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T.P. Chamney

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Preface

Estimating the distribution and abundance of the mineral and fuel resources of Canada is one of the major objectives of the Geological Survey and requires a continuous input of stratigraphic and paleontological data.

This report describes the rock sequence, in terms of its contained microfauna, of the Albian Stage of the Lower Cretaceous near the junction of Snake and Peel rivers in the Yukon Territory. Geological knowledge of this region is, as yet, meagre compared with that of the Alaskan North Slope, the Mackenzie River Delta, and the Canadian Western Interior. The information presented here provides micropaleontological data for the immediate area and, on the basis of biostratigraphic subdivisions, a means of comparing the depositional sequence with lateral equivalents in the better known geological provinces, thereby aiding in the evaluation of potential hydrocarbon accumulations.

D.J. McLaren
Director General
Geological Survey of Canada

Ottawa, 3 November 1975

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ALBIAN FORAMINIFERA OF THE YUKON TERRITORY

Abstract

The results of this study provide a foraminiferal reference sequence for the Albian Stage in the Yukon Territory, a previously little-known region between the Alaskan North Slope and the Canadian Western Interior.

Eighteen families, forty-three genera, and one hundred and thirty-five species of the order Foraminifera are reported from the Albian sequence. Several species recorded in previous publications are redescribed and illustrated; eighteen new species also are described and illustrated. Many of these new species names replace previously used informal designations.

Agglutinated Foraminifera comprise 80 per cent of the recovered microfauna. Such forms are benthonic and are subjected to relatively high energy levels of current action. As a result of this, and because of prevailing less favourable marine conditions, the species undergo considerable morphological adaptation in order to survive. An explanation of such species variations is illustrated with six textfigures portraying morphological series within related taxa.

Taxonomic parameters for several of the described species are shown to be partly subjective, and these require arbitrary divisions between two or more taxa within a morphological series.

Résumé

Les résultats de cette étude fournissent une série de référence basée sur les foraminifères pour l'étage Albien dans le Yukon, région peu connue jusqu'ici située entre le versant nord de l'Alaska et l'intérieur du Canada occidental.

Dix-huit familles, quarante-trois genres, et cent trent-cinq espèces de l'ordre des foraminifères sont mentionnés comme appartenant à la série albienne. Plusieurs espèces signalées dans des publications antérieures sont décrites et illustrées de nouveau; dix-huit espèces nouvelles le sont également. Beaucoup parmi les nouveaux noms d'espèces présentés remplacent des appellations utilisées auparavant mais non reconnues officiellement.

Les foraminifères agglutinés représentent 80 pour cent de la faune microscopique recueillie. De telles formes de vie sont benthoniques et ont été soumises à l'action relativement puissante de courants. Pour cette raison, et du fait de la prépondérance de conditions marines moins favorables, les espèces ont subi une adaptation morphologique considérable pour survivre. Six figures dans le texte tentent d'expliquer par l'image cette évolution des espèces en montrant les diverses séries morphologiques qu'on retrouve au sein des taxons apparentés.

L'étude montre que les paramètres taxonomiques utilisés pour définir plusieurs des espèces décrites sont en parties subjectifs, ce qui exige qu'on fasse des subdivisions arbitraires en deux ou trois taxons au sein d'une même série morphologique.

Introduction

This investigation of the Snake River–Peel River area, more detailed than that of Mountjoy and Chamney (1969), is dictated by its geological location and tectonic setting. The location serves as a hinge point between the sedimentary basins to the north and west, which were in juxtaposition to the more permanent, Lower Cretaceous, boreal marine source (Chamney, 1973a), and the sedimentary basins to the south and east, which represent very restricted marine conditions, replenished only by epeiric marine transgressions over the continental platforms. Control data resulting from this research should permit better correlation southward into the Interior Plains of Manitoba, Saskatchewan, and Alberta and the Foothills of the Rocky Mountains in Alberta.

The tectonic setting is close to active sediment source-areas to the west. This explains the accumulation of sediments of the greywacke type and was responsible for the imposition of a more unfavourable paralic zone of environments on the foraminiferal populations in spite of their proximity to the permanent, boreal marine source. Thus the microfossil facies approaches that of the Canadian Western Interior, which consists of a preponderance of agglutinated benthic Foraminifera. However, that more open marine forms were still present is indicated by the recording of 39 species of calcareous taxa compared with the 52 species of agglutinated benthic taxa. Quantitatively, the agglutinated Foraminifera represent 80 to 90 per cent of the total microfauna recovered. Many of the calcareous Foraminifera are rare, only one or two representative specimens for each taxon having been recovered from the total 1900 ft (579 m) of strata present. *Haplophragmoides* is the most abundant taxon, followed by *Reophax* and *Bathysiphon.* Some isolated beds provide an acme of *Trochammina stelcki* n. sp. and *Valvulineria loetterlei* (Tappan).

The study area extends from the junction of the Snake and Peel rivers, Yukon Territory, to a point approximately 10 miles (16 km) to the north downstream on the Peel River (Textfig. 1, *in pocket*). The reference map is topographic Map 106L, Trail River, scale 1:250 000, with general map co-ordinates from latitude 66°04′30″N, longitude 134°03′45″W, to latitude 66°07′50″N, longitude 134°03′25″W. The area is bounded to the west by the Trevor Range of the Richardson Mountains and to the south by the Mackenzie Mountains. It is on the western edge

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This work was done under the auspices of the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta. T.P. Chamney is now employed by Petro-Canada, 727 7th Avenue SW (Room 1130), Calgary, Alberta, Canada, T2P 0Z6.

of the Peel Plateau, within the major drainage system of the Mackenzie River basin. It is approximately 100 miles (160 km) south of Fort McPherson on the Mackenzie River Delta and approximately 200 miles (320 km) west and north of Norman Wells on the Mackenzie River. Access is possible by small, fixed-wing aircraft equipped with floats for landing on favourable wide stretches of the Peel River, but the best access is by rotary-wing aircraft (Norris, 1963).

The area was mapped in 1962 by members of Operation Porcupine, a reconnaissance survey of the Geological Survey of Canada; E.W. Mountjoy was responsible for the Mesozoic rocks. The results of this survey were published (Mountjoy and Chamney, 1969) on a mapping scale of 1:1 000 000 (Geol. Surv. Can., Map 10-1963), with later revisions. Rock exposures along the Peel and adjacent rivers are numerous but limited in their vertical sequence. Repetition of nearly homogeneous silty shale (mudstone) is common. The Albian succession was thought originally to contain 5000 ft (1524 m) of section, but on the basis of micropaleontology (*see* Mountjoy and Chamney, 1969), this section was reduced to 1900 ft (579 m) of true stratigraphic thickness.

A composite Albian Stage sequence was constructed from four separate field stations as represented by the graphic, lithological columns of Tables 1 and 2 (*in pocket*). It is designated as Section 1, Peel River, Yukon Territory, and has a general location of latitude 66°04′30″N, longitude 134°04′00″W. The individual field station designations and locations of this report are as follows (Trail River map-area, 106L):

115-62	66°04′30″N, 134°03′45″W
116-62	66°05′00″N, 134°04′00″W
117-62	66°06′40″N, 134°05′50″W
118-62	66°07′50″N, 134°03′25″W

Stratigraphic nomenclature used in this investigation is shown in Textfigure 2. Published macrofossil control from the immediate area and the reported regional references also are included in the table. A significant part of the Upper Albian depositional sequence is missing from this area as a result of either nondeposition or erosion. The latter cause is favoured because of the abundance of open-marine Foraminifera at the top of the available exposures and the lack of evidence of shoaling, which would indicate a marine regression prior to nondeposition.

The purpose of this report is to make known the biostratigraphy of this isolated frontier area to the scientific community at large and to the workers in the immediate area charged with the responsibility of resolving the complex geological structure and stratigraphy. In order to report the microfossil content of the study interval, species names are required, just as rock-unit names are established for the purpose of stratigraphic description.

Regional correlation based on Foraminifera from the Albian Stage in the Arctic and the Western Interior Plains of Canada is difficult because this area is primarily a geological province of greywacke, mudstone, and coarser clastic sediments with interfingering rocks indicative of marine and nonmarine environments. The total setting is not hospitable for flourishing populations of pelagic foraminifers. The thickness of the deposits ranges from a zero edge onlapping the Precambrian Shield in the east to 6000 ft (1800 m) in depocentres such as the Sverdrup Basin and the thick succession in northeastern British Columbia (Chamney, 1973). The class of organisms used for biostratigraphy within the Canadian boreal realm may appear to be quite primitive, endemic forms to those micropaleontologists working with rock sequences that were deposited under environmental conditions amenable to supporting more exotic forms of Foraminifera. Experience in their use and a knowledge of the stratigraphy of the area are necessary in order to interpret biostratigraphic determinations.

