genera such as *Fursenkoina* or *Cassidella*. Species of *Bolivina* are not common in Neocomian strata. Bartenstein and Brand (1951, p. 325, Pl. 11, fig. 317) reported *B. textularioides* Reuss from Upper Valanginian deposits of Germany. The present species differs from *B. textularioides* in its smaller test size, overlapping chambers, and wider aperture.

Superfamily SPIRILLINACEA Reuss, 1862

Family SPIRILLINIDAE Reuss, 1862

Subfamily SPIRILLININAE Reuss, 1862

Genus *Spirillina* Ehrenberg, 1843

Spirillina sp.

Plate 9, figure 35

Occurrence and distribution. Assemblage 1*, rare.

Description. Test small, discoidal, planispiral; small proloculus followed by an undivided, tubular, close-coiled second chamber that forms seven to eight volutions; tube gradually increasing in size until ultimate volution in which tube diameter is approximately twice that of penultimate; spiral suture distinct, depressed; wall calcareous with smooth surface; aperture formed by open end of tube.

Dimensions (mm).

	D	T	Sample no.
GSC 98073	0.35	0.06	299

Remarks. Five specimens of *Spirillina* sp. were recovered from the Martin Creek section. This species differs from *S. minima* Shacko, described from German Neocomian deposits (Franke, 1928; Bartenstein and Brand, 1951) and the Albian Duck Creek Formation of Oklahoma and Texas (Tappan, 1943), in having more volutions, an expanded final volution, and larger test size.

Subfamily PATELLININAE Rhumbler, 1906

Genus *Patellina* Williamson, 1858

Patellina sp.

Plate 9, figures 36, 37

Occurrence and distribution. Assemblage 1*, rare.

Description. Test tiny, plano-convex, dorsal side a high, trochoid spire, ventral side flattened, periphery narrowly rounded; spherical proloculus followed by a spirally wound second chamber; later stage of five to six whorls of two chambers each; later chambers narrow and elongate; two chambers visible ventrally with median septae of last two chambers visible at centre of test; wall calcareous with smooth surface; aperture ventral, a distinct arch on inner margin of last chamber extending under the median septum.

Dimensions (mm).

	D	T	Sample no.
GSC 98074	0.18	0.125	332
GSC 98075	0.21	0.15	316

Remarks. Only three specimens of *Patellina* sp. were recovered from the Martin Creek section. Unfortunately, the poor state of preservation of these specimens precluded any further identification.

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family NONIONIDAE Schultze, 1854

Subfamily CHILOSTOMELLINAE Brady, 1881

Genus *Quadrimorphina* Finlay, 1939

Quadrimorphina sp.

Plate 9, figures 38–43

Occurrence and distribution. Assemblage 1*, rare. Subassemblage 2a, rare. Subassemblage 2b, abundant.

Description. Test tiny with low, flattened spire, broadly rounded periphery, and lobulate outline; chambers trochospirally arranged, few in number, forming two to two and a half whorls; all chambers visible dorsally, only four chambers of last whorl visible ventrally; early chambers indistinct but appear to be four to six in a whorl, final whorl of four or five chambers; chambers increase rapidly in size as added, chambers of final whorl inflated; sutures distinct, depressed; wall calcareous with smooth surface; aperture an umbilical-extraumbilical basal slit-like opening.

Dimensions (mm).

	D	T	Sample no.
GSC 98076	0.22	0.125	332
GSC 98077	0.24	0.15	300
GSC 98078	0.22	0.13	306
GSC 98079	0.25	0.15	481
GSC 98080	0.24	0.14	484
GSC 98081	0.22	0.13	530

Remarks. The poor state of preservation of the specimens recovered from both the Martin Creek and Goodenough Creek sections makes comparisons difficult, but *Quadrimorphina* sp. appears to differ from younger species such as *Q. ruckerae* (Tappan, 1957) or *Q. albertensis* Mellon and Wall (1956) in having fewer chambers and in lacking a narrow apertural flap.

Superfamily ROBERTINACEA Reuss, 1850

Family CERATOBULIMINIDAE Cushman, 1927

Subfamily CERATOBULIMININAE Cushman, 1927

Genus *Conorboides* Hofker, 1951

Conorboides walli n. sp.

Plate 9, figures 44–49

Diagnosis. *Conorboides walli* is characterized by numerous chambers, distinct sutures, and an aperture bordered by a broad apertural flap.

Etymology. The specific name is patronymic in honour of J.H. Wall of the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada.

Occurrence and distribution. Assemblage 1*, common. Subassemblage 2b, abundant. Assemblage 3, rare.

Description. Test medium sized, trochoid, planoconvex with a low, rounded to flattened spire of three volutions, periphery rounded; chambers numerous, about eight in early whorls, six (or rarely five) in final whorl, increasing gradually in size as added; last chamber occupies about one quarter of umbilical side; sutures distinct, flush, and oblique on spiral side, depressed and radial on umbilical side; wall calcareous with smooth surface; aperture a low, basal, umbilical arch bordered by a broad apertural flap, apertures of earlier chambers of final whorl remain open and visible in umbilical area.

Dimensions (mm).

	D	T	Sample no.
Holotype GSC 98084	0.35	0.12	267
Paratype GSC 98082	0.38	0.16	300
Paratype GSC 98083	0.39	0.11	284
Paratype GSC 98085	0.34	0.13	292
Paratype GSC 98086	0.35	0.16	301
Paratype GSC 98087	0.40	0.19	284

Remarks. *Conorboides walli* is a very distinctive species. It differs from younger (i.e., Albian) species previously described from the Arctic such as *C. umiatensis* (Tappan, 1957, 1962) in its smaller and more numerous chambers, and by an aperture that is bordered by a broad apertural flap. It differs from *Conorbis valendisensis* Bartenstein and Brand, originally described from German Middle Valanginian deposits (Bartenstein and Brand, 1951), in its low-spired test and more numerous chambers.

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PLATES 1 TO 9

PLATE 1

All figures approximately x35.

Figures 1, 2. *Bathysiphon* sp.
1. Figured specimen GSC 93973.
2. Figured specimen GSC 93974.

Figures 3, 4. *Bathysiphon* sp. cf. *B. granulocoelia* Chamney, 1969
3. Figured specimen GSC 93971.
4. Figured specimen GSC 93972.

Figures 5, 6. *Bathysiphon brosgei* Tappan, 1957
5. Hypotype GSC 93967.
6. Hypotype GSC 93968.

Figures 7, 8. *Bathysiphon vitta* Nauss, 1947
7. Hypotype GSC 93969.
8. Hypotype GSC 93970.

Figure 9. *Hippocrepina* sp. cf. *H. barksdalei* (Tappan), 1957
Figured specimen GSC 93979.

Figures 10–13. *Hippocrepina rugosa* n. sp.
10. Paratype GSC 93975.
11. Holotype GSC 93976.
12. Paratype GSC 93977.
13. Paratype GSC 93978.

Figures 14, 15. *Hyperammina* sp.
14. Figured specimen GSC 93980.
15. Figured specimen GSC 93981.

Figures 16–18. *Psamminosphaera asperata* n. sp.
16. Paratype GSC 93982.
17. Paratype GSC 93983.
18. Holotype GSC 93984.

Figures 19–21. *Saccammina* sp. cf. *S. lathrami* Tappan, 1960
19. Figured specimen GSC 93987.
20. Figured specimen GSC 93988.
21. Figured specimen GSC 93989.

Figures 22, 23. *Saccammina* sp. cf. *S. alexanderi* (Loeblich and Tappan), 1950
22. Figured specimen GSC 93985.
23. Figured specimen GSC 93986.

Figures 24, 25. *Pelosina*? sp.
24. Figured specimen GSC 93990.
25. Figured specimen GSC 93991.

Figures 26–29. *Ammodiscus* sp. cf. *A. tenuissimus* (Gümbel), 1862
26. Figured specimen GSC 93998.
27. Figured specimen GSC 93999.
28. Figured specimen GSC 94000.
29. Figured specimen GSC 94001.

Figure 30. *Ammodiscus* sp. cf. *A. rotalarius* Loeblich and Tappan, 1949
Figured specimen GSC 93997.

Figures 31, 32. *Ammodiscus* sp. cf. *A. mangusi* (Tappan), 1957
31. Figured specimen GSC 93995.
32. Figured specimen GSC 93996.

Figures 33–35. *Ammodiscus* sp. cf. *A. cheradospirus* Loeblich and Tappan, 1950
33. Figured specimen GSC 93992.
34. Figured specimen GSC 93993.
35. Figured specimen GSC 93994.

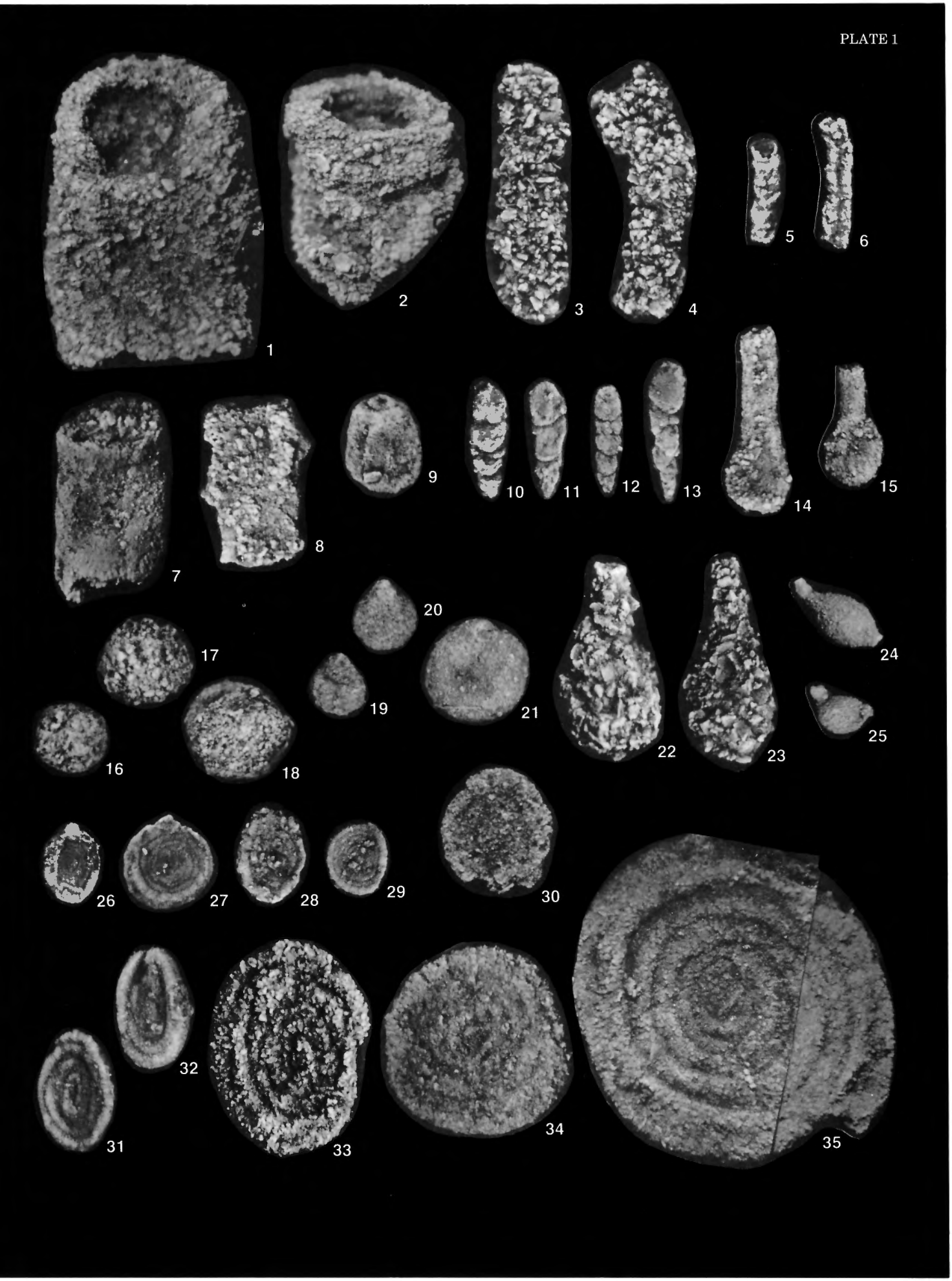
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PLATE 2

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Figures 1–4. *Glomospira subarctica* Chamney, 1969
1. Hypotype GSC 94002.
2. Hypotype GSC 94003.
3. Hypotype GSC 94004.
4. Hypotype GSC 94005.

Figures 5, 6. *Glomospira variabilis* (Kübler and Zwingli), 1870
5. Hypotype GSC 94006.
6. Hypotype GSC 94007.

Figures 7, 8. *Glomospirella arctica* Chamney, 1969
7. Hypotype GSC 94008.
8. Hypotype GSC 94009.

Figures 9–11. *Lituotuba tortuosa* n. sp.
9. Holotype GSC 94010.
10. Paratype GSC 94011.
11. Paratype GSC 94012.

Figures 12–14. *Reophax* sp. cf. *R. deckeri* Tappan, 1940
12. Figured specimen GSC 94015.
13. Figured specimen GSC 94016.
14. Figured specimen GSC 94017.

Figures 15, 16. *Reophax* sp. A
15. Figured specimen GSC 94018.
16. Figured specimen GSC 94019.

Figures 17, 18. *Reophax friabilis* n. sp.
17. Holotype GSC 94013.
18. Paratype GSC 94014.

Figure 19. *Reophax* sp. B
Figured specimen GSC 94020.

Figures 20–22. *Miliammina inornata* n. sp.
20. Paratype GSC 94021.
21. Paratype GSC 94022.
22. Holotype GSC 94023.

Figure 23. *Miliammina* sp. cf. *M. awunensis* Tappan, 1957
Figured specimen GSC 94024.

Figure 24. *Miliammina* sp.
Figured specimen GSC 94025.

Figures 25–27. *Labrospira goodenoughensis* (Chamney), 1969
25. Hypotype GSC 94026, a, lateral view; b, lateral view (wet); c, apertural view.
26. Hypotype GSC 94027.
27. Hypotype GSC 94028, a, lateral view; b, apertural view.

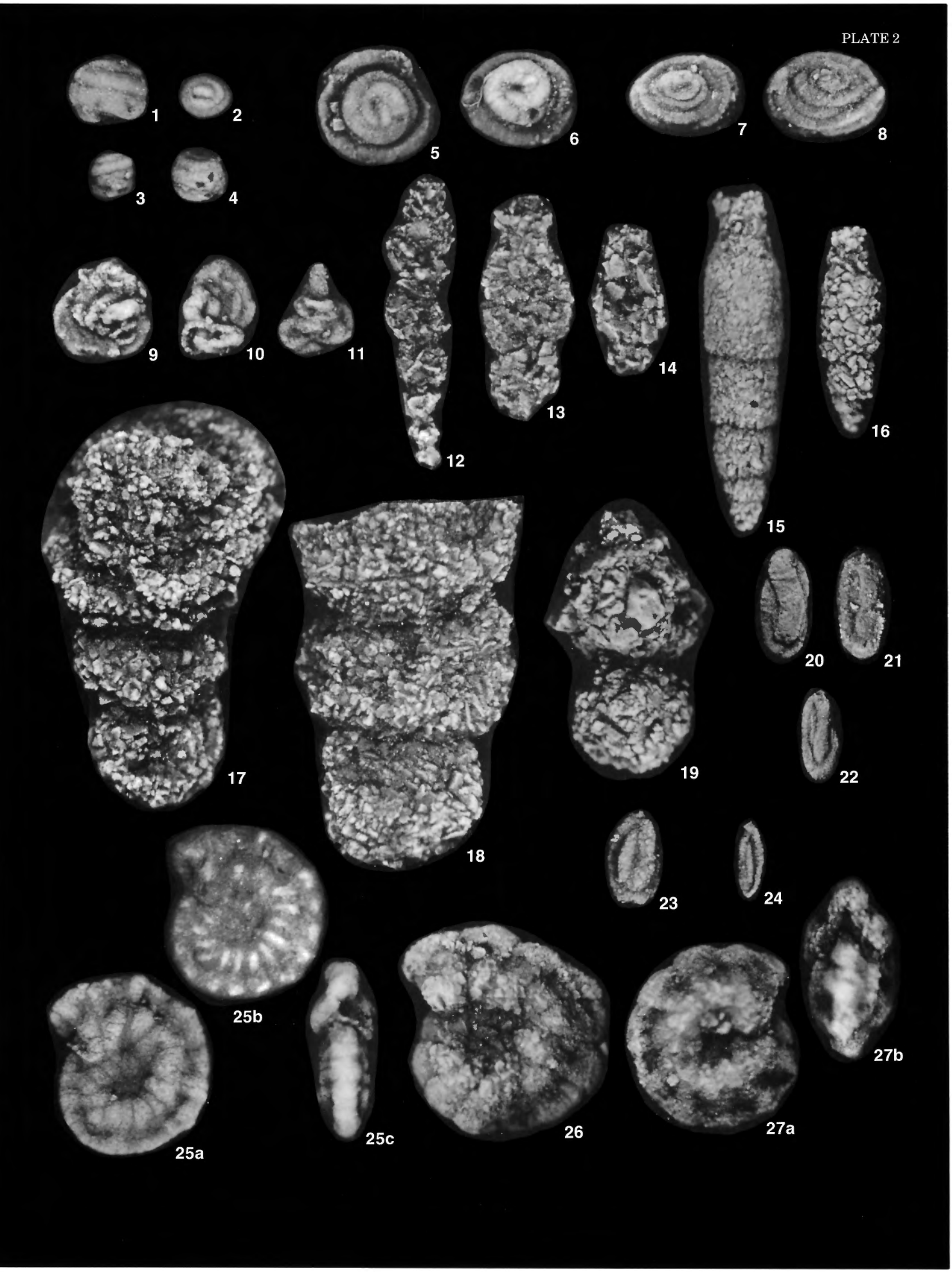
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PLATE 3