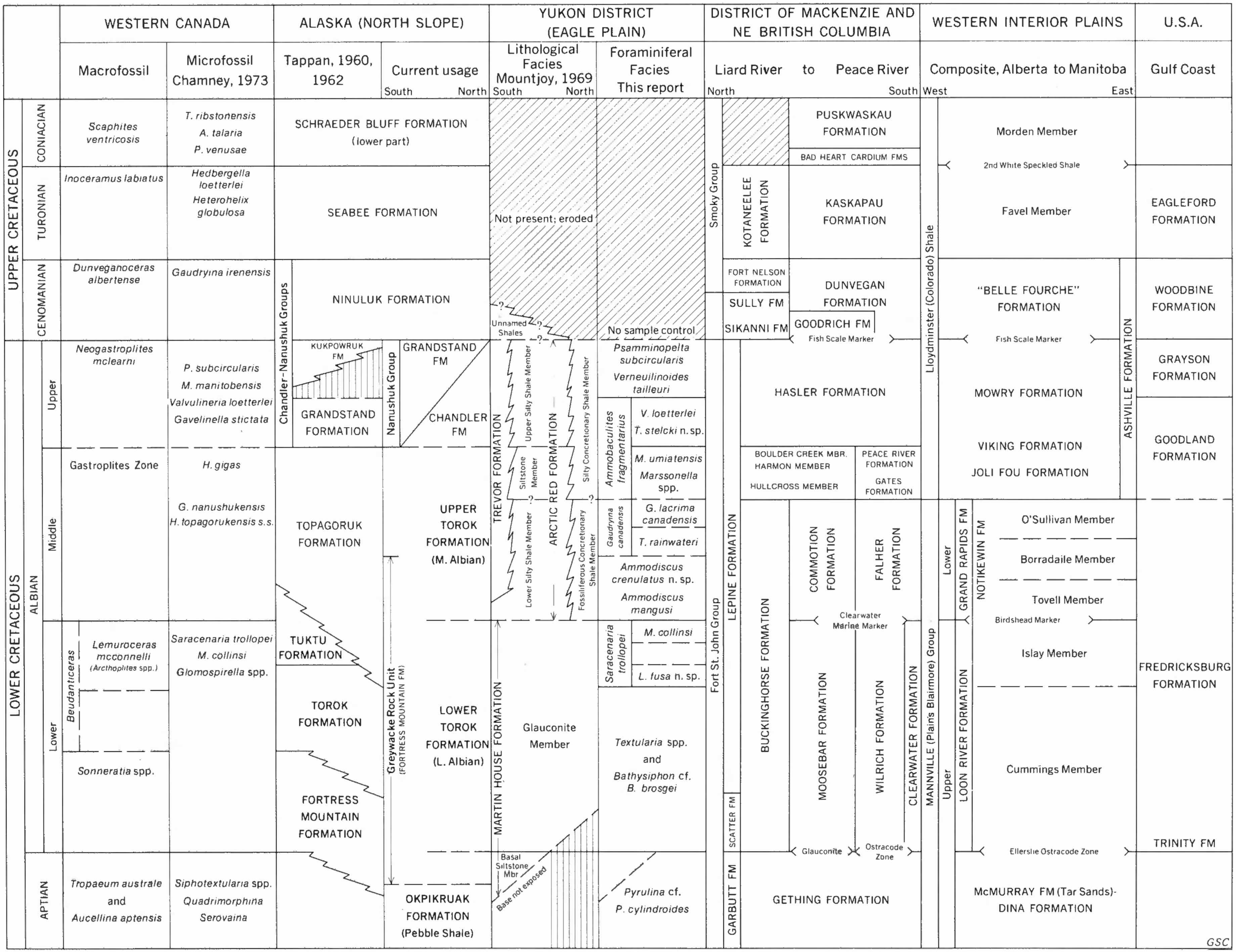
The structural weakness of the agglutinated foraminiferal test walls adds a further limitation. Agglutinated forms comprise 80 to 90 per cent (by quantity) of the recovered Foraminifera, and individual specimens are considerably distorted and altered by diagenetic mineralization. There is evidence also of contemporaneous weathering and mechanical abrasion related to the higher energy levels of detritus transportation within shallow shelf and near-shore environments. These numerous physical alterations, together with natural variations such as dimorphism, hybrids, morphospecies, and general population variations, make indentification of species very difficult. Textfigures 3 to 8 are designed to assist in the diagnosis of species that are not necessarily related in the accepted systematics but do appear morphologically similar as a result of these diagenetic modifications.

Those who have assisted in the technical preparation of this study are acknowledged in the text where appropriate. T. Barnard, University College, London, guided the research, and this is gratefully acknowledged. W.V. Sliter, United States Geological Survey, and W.W. Brideaux, Geological Survey of Canada, read the manuscript critically and offered valuable suggestions for its improvement.

Biostratigraphy

Mountjoy and Chamney (1969) published the physical stratigraphy and biostratigraphy of the area. The present systematic study contributes additional biostratigraphic data. The more accurate speciation of the Foraminifera, accompanied by the tabulated regional occurrence of the described species, documents the original interpretations. The following is the revision accompanied by an explanation for changes in the original biostratigraphic units and in the microfossil content of the physical stratigraphic units. The numbered zones refer to the designated zones in Table 2 (*in pocket*).

1. *Psamminopelta subcircularis–Verneuilinoides tailleuri* assemblage zone (1838 to 1638 ft [560 to 499 m] of Section 1). *Psamminopelta subcircularis* is associated with *Miliammina* in some of the adjacent, lateral sections of equivalent stratigraphic horizons (Mountjoy and Chamney, 1969). These beds can be correlated on the basis of the *Miliammina* ex gr. *M. manitobensis* with the Upper Albian of the Canadian Western Interior. In this latter area, the Upper Albian stratigraphic unit is defined as those beds occurring between the top of the Viking Formation and the base of the Fish Scale Marker. The depositional interval is dated by means of the neogastroplitid ammonites. In Manitoba, the *M. manitobensis* zone is represented by the upper two-thirds of the Ashville Formation or



Textfigure 2. Stratigraphic nomenclature correlation chart.

the Mowry Formation of the United States Geological Survey standard stratigraphic nomenclature (Chamney, 1969d). Thus, the term "Mowry Sea" is shown on the frequency graph (Table 2) to represent the Late Albian marine transgression from the boreal source, which inundated a very extensive area southward into the western interior of Canada and the United States (Chamney, 1973). The foraminiferal assemblage recovered from strata throughout the total extent of this marine invasion is somewhat unique in that very few calcareous foraminifers have been recorded. Abundant agglutinated, benthonic forms and abundant fish remains usually are recovered. This suggests the presence of favourably aerated surface conditions for the fish but very restricted bottom circulation. Such a benthonic environment would reduce predators, allowing the remains of the near-surface organisms to accumulate with little destruction.

Verneuilinoides borealis Tappan has been restudied, and more than one species appear to be represented by the taxon (Chamney, 1972). Each recognizable taxon can be related also to more common occurrences in different stratigraphic horizons, hence more discrete age assignments can be interpreted for Albian subdivisions. *Verneuilinoides borealis* sensu stricto is rare in this assemblage, and the use of the species is pending redefinition of the original taxon. The more common *V. tailleuri* Tappan has been substituted for the name of the zone because its identification in this particular sequence of strata is more reliable. Its regional persistence in the Upper Albian also has been better documented for the Canadian Western Interior (Stelck, 1973). The authors of the following species are to be found in the distribution chart (Table 1). The Appendix, which is alphabetical, shows distribution chart column numbers.

Long-ranging Albian species include

Ammodiscus rotalarius
Gaudryina nanushukensis
Haplophragmoides linki
Reophax troyeri
Trochammina cf. *T. rainwateri*

Species common to underlying late Middle Albian age include

Haplophragmoides peelensis n. sp.
H. topagorukensis s.s.
H. yukonensis n. sp.
Hippocrepina cf. *H. barksdalei*
Reophax minuta
R. vasiformis n. sp.

Species restricted to the interval are

Psamminopelta subcircularis
Verneuilinoides tailleuri
V. ex gr. *V. borealis*

2. *Ammobaculites fragmentarius* assemblage zone (1638 to 1198 ft [499 to 365 m] of Section 1). This zone is subdivided into two assemblage subzones–an upper, *Valvulineria loetterlei*, and a lower, *Marginulinopsis umiatensis* and *Marssonella* spp. (*Dorothia*?). *Ammobaculites fragmentarius* is one of the regional index species for the total Albian Stage in the Canadian Western Interior sedimentary basin. In Section 1, the species does not range higher than the upper Middle Albian and, therefore, has been used as the name species to designate the assemblage zone under discussion. The uppermost ranges of several other agglutinated species, such as the distinctive tricarinate *Tritaxia solea* n. sp. and the larger, more robust species of *Haplophragmoides* aff. *H. gigas*, terminate also at the upper boundary of this zone. This major faunal change is thought to be analogous to similar faunal changes exhibited in the Canadian Western Interior plains area, at the top of the Joli Fou Formation or, possibly, within the sandstones of the overlying Viking Formation. For this reason, the name "Joli Fou Sea" is used for the late Middle Albian interval of marine transgression.