All figures approximately x35.

Figures 1–6. *Cribrostomoides cryptocameratum* n. sp.

1. Holotype GSC 94029, a, lateral view; b, lateral view (wet).
2. Paratype GSC 94030.
3. Paratype GSC 94031.
4. Paratype GSC 94032.
5. Paratype GSC 94033.
6. Paratype GSC 94034.

Figures 7–10. *Haplophragmoides lobatoloculare* n. sp.

7. Paratype GSC 94035, a, lateral view; b, lateral view (wet).
8. Paratype GSC 94036, a, lateral view; b, lateral view (wet).
9. Holotype GSC 94037, a, lateral view; b, apertural view; c, lateral view (wet).
10. Paratype GSC 94038, a, lateral view; b, apertural view; c, lateral view (wet).

Figures 11–13. *Haplophragmoides euryraptum* n. sp.

11. Holotype GSC 94039, a, lateral view; b, apertural view; c, lateral view (wet).
12. Paratype GSC 94040, a, lateral view; b, lateral view (wet).
13. Paratype GSC 94041, a, lateral view; b, lateral view (wet).

Figures 14–17. *Haplophragmoides* sp. cf. *H. concavus* (Chapman), 1910

14. Figured specimen GSC 94042, a, lateral view; b, lateral view (wet).
15. Figured specimen GSC 94043, a, lateral view; b, lateral view (wet).
16. Figured specimen GSC 94044, a, lateral view; b, lateral view (wet).
17. Figured specimen GSC 94045, a, lateral view; b, lateral view (wet); c, opposite lateral view.

Figures 18–21. *Ammobaculites mountgoodenoughensis* n. sp.

18. Paratype GSC 94054.
19. Holotype GSC 94055.
20. Paratype GSC 94056.
21. Paratype GSC 94057.

Figures 22–25. *Ammobaculites? attenuatus* n. sp.

22. Paratype GSC 94062.
23. Holotype GSC 94063.
24. Paratype GSC 94064.
25. Paratype GSC 94065.

Figures 26–33. *Ammobaculites inelegans* n. sp.

26. Paratype GSC 94046.
27. Paratype GSC 94047.
28. Holotype GSC 94048.
29. Paratype GSC 94049.
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31. Paratype GSC 94051.
32. Paratype GSC 94052.
33. Paratype GSC 94053.

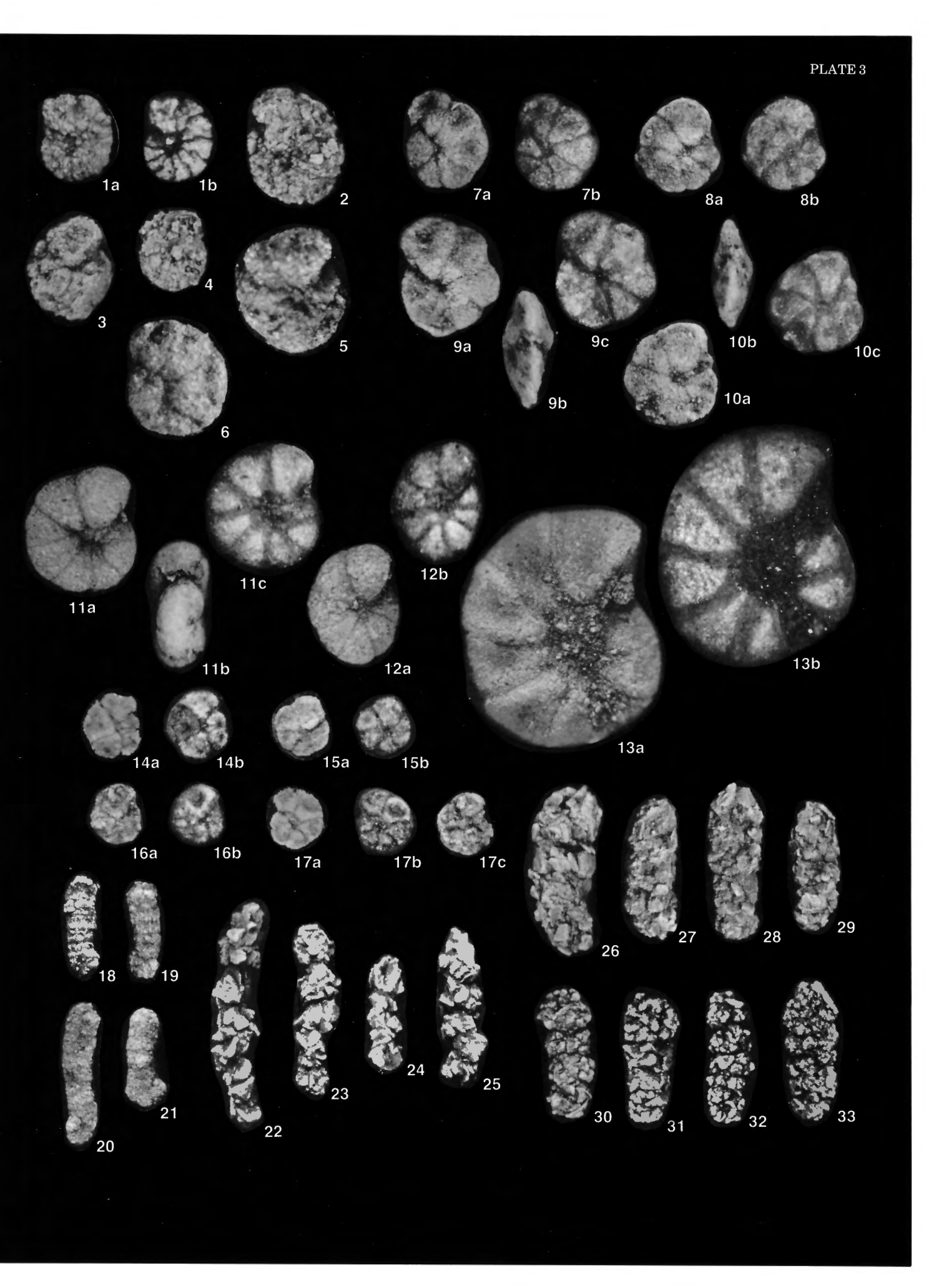
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PLATE 4

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Figures 1–5. *Recurvoides* sp. cf. *R. sublustris* Dain, 1972

1. Figured specimen GSC 94066, a, spiral view; b, spiral view (wet); c, peripheral view.
2. Figured specimen GSC 94067, a, spiral view; b, spiral view (wet).
3. Figured specimen GSC 94068, a, spiral view; b, spiral view (wet).
4. Figured specimen GSC 94069.
5. Figured specimen GSC 94070.