Valvulineria loetterlei–Trochammina stelcki n. sp. assemblage subzone (1638 to 1348 ft [499 to 411 m] of Section 1). The species *V. loetterlei* was chosen as one of the zone names because of its abundance in this interval. Its uppermost range terminates about 100 ft (30 m) below the top of the designated assemblage zone boundary. Its presence in older Albian rocks has been recorded in Alaska (Tappan, 1962) and in the older Clearwater and Moosebar formations of northeastern British Columbia and Alberta (Stelck *et al.*, 1956) as *Gyroidina* cf. *G. nitida* (Reuss). *Trochammina stelcki* n. sp. was chosen as the second zone name because it represents a distinctive species of the genus, which reaches both its acme of development and the limit of its uppermost range at the top of the designated boundary of the assemblage zone. The variety and abundance of calcareous foraminifers in this interval (Table 1, *in pocket*) suggests maximum development of open-marine conditions in this area during Albian time.

Long-ranging species (Early and Middle Albian) include

Bathysiphon brosgei
Gaudryina cf. *G. canadensis*
G. stotti n. sp.
Haplophragmoides peelensis n. sp.
H. yukonensis n. sp.
Reophax cf. *R. incompta*
Saccammina sp.
Verneuilinoides tailleuri

Dentalina cf. *D. dettermani*
Lenticulina fysta n. sp.
L. redunca n. sp.
Marginulinopsis cf. *M. umiatensis*

Species common to the *Ammobaculites fragmentarius* zone are

Ammobaculites fragmentarius
Gaudryina cf. *G. nanushukensis*
Haplophragmoides spissum
Hyperammina cf. *H. gryzbowski*
Textularia ex gr. *T. topagorukensis*
Trochammina stelcki n. sp.

Citharina sp.
Conorbina sp.
Gavelinella cf. *G. awunensis*
Globorotalites rotaliformis
Lenticulina ingenua
L. topagorukensis
Marginulina cephalotes
M. gatesi
Marginulinopsis jonesi

Nodosaria nana
Saracenaria cf. *S. spinosa*
?*Tribrachia* sp.
Valvulineria cf. *V. loetterlei*

Species restricted to the interval are
Gaudryina subcretacea
Psamminopelta sp.
P. bowsheri
Pseudobolivina sp.
Siphotextularia cf. *S. andersoni*
Spiroplectammina sp.
Trochammina stelcki n. sp.

Citharina cf. *C. acuminata*
Dentalina duplexa n. sp.
?*Eurycheilostoma robinsonae*
Frondicularia sp. Tappan, 1962
?*Gavelinella* cf. *G. ammonoides*
Globorotalites alaskensis
Globulina prisca
Lenticulina fysta n. sp.
L. macrodisca
L. redunca n. sp.
Lingulina cf. *L. rediviva*
Marginulina planiuscula
Marginulinopsis umiatensis
Nodosaria doliiformis
N. cf. *N. doliiformis*
Planularia sp.
Rectoglandulina cf. *R. kirschneri*
Saracenaria grandstandensis

Neobulimina cf. *N. subcretacea*
Saracenaria valanginiana
Tribrachia n. sp. 2
Tritaxia solea n. sp.
Vaginulina cf. *V. kochi*
V. mountjoyi n. sp.
Valvulineria loetterlei

Marginulinopsis umiatensis and *Marssonella* spp. (*Dorothia*?) assemblage subzone (1348 to 1198 ft [411 to 365 m] of Section 1). *Marssonella* Cushman, 1933, has been placed in synonymy with *Dorothia* (Loeblich and Tappan, 1964, p. C275), but the uppermost range of the genus contains a group of distinctive, conical species that have been recorded from previous studies as markers in the late Middle Albian and, as such, the original generic assignment of *Marssonella* is indicated. Only a few foraminifers were recovered from this zone; of these, *Marssonella* spp. were the most significant and are common in all sections examined within the same general stratigraphic interval. Because of the paucity of agglutinated forms of foraminifers, the environment interpreted is one of unfavourable marine conditions owing to the great influx of coarse clastic detritus.

Species common to the underlying older Albian are
Gaudryina canadensis
G. nanushukensis
Marssonella spp. (*Dorothia*?)

Species restricted to the interval are
Astacolus sp.
Spiroplectammina cf. *S. koveri*
Textularia cf. *T. gravenori*

3. *Gaudryina canadensis* assemblage zone (1198 to 871 ft [365 to 265 m] of Section 1). The zone name species ranges stratigraphically above and below the interval boundaries, as indicated in the teilzone portion of Table 2. The species was chosen because of its abundance in this section and its common occurrence regionally within the Middle Albian of the Canadian Western Interior. The species best represents the time interval between the two major Albian marine incursions, the Early Albian "Clearwater" and the late Middle Albian "Joli Fou" seas. The zone is divided into two assemblage subzones; the less restricted marine conditions indicated by the *Globulina lacrima canadensis* are referred to as the "Notikewin Sea." In the Albian Stage of the Canadian Interior Plains, there is a similar change toward marine conditions recorded by the sediments of the post-Clearwater and pre-Joli Fou formations. The term "Notikewin" is used in a broad sense because the marine transgressions are somewhat diachronous from northwest to southeast, and the rock stratigraphic terminology, representing this increased salinity in the successive geological provinces, changes with each province.

Globulina lacrima canadensis–Saccammina horrida n. sp. assemblage subzone (1198 to 941 ft [365 to 287 m] of Section 1). This is the upper subdivision of the *Gaudryina canadensis* assemblage zone and includes the homogeneous shale underlying the most persistent sandstone marker in the vicinity of the junction of the Snake and Peel rivers. The calcareous foraminifer *G. lacrima canadensis* persists higher in the stratigraphic sequence of the Yukon than it does in comparable Albian sections to the south and east. In these latter areas, it has been reported only from older Albian rocks of the Clearwater or Moosebar formations (Mellon and Wall, 1956). *Saccammina horrida* n. sp. was chosen to represent the agglutinated, benthonic assemblage of this zone because it is recovered from the stratigraphic equivalents to the south over a vast area of the Canadian Western Interior, where it is very difficult to recover any marine organisms. Beds of stratigraphic equivalence, thus referred to, would include strata of the Mannville Group. The recovered microfauna represents a rather restricted marine environment, with only three calcareous species of Foraminifera present.

Species common to older Albian are
Ammobaculites cf. *A. fragmentarius*
Bathysiphon emacerata n. sp.
Eponides sp.
Haplophragmoides topagorukensis s.s.
Nodosaria cf. *N. concinna*

Species restricted to the interval are
Globulina lacrima canadensis
?*Histopomphus* cf. *H. redriverensis*
Reophax cf. *R. minuta*
Saccammina horrida n. sp.

Trochammina rainwateri–Reophax fuscus n. sp. assemblage subzone (941 to 871 ft [287 to 265 m] of Section 1). *Trochammina rainwateri* and varieties of the species have been recovered throughout the Albian of the study-area. It was chosen as a zone name because of its abundance in comparison with other foraminifers recovered. The upper boundary of this zone, however, is coincident with the uppermost range of *Reophax fuscus* n. sp. These simple, uniserial, agglutinated forms are long-ranging throughout the Albian (Table 2), but if detailed study of the genera is undertaken, such range limits become useful in intervals of poor recovery such as this one. Such intervals signify restricted marine conditions and intermittent connections with open-marine waters.

Species common to older Albian are

Ammobaculites cf. *A. reophacoides*
Gyroidina (or *Serovaina*?) sp.
Haplophragmoides sp. C cf. Stelck and Wall
Reophax fuscus n. sp.

Species restricted to the interval are

?*Gaudryinella* sp.
Trochammina rainwateri

4. *Ammodiscus crenulatus* n. sp.–*Ammodiscus mangusi* assemblage zone (871 to 632 ft [265 to 192 m] of Section 1). The depositional interval represented by this zone contains the uppermost range of several significant Early Albian species. The general abundance of *Ammodiscus* spp. is considered more significant because these forms are usually associated with the uppermost range of *Glomospirella* spp. in equivalent zones of other northern sections. The latter genus originated in the Permian, reached its acme of development in the Neocomian (Barremian), and appears to have become extinct in the early Middle Albian. In some species of *Glomospirella,* the initial variable plane of the coiling tube is easily overlooked, and the obvious remaining planispiral tube arrangement is mistaken for *Ammodiscus.* This group of primitive, tubular coiled forms, which have a high silica cement ratio to agglutinated grains in the test wall, is quite tolerant to additions of fresh water. The assemblage zone suggests that the environment was one of very restricted marine conditions with little deposition of coarse clastic sediment in quiet-water conditions. In all specimens recovered, the ratio of silica cement to agglutinated clastic grains is high, indicating abundant silica and a paucity of clastic grains.

Species common to older Albian are

Haplophragmoides ex gr. *H. yukonensis* n. sp.
H. aff. *H. neocomianus*

Species restricted to the interval are

Ammodiscus crenulatus n. sp.
A. mangusi
A. rotalarius
Bathysiphon strombotubulare n. sp.

5. *Saracenaria trollopei* zone (622 to 331 ft [190 to 101 m] of Section 1). This distinctive species and its companion assemblage subzone species are confined to the designated interval. They are associated throughout this Lower Albian Stage with the ammonites *Lemuroceras* and *Beudanticeras.* In Alaska, this association is present in the Wolf Creek Test Well No. 3, from 3092 to 3122 ft (943 to 952 m) in the upper part of the Topagoruk Formation, approximately 350 ft (107 m) below the base of the Grandstand Formation (Bergquist, 1959, p. 482). In northeastern British Columbia, a similar association is present in the Clearwater and Moosebar formations (Stelck *et al.,* 1956, pp. 11–14).

The lithological character of the total *S. trollopei* zone of the study-area is much coarser than its stratigraphic equivalents to the south in areas of the Moosebar and Clearwater formations. It compares more favourably, however, with the lithofacies and bathymetry of the Cummings Member of the Mannville Group in the plains of Alberta and Saskatchewan. The environmental interpretations based on the *S. trollopei* microfaunal assemblage indicate a transgressive marine cycle. The base consists of coarse, clastic sediments yielding a few open-marine, calcareous Foraminifera. These reach the acme of development in the uppermost shale member. In this shale, the open-marine inference is strengthened further by the presence of the radiolarians *Dictyomitra* sp. and *Lithocampe* sp., which were recovered as pyritic casts.

The relative extent of marine transgressions based on the quantity and quality of open-marine calcareous foraminifers is of significance. Deposits of the "Clearwater Sea" have resulted in a thicker stratigraphic sequence than those of the "Joli Fou Sea," but sediments of the latter contain a much greater number and variety of calcareous species in the Yukon area. To the south and east, in the Plains province, the characteristic lithofacies of the Joli Fou Formation (*Haplophragmoides gigas* zone) persists farther south and east over the Plains than does that of the Clearwater Formation. The Joli Fou Formation, at its southern extremity, provides rare calcareous species, whereas the Clearwater Formation equivalent, where present, usually provides a few calcareous, lagenid species. Because of this, it is suggested that the "Joli Fou Sea" was a much more extensive marine transgression, of shorter duration, which did not permit the establishment of the more environmentally sensitive calcareous species during its invasion into the Canadian Western Interior.

Species common to the underlying Albian/Aptian transitions are

Bathysiphon cf. *B. brosgei*
Gaudryina cf. *G. barrowensis*
Glomospirella sp.
Saracenaria valanginiana

Species restricted to the interval are

Gaudryina cf. *G. subcretacea* (tricarinate)
Astacolus cf. *A. incrassatus*
Citharina recta
Gavelinella sp.
Globulina cf. *G. prisca*
Lenticulina erecta
L. topagorukensis
Marginulina cf. *M. planiuscula*
Marginulinopsis collinsi
M. cf. *M. collinsi*
Nodosaria sp.
?*Planularia* cf. *P. umbonata*
Quadrimorphina sp.
Saracenaria trollopei
Valvulineria sp.

Marginulinopsis collinsi assemblage subzone (622 to 590 ft [190 to 180 m] of Section 1). The upper subdivision of the *S. trollopei* zone, *M. collinsi,* is separated from the lower, *Len-*

ticulina fusa n. sp., by 60 ft (18 m) of more indurated sandstone. The *M. collinsi* species, designating this assemblage of several distinctive calcareous species, has been recovered from numerous stratigraphic equivalents over a very large geographical area from Arctic America to the Canadian Western Interior. It is not as common in the Lower Albian of the Yukon as some of the equally distinctive calcareous species plotted in the chart of Table 1 for this depositional interval, but it was selected to represent the assemblage because of its abundance in regions to the south.

Lenticulina fusa n. sp.–*Bathysiphon* cf. *B. brosgei* assemblage subzone (430 to 330 ft [131 to 101 m] of Section 1). The depositional interval of this lower subdivision of the *S. trollopei* zone has provided microfaunal elements in common with both the underlying *Textularia* spp. assemblage zone and the overlying *Marginulinopsis collinsi* assemblage subzone. The *L. fusa* n. sp. subzone appears to represent an additional depositional interval of older Early Albian age. This conclusion is made from a comparison with the equivalent *S. trollopei* zone (*Beudanticeras* zone) in the Clearwater and Moosebar formations to the south in the Canadian Western Interior. In this latter area, only the upper subdivision of *M. collinsi* has been reported.

6. *Textularia* spp.–*Bathysiphon* cf. *B. brosgei* assemblage zone (330 to 0 ft [101 to 0 m] of Section 1). The depositional interval of the basal 300 ft (92 m) in Section 1, in the vicinity of the junction of the Snake and Peel rivers, is composed predominantly of silt and sand. The assumed high-energy environment was unfavourable for Foraminifera, thus only a few agglutinated benthonic species are present. Therefore, the total interval has been assigned tentatively to one assemblage zone, with the more distinctive 30-ft (9-m) assemblage subzone, *Pyrulina* cf. *P. cylindroides,* at the base. With the exception of this subzone, the few benthonic foraminifers reported did not contribute to the age dating. Assignment of the depositional interval to a transitional age is based on its stratigraphic position between the known Lower Albian *Saracenaria trollopei* zone and the ?Aptian *P.* cf. *P. cylindroides* assemblage subzone. The latter age assignment is based on similar foraminiferal species obtained from sample material dated by macrofossils from the Barrier Creek area, north and west of the Peel River section outlined in this report. The sample material was contributed by J.A. Jeletzky in the form of fragmentary remains of the Aptian ammonite species *Tropaeum* cf. *T. australe,* GSC loc. 35695 (Jeletzky, pers. comm., 1965). Foraminifera, including *Pyrulina* cf. *P. cylindroides,* were obtained after laboratory preparation of the internal sediment filling of the macrofossil specimens.

Rock-units

The microfossil distribution chart of Table 1 was compiled first in order to establish the vertical succession of the Foraminifera. Then the micropaleontological subdivisions were interpreted, as illustrated in Table 2, in terms of zones, assemblage zones, and assemblage subzones. The biostratigraphic relationships to the mappable rock-units in the field were then added. The following discussion describes the rock-unit subdivisions of the Albian Stage in accordance with the modified biostratigraphic zonation.

Martin House Formation

Basal siltstone member. The single calcareous Foraminifera recovered from the lower 325 ft (99 m) of Section 1 was from the basal 73 ft (22 m) in sample 1a (Table 1). The significance of this is that the latter interval was one where more open-marine conditions existed than those suggested by the microfaunal recovery from the remainder of the basal siltstone member, which provided a few simple, agglutinated, benthonic foraminifers indicating very restricted marine environment. No marine microfossils were recovered from sample 2. The age assignment to ?Aptian has been discussed above, and the interval has been designated as the *Pyrulina* cf. *P. cylindroides* assemblage subzone.

Glauconite member. A lower *Textularia* spp.–*Bathysiphon* cf. *B. brosgei* assemblage zone and an upper *Saracenaria trollopei* zone have been considered as two distinct assemblages. Species of the *S. trollopei* zone range upward for 25 ft (8 m) into the basal shale of the overlying member. The deduced ecology of these two assemblages shows a change from the lower agglutinated, benthonic assemblage, indicative of restricted marine environment, upward into the calcareous assemblage, characteristic of more open-marine species. Age assignment of the *S. trollopei* zone (including the *Marginulinopsis collinsi* subzone) to the Early Albian is well documented, as discussed above; the lower assemblage zone has not been dated satisfactorily. Several agglutinated foraminiferal species, representing only the more tolerant primitive forms, are common to both depositional intervals. With reference to the teilzones of Table 2, the species ranges of *Gaudryina* cf. *G. barrowensis* and *Gaudryina* cf. *G. subcretacea* have almost simultaneous termination near the boundary of the upper and lower zones. This rather distinct microfaunal facies change, however, does indicate a possible hiatus that terminated the range of these species. Therefore, the boundary between the two zones within the glauconitic member possibly may represent a stage boundary. The age assignment of the lower zone has been shown as Albian-?Aptian transition.