Figures 6–9. *Ammobaculites validus* n. sp.

6. Holotype GSC 94058.
7. Paratype GSC 94059.
8. Paratype GSC 94060.
9. Paratype GSC 94061.

Figures 10–12. *Recurvoides* ex. gr. *R. stschekuriensis* Dain, 1972

10. Figured specimen GSC 94071, a, spiral view; b, spiral view (wet).
11. Figured specimen GSC 94072, a, spiral view; b, spiral view (wet).
12. Figured specimen GSC 94073, a, spiral view; b, spiral view (wet); c, peripheral view.

Figures 13–16. *Recurvoides* ex. gr. *R. disputabilis* Dain, 1972

13. Figured specimen GSC 94074, a, umbilical view; b, spiral view (wet); c, peripheral view.
14. Figured specimen GSC 94075, a, spiral view; b, spiral view (wet); c, peripheral view.
15. Figured specimen GSC 94076, a, spiral view; b, peripheral view; c, spiral view (wet).
16. Figured specimen GSC 94077.

Figures 17–21. *Trochammina* ex. gr. *T. neocomiana* Myatliuk, 1939

17. Figured specimen GSC 94083, a, spiral view; b, umbilical view.
18. Figured specimen GSC 94084, a, spiral view; b, umbilical view.
19. Figured specimen GSC 94085, a, spiral view; b, spiral view (wet); c, umbilical view.
20. Figured specimen GSC 94086.
21. Figured specimen GSC 94087.

Figures 22–26. *Recurvoides* ex. gr. *R. canningensis* (Tappan), 1955

22. Figured specimen GSC 94078, a, spiral view; b, spiral view (wet); c, umbilical view.
23. Figured specimen GSC 94079, a, spiral view; b, spiral view (wet).
24. Figured specimen GSC 94080, a, spiral view; b, spiral view (wet).
25. Figured specimen GSC 94081, a, spiral view; b, umbilical view.
26. Figured specimen GSC 94082, a, spiral view; b, umbilical view.

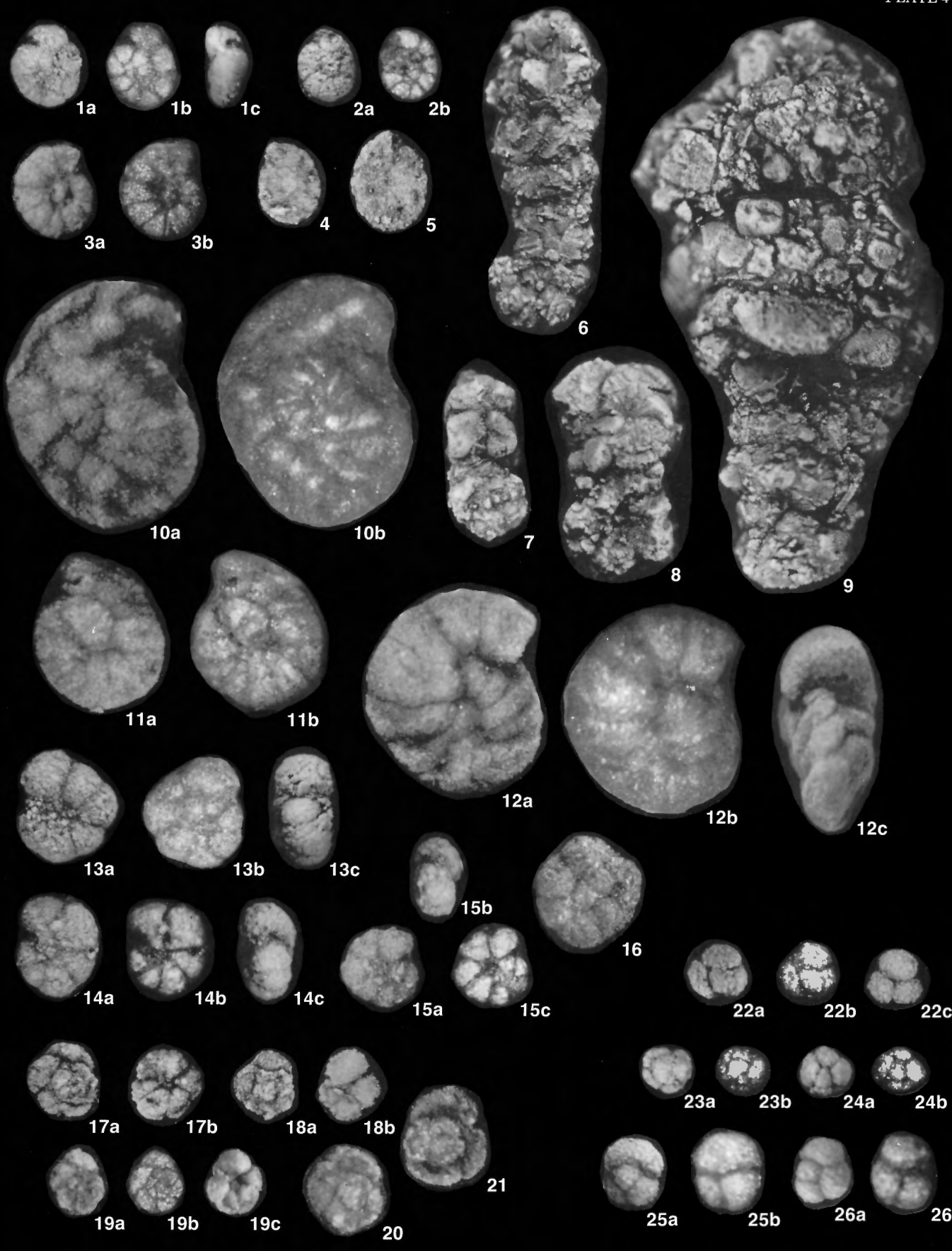
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PLATE 5

All figures approximately x35.

Figures 1–5. *Verneuilina caldwelli* n. sp.
1. Paratype GSC 94088.
2. Holotype GSC 94089.
3. Paratype GSC 94090.
4. Paratype GSC 94091.
5. Paratype GSC 94092.

Figures 6–12. *Gaudryina tailleuri* (Tappan), 1957
6. Hypotype GSC 94093.
7. Hypotype GSC 94094.
8. Hypotype GSC 94095.
9. Hypotype GSC 94096.
10. Hypotype GSC 94097.
11. Hypotype GSC 94098.
12. Hypotype GSC 94099.

Figures 13–16. *Uvigerinammina laxa* n. sp.
13. Holotype GSC 94100.
14. Paratype GSC 94101.
15. Paratype GSC 94102.
16. Paratype GSC 94103.

Figures 17–19. *Verneuilinoides implexus* n. sp.
17. Paratype GSC 94104.
18. Holotype GSC 94105.
19. Paratype GSC 94106.

Figures 20–23. *Arenobulimina mcneili* n. sp.
20. Holotype GSC 94107.
21. Paratype GSC 94108.
22. Paratype GSC 94109.
23. Paratype GSC 94110.

Figures 24–26. *Quinqueloculina opedentata* n. sp.
24. Paratype GSC 94111, a, lateral view; b, opposite lateral view.
25. Paratype GSC 94112, a, lateral view; b, opposite lateral view.
26. Holotype GSC 94113, a, lateral view; b, apertural view.

Figure 27. *Quinqueloculina* sp.
Figured specimen GSC 94114.

Figures 28–31. *Nodosaria obscura* Reuss, 1845
28. Hypotype GSC 94115.
29. Hypotype GSC 94116.
30. Hypotype GSC 94117.
31. Hypotype GSC 94118.

Figures 32–34. *Nodosaria* sp. cf. *N. sceptrum* Reuss, 1863
32. Figured specimen GSC 94119.
33. Figured specimen GSC 94120.
34. Figured specimen GSC 94121.

Figure 35. *Nodosaria* sp. A
Figured specimen GSC 94122.

Figure 36. *Nodosaria* sp. B
Figured specimen GSC 94123.