Arctic Red Formation

Lower silty shale member. Foraminifera recovered from the lower silty shale member was divisible into two assemblage zones. In addition, the basal 25 ft (8 m) of shale were included in the underlying marine transgressive zone. The lower subdivision is represented by the *Ammodiscus crenulatus* n. sp. and *Ammodiscus mangusi* assemblage zone and the upper by the *Gaudryina canadensis* assemblage zone, which is divisible into two distinct assemblage subzones: a lower, *Trochammina rainwateri–Reophax fuscus* n. sp., and an upper, *Globulina lacrima canadensis–Saccammina horrida* n. sp. The microfauna indicate a change from the lower, restricted-marine condition of the *Ammodiscus* spp. interval to the upper, open-marine environment of the *Globulina lacrima canadensis* zone. Age assignment of the lower silty shale member has been placed between the underlying, well-documented Lower Albian *Saracenaria trollopei* zone and the overlying upper Middle Albian *Valvulineria loetterlei* assemblage subzone. The facies boundary with the overlying siltstone member is contained within the upper part of this rock-stratigraphic-unit and rises stratigraphically from south to north. At approximately the lowest stratigraphic horizon of the interfingering sequence of coarse clastic strata, a microfaunal facies change is indicated by the simultaneous termination of three species, shown in the teilzone column of Table 2. This facies change occurs approximately 100 ft (30 m) above the base of the member and affects the uppermost species ranges of *Haplophragmoides* ex gr. *H. yukonensis* n. sp., a very small form of *H.* aff. *H. spissum, H.* aff. *H. neocomianus,* and *Reophax* spp.

Some of the basal part of the lower silty shale member represents Early Albian deposition, and the remainder of the member was deposited in early Middle Albian time. Again, it should be emphasized that the finer time subdivisions of early and late for the Middle Albian are arbitrarily designated to coincide with the interpreted cyclical environments of deposition within the Middle Albian and, therefore, may not coincide exactly with these boundaries.

Siltstone member and equivalent northern facies. The siltstone member is present in the southern part of the report-area but, in the northern part, is represented by silty concretionary shale similar to that of the underlying lower silty shale member. The high-energy environment of deposition reflected in the coarser, clastic silt of the basin affected the microfauna of this area. Microfossil recovery was poor from the lower two-thirds of this depositional interval, and the only distinctive Foraminifera present was *Marssonella* spp., which was used to name the assemblage subzone of the total assemblage zone of *Ammobaculites fragmentarius.* The recovery of *Valvulineria loetterlei* and associated calcareous foraminifers from the upper one-third of the siltstone member and its northern equivalent indicates an environment closer to normal marine conditions. This point of change within the member represents the arbitrary boundary between the early and the late Middle Albian. The type of microfossils present indicate that the upper two-thirds of the siltstone plus the lower one-third of the overlying upper silty shale member represent a complete depositional cycle from restricted-marine (*Marssonella* spp.) to open-marine (*Valvulineria loetterlei*) conditions in the late Middle Albian.

Upper silty shale member and equivalent northern facies. A distinct microfaunal change occurs approximately 225 ft (69 m) above the base of the upper silty shale member in Section 1. The prolific, open-marine, calcareous Foraminifera of the *Valvulineria loetterlei* assemblage subzone in the lower 225 ft (69 m) are terminated, as are several long-ranging, Middle Albian, agglutinated species shown in the teilzone range of Table 2. The remainder of the upper depositional interval provided only agglutinated, benthonic species designated as the *Psamminopelta subcircularis–Verneuilinoides tailleuri* zone. Thus the somewhat consistent pattern of environmental cycles observed within the underlying Early and Middle Albian intervals appears to be broken within this member. The previous sequences have included a regressive and 'stillstand' interval of restricted marine conditions after a transgressive, open-marine assemblage such as the *V. loetterlei* of the lower one-third of the member. But, in this case, restricted but open-marine conditions persisted, supporting abundant agglutinated Foraminifera but no calcareous species. The changes mentioned above coincide with the suggested position of the Upper Albian–Middle Albian boundary at this contact, 225 ft (69 m) above the base of the member. *Verneuilinoides tailleuri* and *P. subcircularis* have been reported previously from the Upper Albian of Alaska (Tappan, 1962).

Systematic Descriptions

Classification used for this report is that of Loeblich and Tappan (1964). The textfigures compare taxa of different families but with similar external morphology. Similarities of taxa within the morphogroups illustrate an inherent weakness of the classification, particularly when specimens were poorly preserved.

The system of curating used for all material is that of the Geological Survey of Canada. The illustrated specimens carry type numbers GSC 34758 to GSC 34899 and are deposited in the type collection, Ottawa, Ontario. Rock samples carry numbers GSC locations C-25730 to C-25767 and are deposited at the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

Magnifications of all figured specimens are indicated for each figure or group of figures. A solid line represents 0.50 mm and a broken line 0.25 mm. The photomicrographs were taken with the assistance of D.L. Herron, and some of the original camera lucida drawings were done by Sandy Haeseker. The more recently developed 'zoom tube' for the camera lucida apparatus enabled recopy and fill-in of details on the original drawings.

Family Rhizaminidae Cushman, 1927
Genus *Bathysiphon* Sars, 1872
Bathysiphon brosgei Tappan
Plate 1, figures1–3

Bathysiphon brosgei Tappan, 1957, p. 202, Pl. 65, figs. 1–5; 1962, p. 128, Pl. 29, figs. 1–5.

Material and occurrence. Hypotype GSC 34758 (Pl. 1, fig. 1) is from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample 1c (GSC loc. C-25738), of Middle Albian age. Hypotypes GSC 34759 and 34760 (Pl. 1, figs. 2, 3) are from the upper part of the glauconite member, Martin House Formation, field station MJ 116-62, sample 2c (GSC loc. C-25755), of Early Albian age. The species occurs in the glauconite member and the siltstone member, which represents a range in age from Early to Middle Albian (Table 1, col. 82), and it is abundant–10 specimens or more per 100 g of sample.

The range of the species in Alaska (Tappan, 1962) is from the Fortress Mountain Formation (Aptian? to Lower Albian) through the Nanushuk Group (Middle? Albian to Cenomanian) and into the Colville Group (Turonian and Senonian). Thus, with the exception of the Neocomian Stage, it is reported to occur throughout the total Lower and Upper Cretaceous Series. All of the figured specimens, however, are reported to be from the Topagoruk Formation of Early? to Middle Albian age.

In epeiric sea conditions, where this taxon may be the only microfauna recovered, there are significant species differences in this simple form. Wall construction appears to be related to the size of the grains selected by a species. Very fine grains are associated with multiple layers of grains, whereas large agglutinated particles usually occur as a single layer. These two extreme forms also seem to be controlled by environments of deposition and thus are useful for the correlation of stratigraphic horizons. During the initial advance of the Albian seas where marine stress conditions were optimal, the coarsely agglutinated forms were dominant. Similar relationships have been observed in the Jurassic and other stages of the Cretaceous.

Discussion. The range in length of the fragmentary portions of the test is 0.70–1.04 mm and in maximum width the range is 0.20–0.45 mm; the average wall thickness is 0.03 mm. The thickness of the test wall approximates three diameters of the average quartz grain agglutinated into the test wall. Some specimens exhibit slight variable tapers and irregular kinks along the length of the test that suggest some similarities to *Hyperammina gryzbowski* Dylazanka, 1923. The original test wall is extremely siliceous and has rare, larger quartz grains as well as adventitious material irregularly scattered over the surface.

Bathysiphon emacerata n. sp.
Plate 1, figures 4, 5

Material and occurrence. Holotype GSC 34761 (Pl. 1, fig. 4) is from the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1f (GSC loc. C-25741), of Middle Albian age. Paratype GSC 34762 (Pl. 1, fig. 5) is from the glauconite member, Martin House Formation, field station MJ 116-62, sample 2c (GSC loc. C-25755), of Early Albian age. The occurrence range (Table 1, col. 98) is from the middle part of the glauconite member to the top of the lower silty shale member. The species is somewhat restricted in age, representing early Early Albian to late Middle Albian. The acme of occurrence is in the glauconite member, where an average of 10 specimens per 100 g of sample was recovered.

Description. Test elongate, consisting of a proloculus followed by an undivided, slender, tubular chamber, slightly curved and irregularly bent or constricted; wall finely agglutinated with considerable silica cement, rather smoothly finished; aperture rounded at open end of the tubular chamber.

Length of holotype is 0.64 mm and maximum width is 0.09 mm. The paratypes are 0.40–0.55 mm long and 0.06–0.08 mm wide; the average wall thickness is 0.016 mm—approximately the diameter of a single quartz grain.

Discussion. The inherited selectivity of the new species, to select a thickness of just one grain for the test wall, is a very distinctive feature. The somewhat variable width and irregular constrictions of the preserved test indicate the weak structure of the wall, attributed to its single-quartz-grain thickness.