Figures 37–39. *Dentalina communis* d'Orbigny, 1826
37. Hypotype GSC 94124.
38. Hypotype GSC 94125.
39. Hypotype GSC 94126.

Figures 40–42. *Dentalina* sp. A
40. Figured specimen GSC 94127.
41. Figured specimen GSC 94128.
42. Figured specimen GSC 94129.

Figures 43–45. *Dentalina* sp. B
43. Figured specimen GSC 94130.
44. Figured specimen GSC 94131.
45. Figured specimen GSC 94132.

Figure 46.
Figured specimen GSC 94136.

Figures 47–50. *Dentalina*? sp.
47. Figured specimen GSC 94137.
48. Figured specimen GSC 94138.
49. Figured specimen GSC 94139.
50. Figured specimen GSC 94140.

Figures 51–53. *Dentalina* sp. C
51. Figured specimen GSC 94133.
52. Figured specimen GSC 94134.
53. Figured specimen GSC 94135.

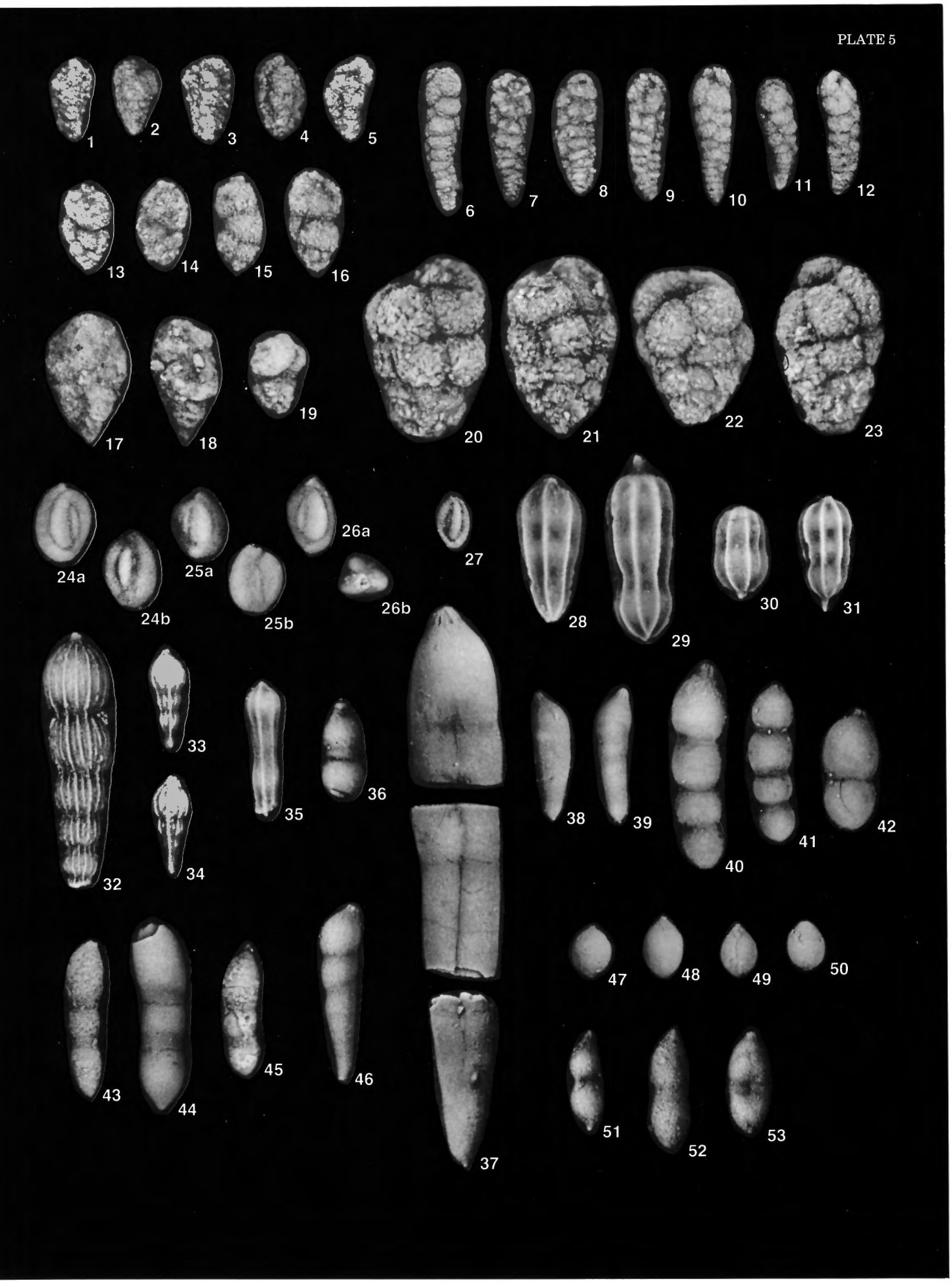
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PLATE 6

All figures approximately x35.

Figures 1–4. *Geinitzinita arctocretacea* (Gerke), 1969
1. Hypotype GSC 94141.
2. Hypotype GSC 94142.
3. Hypotype GSC 94143.
4. Hypotype GSC 94144.

Figures 5–7. *Pseudonodosaria* sp. B
5. Figured specimen GSC 94151.
6. Figured specimen GSC 94152.
7. Figured specimen GSC 94153.

Figures 8–10. *Pseudonodosaria* sp. cf. *P. netrona* (Tappan), 1960
8. Figured specimen GSC 94145.
9. Figured specimen GSC 94146.
10. Figured specimen GSC 94147.

Figures 11–13. *Pseudonodosaria* sp. A
11. Figured specimen GSC 94148, megalospheric.
12. Figured specimen GSC 94149, megalospheric.
13. Figured specimen GSC 94150, microspheric.

Figure 14. *Pseudonodosaria*? sp.
Figured specimen GSC 94154.

Figures 15–18. *Lenticulina* sp. cf. *L. macrodisca* (Reuss), 1863
15. Figured specimen GSC 94155, a, lateral view; b, lateral view (wet); c, apertural view.
16. Figured specimen GSC 94156, a, lateral view; b, lateral view (wet); c, apertural view.
17. Figured specimen GSC 94157, a, lateral view; b, apertural view.
18. Figured specimen GSC 94158, a, lateral view; b, lateral view (wet).

Figures 19–21. *Lenticulina* sp. cf. *L. saxonica saxonica* Bartenstein and Brand, 1951
19. Figured specimen GSC 94159.
20. Figured specimen GSC 94160, a, lateral view; b, opposite lateral view; c, apertural view.
21. Figured specimen GSC 94161, a, lateral view; b, opposite lateral view; c, apertural view.

Figures 22–25. *Darbyella pseudolenticularis* n. sp.
22. Paratype GSC 94163, a, lateral view; b, lateral view (wet); c, apertural view.
23. Holotype GSC 94164, a, lateral view; b, lateral view (wet); c, apertural view.
24. Paratype GSC 94165, a, lateral view; b, lateral view (wet); c, apertural view.
25. Paratype GSC 94166, a, lateral view; b, lateral view (wet); c, apertural view.

Figure 26. *Darbyella*? sp.
Figured specimen GSC 94167, a, lateral view; b, apertural view.

Figure 27. *Lenticulina* sp.
Figured specimen GSC 94162, a, lateral view; b, apertural view.

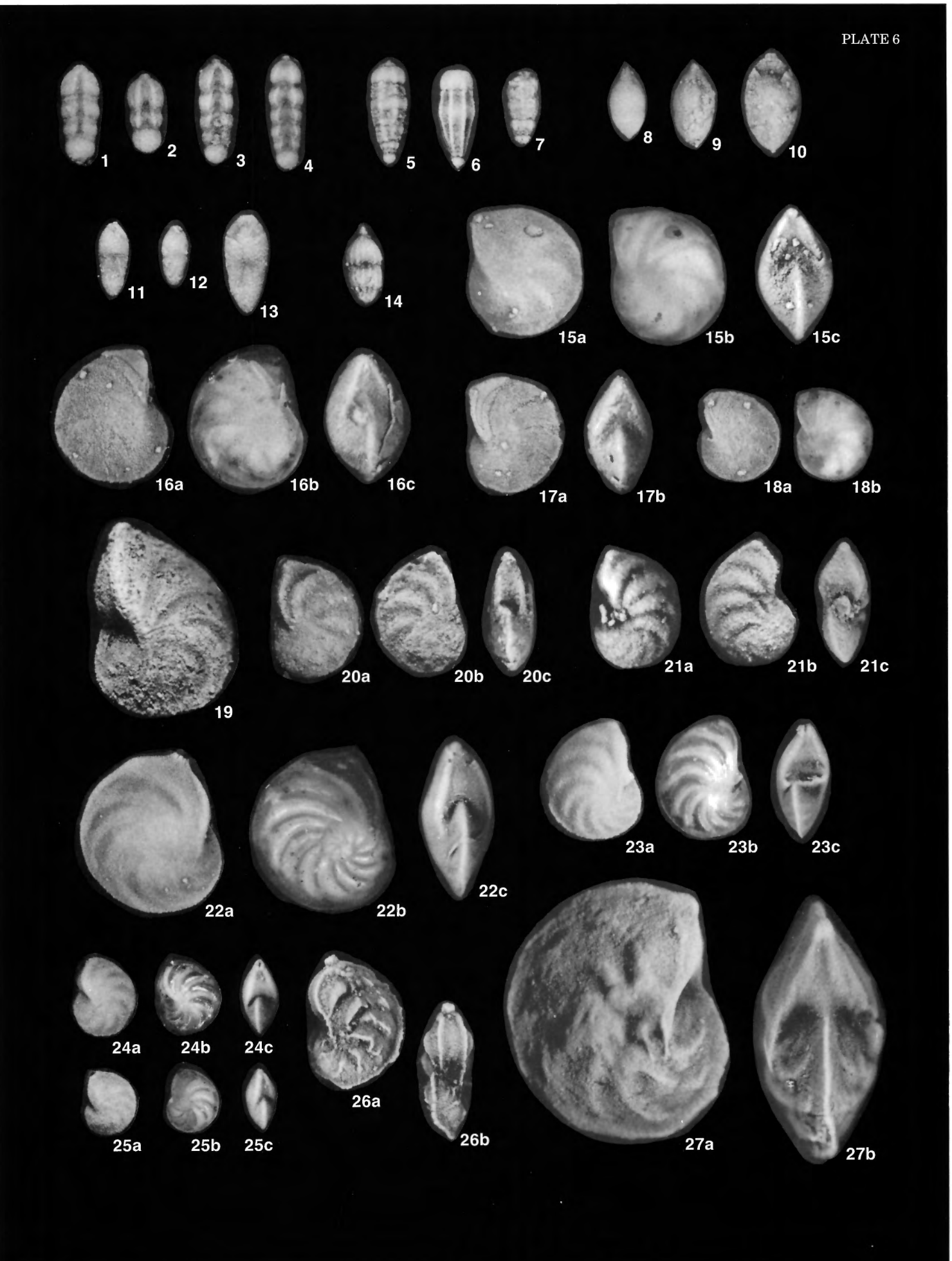
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PLATE 7

All figures approximately x35.

Figures 1–4. *Frondicularia concinna* Koch, 1851
1. Hypotype GSC 94177.
2. Hypotype GSC 94178, a, lateral view; b, lateral view (wet).
3. Hypotype GSC 94179.
4. Hypotype GSC 94180, a, lateral view; b, lateral view (wet).

Figures 5–8. *Astacolus strombecki* (Reuss), 1863
5. Hypotype GSC 94168, a, lateral view; b, lateral view (wet).
6. Hypotype GSC 94169, a, lateral view; b, lateral view (wet).
7. Hypotype GSC 94170, a, lateral view; b, lateral view (wet).
8. Hypotype GSC 94171, a, lateral view; b, lateral view (wet).

Figures 9–11. *Astacolus* sp. cf. *A. incrassatus* (Reuss), 1863
9. Figured specimen GSC 94172.
10. Figured specimen GSC 94173.
11. Figured specimen GSC 94174.

Figure 12. *Astacolus* sp.
Figured specimen GSC 94175.

Figures 13–15. *Frondicularia* sp.
13. Figured specimen GSC 94181.
14. Figured specimen GSC 94182.
15. Figured specimen GSC 94183.

Figure 16. *Frondicularia*? sp.
Figured specimen GSC 94184.

Figure 17. *Citharina* sp.
Figured specimen GSC 94176.

Figures 18, 19. *Marginulina pyramidalis* (Koch), 1851
18. Hypotype GSC 94185.
19. Hypotype GSC 94186.

Figures 20–23. *Marginulina* sp. A
20. Figured specimen GSC 94189.
21. Figured specimen GSC 94190.
22. Figured specimen GSC 94191.
23. Figured specimen GSC 94192.

Figures 24–26. *Marginulina* sp. B
24. Figured specimen GSC 94193.
25. Figured specimen GSC 94194.
26. Figured specimen GSC 94195.

Figures 27, 28. *Marginulina* sp. cf. *M. pinguicula* Tappan, 1955
27. Figured specimen GSC 94187.
28. Figured specimen GSC 94188, a, lateral view; b, lateral view (wet).

Figures 29–32. *Marginulina* sp. C
29. Figured specimen GSC 94196.
30. Figured specimen GSC 94197.
31. Figured specimen GSC 94198.
32. Figured specimen GSC 94199.

Figure 33. *Marginulina* sp.
Figured specimen GSC 94200.

Figure 34. *Marginulina*? sp. A
Figured specimen GSC 94201.

Figure 35. *Marginulina*? sp. B
Figured specimen GSC 94202.

Figures 36–39. *Marginulinopsis gracilissima* (Reuss), 1863
36. Hypotype GSC 94203, a, lateral view; b, peripheral view.
37. Hypotype GSC 94204, a, lateral view; b, peripheral view.
38. Hypotype GSC 94205, a, lateral view; b, peripheral view.
39. Hypotype GSC 94206.

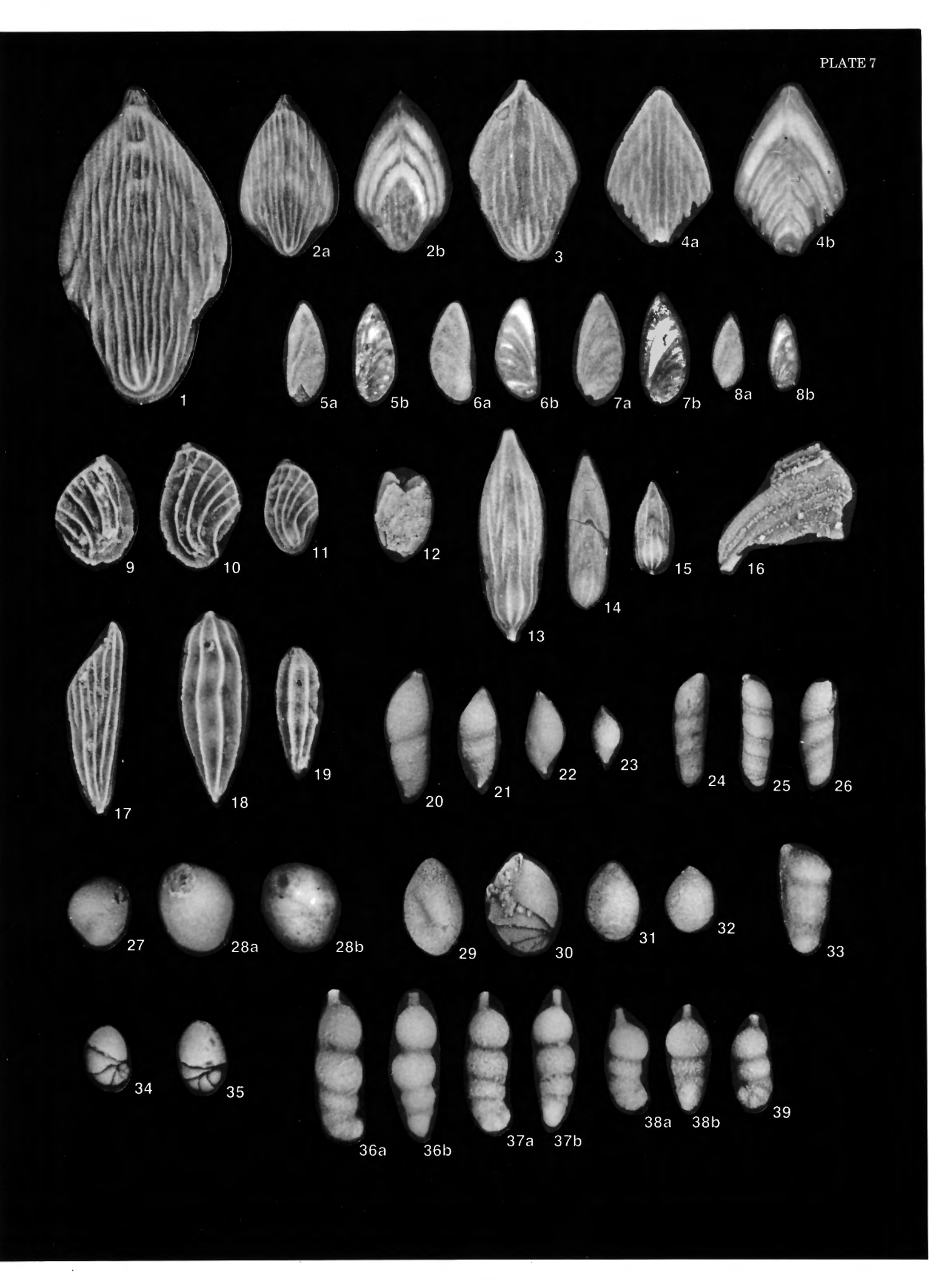
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PLATE 8