Bathysiphon strombotubulare n. sp.
Plate 1, figures 6, 7

Material and occurrence. Holotype GSC 34763 (Pl. 1, fig. 6) is from the basal siltstone member, Martin House Formation, field station MJ 115-62, sample 1a (GSC loc. C-25767), of Aptian age. Paratype GSC 34764 (Pl. 1, fig. 7) is from the same sample. The range of the species, shown in Table 1, col. 112, is from the basal siltstone member to the lower part of the lower silty shale member (i.e., predominantly in the Martin House Formation). The age range is from the Aptian to the latest Early Albian. It occurs in quantities of a few to common, the average being four specimens per 100 g of sample.

Description. Test is an elongate tube consisting of a proloculus followed by a somewhat irregularly constricted tube with subparallel sides; wall agglutinated with medium to coarse quartz grains scattered throughout and contributing to a sugary texture; aperture slightly constricted at open end of the tube.

Length of the holotype is 1.28 mm and maximum width is 0.38 mm. The length of the paratypes ranges from 0.90 to 1.28 mm, and the maximum width is never greater than 0.40 mm. The average tube wall thickness is 0.08 mm, which is four times the diameter of the fine quartz grains.

Discussion. The new species is larger in all dimensions than *B. scintillata* Chamney, 1969, from the underlying beds of Barremian age. Although the wall of the present species is four times the thickness of *B. scintillata,* the twisted preservation shows considerable weakness in its structure. The sugary texture of the wall indicates that the number of grains is greater than the amount of silica cement. This may be the cause of the structural weakness.

Family Saccamminidae Brady, 1884
Genus *Saccammina* Sars, 1864
Saccammina horrida n. sp.
Plate 1, figures 8, 9

Material and occurrence. The holotype GSC 34766 (Pl. 1, fig. 9) is from the top of the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1f (GSC loc. C-25741), of Middle Albian age. Paratype GSC 34765 (Pl. 1, fig. 8) is from the same sample. The range of the species, shown in Table 1, col. 99, is restricted to the upper part of the lower silty shale member, of Middle Albian age. There are only a few specimens recovered from each 100 g of sample.

Description. Test unilocular, rounded to ovate in outline, compressed with central depression of the original collapsed sphere; wall with considerable cement and lesser amounts of grains of medium size, roughly finished; aperture rounded to ovate, surrounded by a slightly raised rim.

The diameter of the holotype is 0.37 mm, and the thickness is 0.33 mm. The diameter of the paratypes ranges from 0.44 to 0.55 mm; the average thickness is 0.30 mm.

Discussion. The new species is smaller in all dimensions and has a greater amount of silica cement compared to grains than has *S. lathrami* Tappan, 1957. The stratigraphic horizon for this locally restricted species is very significant in delineating the overlying siltstone member, which is a potential hydrocarbon reservoir. For this reason it is useful to define the taxon as a new species.

Family Hyperamminidae Eimer and Fickert, 1899
Genus *Hippocrepina* Parker *in* Dawson, 1860
Hippocrepina barksdalei (Tappan)
Plate 1, figures 10, 11

Hyperamminoides barksdalei Tappan, 1957, p. 202, Pl. 65, figs. 6–12; 1962, p. 129, Pl. 29, figs. 21–27.
Hippocrepina barksdalei (Tappan) Loeblich and Tappan, 1964, p. C-188.

Material and occurrence. Hypotypes GSC 34767 and 34768 (Pl. 1, figs. 10, 11) are from the siltstone member, Arctic Red

Formation, field station MJ 118-62, sample 1e (GSC loc. C-25736), of Middle Albian age. The species ranges, as shown in Table 1, col. 3, from the siltstone member to the upper part of the upper silty shale member; in age, from the Middle to Late Albian. It is common in occurrence, with approximately eight specimens per 100 g of sample. The type species in Alaska is reported by Tappan (1962) from the Topagoruk and Grandstand formations of Middle and Late Albian ages.

Discussion. The hypotypes are 0.40–0.57 mm long and 0.19–0.25 mm wide. These dimensions fall within the median range of the type species in Alaska, but the present species is coarser and a little more irregular in outline.

Family Ammodiscidae Reuss, 1862
Genus *Ammodiscus* Reuss, 1862
Ammodiscus rotalarius Loeblich and Tappan
Plate 1, figures 15 (*a–c*), 16 (*a–c*)

Ammodiscus rotalarius Loeblich and Tappan, 1949, v. 23, no. 3, p. 247, Pl. 46, fig. 1; Tappan, 1962, p. 131, Pl. 30, figs. 5–8.

Material and occurrence. Hypotypes GSC 34769 and 34770 (Pl. 1, figs. 15, 16) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a, (GSC loc. C-25735), of Middle Albian age. The species occurs (Table 1, col. 7) in the lower silty shale, siltstone, and upper silty shale members, indicating a range in age from Early to Late Albian. The acme of occurrence is in Upper Albian strata having six to eight specimens per 100 g of sample. The species is reported by Tappan (1962) in Alaska from the Torok, Topagoruk, and Grandstand formations, which represent the total Albian sequence.

Discussion. The maximum diameter of the figured specimens is 0.27–0.36 mm and the minimum is 0.25–0.30 mm. The average thickness of the test is 0.05 mm, which is the tube diameter; the wall thickness is approximately 0.016 mm. The small size and poor preservation can make it difficult to distinguish between this species and similar forms of *Glomospirella* (Chamney, 1969b). It is necessary to wet the specimens and examine them with incident lighting to distinguish between the early growth stage of the proloculus followed by the planispiral coil, and the quinqueloculine, early coiling of the *Glomospirella.*

Ammodiscus crenulatus n. sp.
Plate 1, figures 17 (*a* and *b*), 18 (*a* and *b*)

Ammodiscus sp., Stelck *et al.*, 1956, p. 26, Pl. 2, figs. 31, 32.

Material and occurrence. Holotype GSC 34771 (Pl. 1, fig. 17) is from the lower part of the lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 4c (GSC loc. C-25750), of Early Albian age. Paratype GSC 34772 (Pl. 1, fig. 18) is from the basal siltstone member, Martin House Formation, field station MJ 115-62, sample 1b (GSC loc. C-25766), of Aptian age. The occurrence of the species, shown in Table 1, col. 116, is from the basal siltstone member to the lower silty shale member and represents a range in age from Aptian to Early Albian. Only a few specimens are recovered from each 100 g of sample.

Description. Test discoidal, consisting of a proloculus and an elongate tubular second chamber of 4.5 planispiral coils, undivided, irregularly wrinkled with a slight variable plane of coiling, possibly the result of preservation; wall finely agglutinated with considerable silica cement, thin, translucent and insoluble in acid, surface crenulated, some areas with scintillating lustre from very fine quartz grains, other areas smoothly finished with variable intensities of iron mineral colouring; aperture at the open end of the tube.

The maximum diameter of the holotype is 0.43 mm and the minimum is 0.31 mm. The paratypes range in diameter from 0.25 to 0.45 mm, with an average mature tube diameter of 0.03 mm.

Discussion. *Ammodiscus* sp. Stelck and Wall, from the Lower Albian Clearwater Formation in Alberta, is considered to be conspecific with the present species but shows a slight difference in wall thickness. It also is more siliceous and larger in all dimensions than *A. kiowensis* Loeblich and Tappan, 1950, from the Middle Albian in the Gulf Coast area. The very thin wall of *A. crenulatus* n. sp. resulted in crenulation, or wrinkling, during preservation.

Ammodiscus mangusi (Tappan)
Plate 1, figures 19 (*a* and *b*), 20 (*a* and *b*)

Involutina mangusi Tappan, 1957, p. 203, Pl. 65, figs. 13, 14.
Ammodiscus mangusi (Tappan), Tappan, 1962, p. 131, Pl. 30, figs. 3, 4.

Material and occurrence. Hypotype GSC 34773 (Pl. 1, fig. 19) is from the lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 4c (GSC loc. C-25750), of Early Albian age. Hypotype GSC 34774 (Pl. 1, fig. 20) is from sample 4a (GSC loc. C-25752) of the same field station. The range of the species, shown in Table 1, col. 111, is restricted to the Lower Albian, and only a few specimens were obtained from each 100 g of sample. The species is included as a microfossil zone name, in combination with *A. crenulatus* n. sp., in order to retain the regional significance of correlation into the Alaska geological province. The type species in Alaska, reported by Tappan (1962), occurs in the Topagoruk and Grandstand formations, and the age range is from Early? to Late Albian.

Discussion. The maximum diameter of the hypotypes is 0.45–0.53 mm and the minimum is 0.30–0.38 mm. The average diameter of the mature tube is 0.043 mm, and the approximate wall thickness is 0.016 mm. The wall thickness approximates the diameter of a single, fine, quartz grain. Such quartz grains are the source of the agglutinates for the test wall.

Family Reophacidae Cushman, 1910
Genus *Reophax* Montfort, 1808
Reophax vasiformis n. sp.
Plate 1, figures 12–14

Material and occurrence. Holotype GSC 34894 (Pl. 1, fig. 12) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2e (GSC loc. C-25731), of Late Albian age. Paratypes GSC 34895 and 34896 (Pl. 1, figs. 13, 14) are from the same sample. The range of the species, shown in Table 1, col. 5, is from the Middle Albian lower silty shale member to the Upper Albian upper silty shale member. It occurs in quantities of two to five specimens per 100 g of sample.