All figures approximately x35.

Figures 1–3. *Marginulinopsis jonesi* (Reuss), 1863
1. Hypotype GSC 94207.
2. Hypotype GSC 94208.
3. Hypotype GSC 94209.

Figures 4–8. *Marginulinopsis robusta* (Reuss), 1863
4. Hypotype GSC 94210, a, lateral view; b, apertural view.
5. Hypotype GSC 94211, a, lateral view; b, apertural view.
6. Hypotype GSC 94212.
7. Hypotype GSC 94213.
8. Hypotype GSC 94214.

Figure 9. *Marginulinopsis* sp. cf. *M. reiseri* Tappan, 1960
Figured specimen GSC 94215, a, lateral view; b, peripheral view.

Figures 10–12. *Marginulinopsis* sp.
10. Figured specimen GSC 94216, a, lateral view; b, peripheral view.
11. Figured specimen GSC 94217.
12. Figured specimen GSC 94218.

Figures 13–15. *Saracenaria pravoslavlevi* Fursenko and Polenova, 1950
13. Hypotype GSC 94226, a, lateral view; b, lateral view (wet).
14. Hypotype GSC 94227, a, lateral view; b, apertural view.
15. Hypotype GSC 94228, a, lateral view; b, apertural view.

Figures 16–18. *Saracenaria* sp. cf. *S. porcupinensis* Chamney, 1978
16. Figured specimen GSC 94229, a, lateral view; b, apertural view.
17. Figured specimen GSC 94230, a, lateral view; b, apertural view.
18. Figured specimen GSC 94231, a, lateral view; b, apertural view.

Figures 19–21. *Saracenaria brookeae* n. sp.
19. Holotype GSC 94219, a, lateral view; b, apertural view.
20. Paratype GSC 94220.
21. Paratype GSC 94221, a, lateral view; b, apertural view.

Figures 22–25. *Saracenaria compressa* n. sp.
22. Holotype GSC 94222, a, lateral view; b, apertural view.
23. Paratype GSC 94223.
24. Paratype GSC 94224.
25. Paratype GSC 94225.

Figure 26. *Vaginulina kochii* Roemer, 1841
Hypotype GSC 94232, a, lateral view; b, lateral view (wet).

Figure 27. *Vaginulina* sp. D
Figured specimen GSC 94240, a, lateral view; b, apertural view.

Figures 28, 29. *Vaginulina* sp. cf. *V. calliopsis* (Reuss), 1863
28. Figured specimen GSC 94233, a, lateral view; b, apertural view.
29. Figured specimen GSC 94234, a, lateral view; b, apertural view.

Figure 30. *Vaginulina* sp. B
Figured specimen GSC 94238, a, lateral view; b, apertural view.

Figures 31–33. *Vaginulina* sp. A
31. Figured specimen GSC 94235.
32. Figured specimen GSC 94236.
33. Figured specimen GSC 94237.

Figure 34. *Vaginulina* sp. C
Figured specimen GSC 94239, a, lateral view; b, apertural view.

Figure 35. *Vaginulina*? sp.
Figured specimen GSC 94241.

Figures 36–38. *Vaginulinopsis* sp. cf. *V. pachynota* Dam, 1946
36. Figured specimen GSC 94242, a, lateral view; b, lateral view (wet).
37. Figured specimen GSC 94243, a, lateral view; b, lateral view (wet).
38. Figured specimen GSC 94244 a, lateral view; b, lateral view (wet).

Figures 39, 40. *Vaginulinopsis* sp.
39. Figured specimen GSC 94245.
40. Figured specimen GSC 94246.

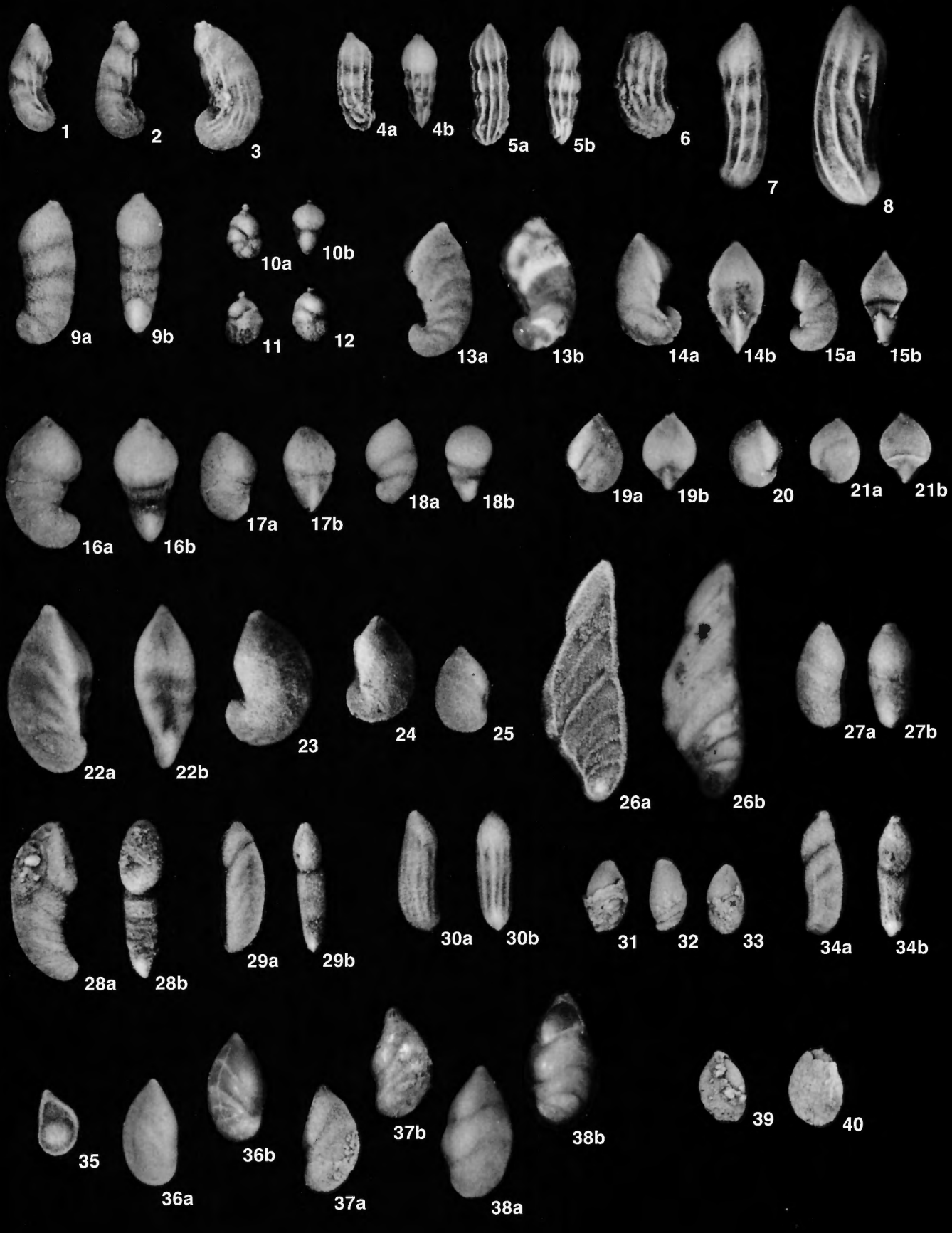
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PLATE 9

All figures approximately x35, unless otherwise stated.

Figure 1. *Lingulina*? sp.
Figured specimen GSC 94247.

Figure 2. *Lingulonodosaria*? sp.
Figured specimen GSC 94248.

Figure 3. *Eoguttulina*? sp.
Figured specimen GSC 94249.

Figures 4, 5. *Globulina* sp. cf. *G. lacrima* Reuss, 1845
4. Figured specimen GSC 94255.
5. Figured specimen GSC 94256.

Figures 6, 7. *Globulina* sp. cf. *G. exserta* (Berthelin), 1880
6. Figured specimen GSC 94253.
7. Figured specimen GSC 94254.

Figures 8–10. *Globulina prisca* Reuss, 1863
8. Hypotype GSC 94250.
9. Hypotype GSC 94251.
10. Hypotype GSC 94252.

Figures 11–13. *Pyrulinoides* sp. cf. *P. thurrelli* Tappan, 1957
11. Figured specimen GSC 94257.
12. Figured specimen GSC 94258.
13. Figured specimen GSC 94259.

Figure 14. *Tristix* sp. cf. *T. acutangulus* (Reuss), 1863
Figured specimen GSC 94260.

Figures 15, 16. *Oolina* sp. cf. *O. sulcata* (Walker and Jacob), 1798
15. Figured specimen GSC 94269.
16. Figured specimen GSC 94270.

Figures 17–19. *Oolina apiculata emaciata* (Reuss), 1862
17. Hypotype GSC 94261.
18. Hypotype GSC 94262.
19. Hypotype GSC 94263.

Figures 20, 21. *Oolina* sp. cf. *O. globosa* (Montagu), 1803
20. Figured specimen GSC 94267.
21. Figured specimen GSC 94268.

Figures 22–24. *Oolina hauteriviana hauteriviana* (Bartenstein and Brand), 1951
22. Hypotype GSC 94264.
23. Hypotype GSC 94265.
24. Hypotype GSC 94266.

Figure 25. *Oolina* sp.
Figured specimen GSC 94271.

Figures 26–33. *Praebulimina*? *gravelliniformis* n. sp.
26. Holotype GSC 98065.
27. Paratype GSC 98066.
28. Paratype GSC 98067.
29. Paratype GSC 98068.
30. Paratype GSC 98069.
31. Paratype GSC 98070.
32. Paratype GSC 98071.
33. Paratype GSC 98072.

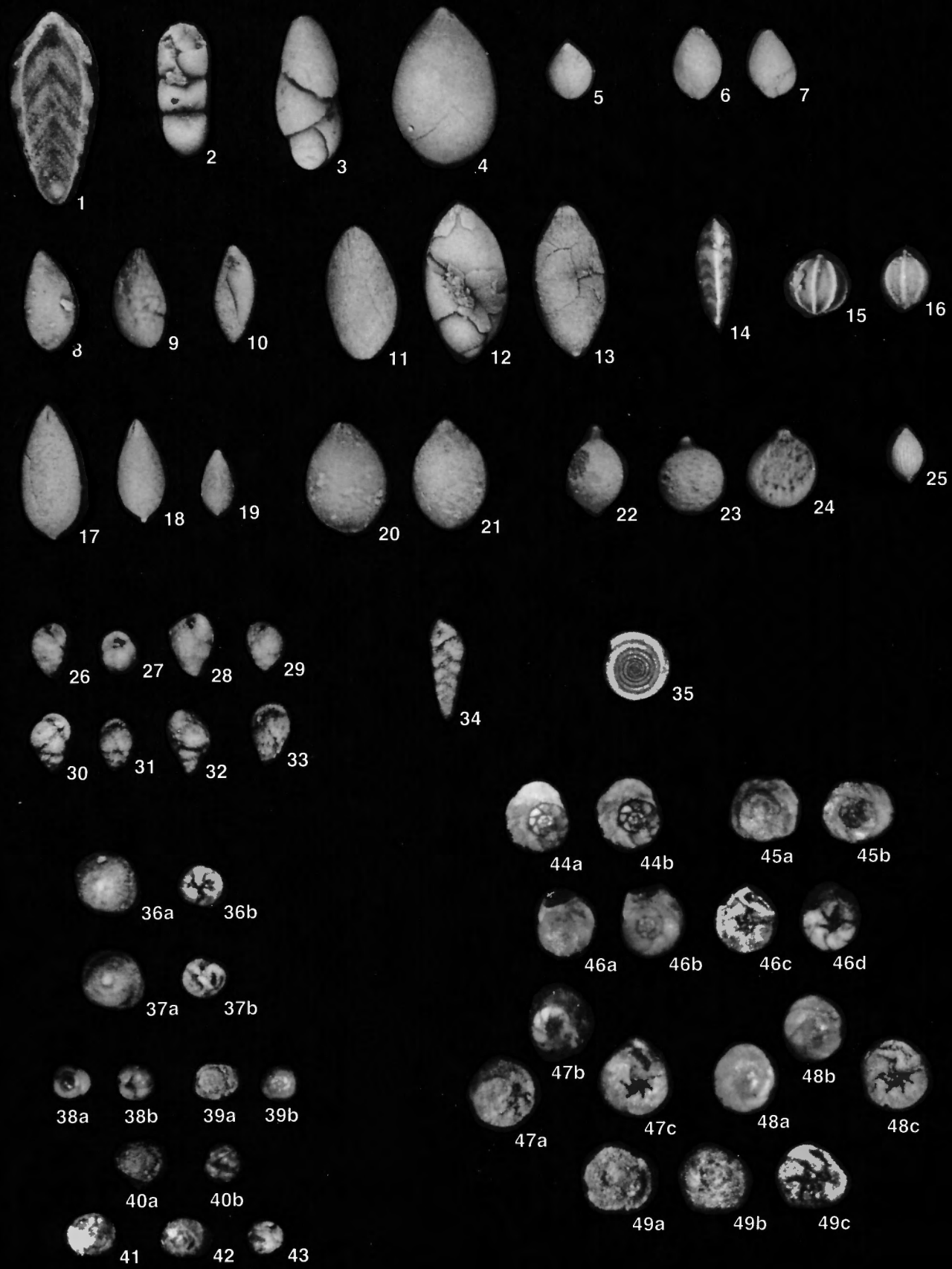
Figure 34. *Bolivina* sp.
Figured specimen GSC 94272.

Figure 35. *Spirillina* sp.
Figured specimen GSC 98073.

Figures 36, 37. *Patellina* sp.
36. Figured specimen GSC 98074, a, spiral view (x50 approx.); b, umbilical view.
37. Figured specimen GSC 98075, a, spiral view (x50 approx.); b, umbilical view.

Figures 38–43. *Quadrimorphina* sp.
38. Figured specimen GSC 98076, a, spiral view; b, umbilical view.
39. Figured specimen GSC 98077, a, spiral view; b, spiral view (wet).
40. Figured specimen GSC 98078, a, spiral view; b, umbilical view.
41. Figured specimen GSC 98079.
42. Figured specimen GSC 98080.
43. Figured specimen GSC 98081.

Figures 44–49. *Conorboides walli* n. sp.
44. Paratype GSC 98082, a, spiral view; b, spiral view (wet).
45. Paratype GSC 98083, a, spiral view; b, spiral view (wet).
46. Holotype GSC 98084, a, spiral view; b, spiral view (wet); c, umbilical view; d, umbilical view (wet).
47. Paratype GSC 98085, a, spiral view; b, spiral view (wet); c, umbilical view.
48. Paratype GSC 98086, a, spiral view; b, spiral view (wet); c, umbilical view.
49. Paratype GSC 98087, a, spiral view; b, spiral view (wet); c, umbilical view.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