Description. Test elongate, chambers very constricted to a slender tubular neck; complete test probably consists of two or three chambers uniserially arranged; wall coarsely agglutinated, the grains being in greater quantity than the cement; chambers flask-shaped, much longer than wide, slight constrictions, probably from crushing and distortion in preservation; aperture terminal, rounded, at the terminal end of the constricted chamber.

The length of the holotype is 0.68 mm and the maximum width is 0.30 mm. The paratypes are 0.65–0.90 mm long and 0.30–0.37 mm wide; the average test wall thickness is 0.04 mm.

Discussion. Paratype (Pl. 1, fig. 13) possibly represents the proloculus and second chamber, with the extreme terminal constriction simulating a "neck." This feature is present in later chambers, as shown in the remaining illustrations. If the tubelike neck portion is not present, it is difficult to distinguish between these and unilocular forms of *Reophax (Proteonina). Hippocrepina (Hyperamminoides) barksdalei* (Tappan) is also a unilocular form, but it is very siliceous and exhibits a flattened, wider terminal end with a faint collar development around the aperture.

Reophax cf. *R. incompta* Loeblich and Tappan
Plate 2, figures 1–3

Reophax incompta Loeblich and Tappan, 1946, p. 242, Textfig. 1.

Material and occurrence. Hypotypes GSC 34775 to 34777 (Pl. 2, figs. 1–3) are from the base of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The range of occurrence of the species, shown in Table 1, col. 27, is from the basal siltstone member, Martin House Formation, to the upper silty shale member, Arctic Red Formation. Thus, the age is from Aptian to Middle Albian. It is one of the most abundant species of Foraminifera recovered from the total field sections in the area under investigation. The maximum recovery of specimens averages greater than 20 per 100 g of sample from the upper silty shale member. The type species in Oklahoma is from the Weno Formation, Washita Group.

Discussion. Only partial tests were recovered, the lengths of which vary from 0.35 mm for proloculus and five chambers to 1.57 mm for nine chambers; the average width of adult chambers is 0.40 mm. Some specimens show a slight offset of the linear chamber arrangement. The type specimens of *R. incompta* have a few more chambers than the present species, but no complete specimens were recovered. *Reophax clavulina* (Reuss) Cushman and Deaderick, 1944, from the Albian of the Gulf Coast, is larger in all dimensions.

Reophax fuscus n. sp.
Plate 2, figures 4(*a* and *b*)–7

Material and occurrence. Holotype GSC 34778 (Pl. 2, fig. 4) is from the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1c (GSC loc. C-25744), of Middle Albian age. Paratype GSC 34779 (Pl. 2, fig. 5) is from the upper silty shale member, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. Paratypes GSC 34780 and 34781 (Pl. 2, figs. 6, 7) are from the glauconite member, Martin House Formation, field station MJ 115-62, sample 3b (GSC loc. C-25763), of Albian/Aptian age in the transitional interval. The range of the species, shown in Table 1, col. 105, is throughout the Aptian, Lower Albian, and up to the middle part of the Middle Albian. It is represented in the upper part of this range by 10 specimens per 100 g of sample.

Description. Test short, broad, consisting of a linear series of three to five slightly inflated chambers gradually increasing in size as added, but maintaining slightly greater breadth than height; sutures somewhat indistinct, horizontal and depressed; the indistinct nature of the sutures results from coarse quartz grains in the agglutinated test wall structure; some specimens exhibit more silica cement than others, and all are medium brown; aperture terminal, rounded.

Length of the holotype is 0.36 mm and maximum breadth is 0.15 mm. Paratypes are 0.31–0.38 mm long; the average mature chamber height is 0.07 mm and the breadth is a constant 0.15 mm.

Discussion. This species has been reported previously in service reports by the author as *Reophax* sp. 5 (28G) and is compared with *R. polyeides* Deeke. The latter species is finely agglutinated and has more pronounced, inflated chambers.

Family Lituolidae Lamark, 1809
Genus *Haplophragmoides* Cushman, 1910
Haplophragmoides topagorukensis Tappan
Plate 3, figures 1, 2 (*a* and *b*), 3

Haplophragmoides topagorukensis Tappan, 1957, p. 203, Pl. 65, figs. 15, 16, 18, 24; 1962, p. 135, Pl. 31, figs. 4, 5, 7, 12, 13 (not remaining figures).

Material and occurrence. Hypotype GSC 34785 (Pl. 3, fig. 1) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25731). Hypotypes GSC 34786 and 34787 (Pl. 3, figs. 2, 3) are from the siltstone member, of the same formation and field station, sample 1c (GSC loc. C-25740). All of Middle Albian age. The species occurs, as shown in Table 1, col. 11, in the lower silty shale, siltstone, and upper silty shale members and, thus, is restricted to Middle Albian age. The species is common, reaching a quantity of 10 specimens per 100 g in some samples. The occurrences reported by Tappan (1962) in Alaska are in the Topagoruk and Grandstand formations, which are of Middle and Late Albian ages.

Discussion. The hypotypes are within the average size of the species from Alaska. The maximum diameter is 0.30–0.50 mm and the minimum is 0.30–0.43 mm; test thickness is 0.20 mm. Tappan (1962, p. 135, Pl. 31, figs. 1–15) considered the very broad parameters selected for the species to be necessary because of the numerous variations in preserved forms due to distortion and compaction. This premise could be applied to all microfossil taxa in the Arctic. *Haplophragmoides,* however, is one of the more resistant forms because of its lenticular shape and comparatively strong, internal septa. The application of the taxon *H. topagorukensis* Tappan into the Canadian Arctic has resulted in delineation of three separate morphological species. The three species imply three biochronological intervals in the stratigraphic sequence of the Albian Stage.

Note. Textfigure 3 illustrates the regrouping of Tappan's original species of *H. topagorukensis.* The proposed new assignments demonstrate that *H. topagorukensis* s.s. is characteristic of the Late Albian age, although some specimens are present in the Middle Albian. *Haplophragmoides yukonensis* n. sp. is

Haplophragmoides topagorukensis
Tappan, 1957 (Morphospecies)

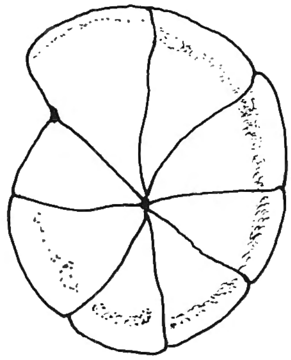


Figure 5. Holotype, x70

Biospecies *H. topagorukensis s. stricto*

Figures	Formations	Albian subdivisions
4	Grandstand	Upper
5	Topagoruk	Middle
7	Topagoruk	Middle
9	Topagoruk	Middle
12	Grandstand	Upper
13	Grandstand	Upper

Range in age: Upper to Middle Albian

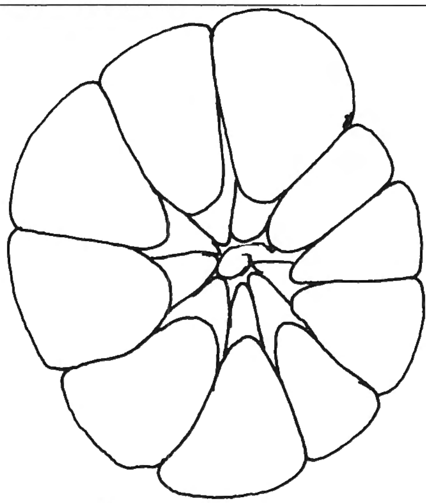


Figure 6. Paratype, x70

Biospecies *H. yukonensis* n. sp.

Figures	Formations	Albian subdivisions
6	Topagoruk	Middle
8	Topagoruk	Middle
14	Torok	Lower

Range in age: Middle to Lower Albian

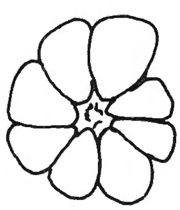


Figure 11. Paratype, x70

Biospecies *H. peelensis* n. sp.

Figures	Formations	Albian subdivisions
1	Topagoruk	Middle
2	Topagoruk	Middle
3	Topagoruk	Middle
10	Torok	Lower
11	Fortress Mountain	Lower to ?Aptian
15	Grandstand	Upper?

Range in age: Upper?, Middle and Lower Albian

GSC

Textfigure 3. Diagnosis of *Haplophragmoides topagorukensis* Tappan, 1957 (ref. 1962, U.S. Geological Survey Prof. Paper 236-C, Pl. 31, figs. 1–15, p. 135).

found in the Lower and Middle Albian, and *H. peelensis* n. sp. appears to be more ecologically controlled, as a very small, simple form representative of unfavourable marine conditions from Aptian?, Lower, Middle, and Upper? Albian.

Haplophragmoides yukonensis n. sp.
Plate 2, figures 8 (*a–c*), 9 (*a* and *b*)

Haplophragmoides topagorukensis Tappan, 1957, p. 203, Pl. 65, figs. 17, 23; 1962, p. 135, Pl. 31, figs. 6, 8, 14 (not the remaining figures).

Material and occurrence. Holotype GSC 34882 (Pl. 2, fig. 8) is from the siltstone member, Arctic Red Formation, of field station MJ 118-62, sample 1d (GSC loc. C-25737), of Middle Albian age. Paratype GSC 34883 (Pl. 2, fig. 9) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The new species occurs, as shown in Table 1, col. 17, in the glauconite and the upper silty shale members, representing Early and Middle Albian ages. It is one of the most abundant species, more than 10 specimens per 100 g of sample having been recovered.

Description. Test planispiral, evolute in part, biumbilicate, periphery subrounded, 14 chambers in the final whorl, 6 to 7 chambers of the inner whorl visible in the umbilical area; wall finely agglutinated, cement and grains in equal amounts, distortion of the test in preservation is common; chambers increasing gradually in size as added and commonly collapsed, resulting in raised borders of periphery and sutures; sutures straight, radial, thickened, simulating internal labyrinthic structure; collapsed chambers result in a preservation form of limbate sutures, greater thickening at junction with the umbilical area, forming low raised nodes as a subdued umbilical ring; surface slightly roughened, faint pale brown, translucent peripheral edge; aperture on arch at the base of the final chamber face on the periphery.

The maximum diameter of the holotype is 0.85 mm, the minimum is 0.72 mm, and the thickness of the test is 0.25 mm, with an average agglutinate grain size of 0.008 mm.

Discussion. The size and the raised umbilical margins are similar to *H. gigas* Cushman from the Middle Albian Joli Fou Formation in the Canadian Western Interior, but this species lacks the distinctive sigmoid suture. The evolute form of *H. topagorukensis* Tappan (1962, Pl. 31, fig. 6) has fewer chambers in the final whorl (*see* Textfig. 3), but the size, radial sutures, and somewhat collapsed chambers are similar. The very evolute form of *H. multiplum* Stelck *et al.*, 1956, is very much smaller than *H. yukonensis* n. sp., but it has the same number of chambers and similar expression of the raised inner margin.

Haplophragmoides ex gr. *H. yukonensis* n. sp.
Plate 2, figure 10 (*a* and *b*)

Material and occurrence. The figured specimen GSC 34784 (Pl. 2, fig. 10) is from the lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 4c (GSC loc. C-25750), of Early Albian age. The species is found, as shown in Table 1, col. 117, in the basal siltstone, glauconite, and lower silty shale members and has a range in age from Aptian to Early Albian. Quantity is 6–20 specimens per 100 g of sample. The uppermost stratigraphic range overlaps the lowermost range of the type *H. yukonensis* n. sp.

Discussion. The maximum diameter of the figured specimen is 0.66 mm, the minimum is 0.58 mm, and the test thickness is approximately 0.16 mm. There are 14 chambers in the final whorl, similar to *H. yukonensis* n. sp., but it is smaller and slightly more evolute, and it shows a distinctive scalloped periphery in the last five chambers. This may be the result of extreme collapse of the chambers, leaving the thick sutures protruding along the periphery.

Haplophragmoides peelensis n. sp.
Plate 3, figures 4, 5

Haplophragmoides topagorukensis Tappan, 1957, p. 203, Pl. 65, figs. 19, 21, 22, 25; 1962, p. 135, Pl. 31, figs. 1–3, 10, 11, 15 (not the remaining figures).

Material and occurrence. Holotype GSC 34788 and paratype 34789 (Pl. 3, figs. 4 and 5) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The new species, as shown in Table 1, col. 18, occurs in the glauconite, lower silty shale, siltstone, and basal upper silty shale members. This represents an age range of from Early to Middle Albian, similar to the occurrences of *H. topagorukensis* Tappan, 1957, in Alaska (*see* Textfig. 3).

Description. Test planispiral, rounded periphery, involute, biumbilicate, open umbilical area, some specimens with foreign material covering the opening, eight chambers in the final whorl; wall agglutinated, with grains in greater proportion than cement; slightly roughened surface, with scattered coarser material adhering to the wall; chambers inflated, increasing gradually in size as added; sutures radial, depressed, thickened; aperture on arch at the base of the final chamber face on the periphery.

The maximum and minimum diameters of the holotype are 0.46 and 0.375 mm, respectively. The maximum diameters of the paratypes range from 0.45 to 0.58 mm and the minimum from 0.35 to 0.50 mm, and the approximate test thickness is 0.17 mm.

Discussion. Paratypes of *H. topagorukensis* Tappan (1962, Pl. 31, figs. 1–3, 10, 11, 15) are referred to present species, but not the holotype (Tappan, 1962, Pl. 31, fig. 5) and the similar paratypes of figures 4, 7, 9, 12, and 13. The remainder of the figured specimens of *H. topagorukensis* are referred to *H. yukonensis* n. sp. of this report (*see* Textfig. 3). *Haplophragmoides peelensis* n. sp. differs from the designated specimens of *H. topagorukensis* Tappan (Textfig. 3) by exhibiting an evolute chamber arrangement with globular chambers, resulting in a lobate periphery.

Haplophragmoides linki Nauss
Plate 3, figures 6 (*a* and *b*), 7

Haplophragmoides linki Nauss, 1947, p. 339, Pl. 49, fig. 7; Stelck, 1973, Pl. 2, figs. 14, 15.

Material and occurrence. Hypotype GSC 34790 (Pl. 3, fig. 6) is from the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1c (GSC loc. C-25744), of

Middle Albian age. Hypotype GSC 34791 (Pl. 3, fig. 7) is from the same formation and field station, sample 1b (GSC loc. C-25745), of Middle Albian age. The species occurs, as shown in Table 1, col. 10, in the lower silty shale, siltstone, and upper silty shale members of Middle Albian age. An additional, very small form, similar in part to the present species and referred to *H. neocomianus* (Chapman), extends the range of minute forms into the Lower Albian glauconite member of the Martin House Formation. The type species of *H. linki* was described by Nauss (1947) in Alberta from the lower Lloydminster Shale (Joli Fou Formation equivalent) of Middle Albian age.

Discussion. The average diameter of the hypotypes is 0.20 mm, and there are approximately seven chambers in the final whorl. Very small forms of *Haplophragmoides* in the overlying Upper Cretaceous are referred to *H. crickmayi*; in the underlying Neocomian, similar small forms are referred to *H. neocomianus* (Chapman), 1891. These minute, agglutinated species are difficult to diagnose because of their poor preservation and simple form. The present species is common, averaging 10 specimens per 100 g of sample, and it is recovered from most sequences of restricted-marine sediments in the Western Interior and in Arctic Canada.

Haplophragmoides cf. *H. spissum* Stelck *et al.*
Plate 3, figure 8 (*a* and *b*)

Haplophragmoides spissum Stelck *et al.*, 1956, p. 39, Pl. 4, figs. 27, 28.

Material and occurrence. Hypotype GSC 34792 (Pl. 3, fig. 8) is from the lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 5 (GSC loc. C-25747), of Middle Albian age. The species occurs, as shown in Table 1, col. 84, in the lower silty shale and the siltstone members, both of Middle Albian age. One hundred grams of sample contain from three to five specimens. The type species was described by Stelck *et al.* (1956, p. 39) as being "from the Fort St. John shales, 195 feet above the Gates sandstone," of Middle? Albian age, in British Columbia.

Discussion. The 15 chambers in the final whorl and the additional 9 chambers in the inner whorl are all packed within a minimum diameter of 0.38 mm, which makes this a very distinctive species. It is smaller than the types in British Columbia and slightly more evolute.

Genus *Ammobaculites* Cushman, 1910
Ammobaculites fragmentarius Cushman
Plate 3, figures 9 (*a* and *b*), 10

Ammobaculites fragmentaria Cushman, 1927, p. 130, Pl. 1, fig. 8; Nauss, 1947, p. 331 (range chart).
Ammobaculites fragmentarius Cushman, Tappan, 1962, p. 136, Pl. 32, figs. 8–11.

Material and occurrence. Hypotype GSC 34792 (Pl. 3, fig. 9) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. Hypotype GSC 34793 (Pl. 3, fig. 10) is from the siltstone member, field station MJ 118-62, sample 1b (GSC loc. C-25736), of Middle Albian age. The species is restricted to the Middle Albian (*see* Table 1, col. 14). Its occurrence in the sample increases upward in the section to a quantity greater than 20 specimens per 100 g of sample in the uppermost sample (2d). In Alaska, the species occurs in the Torok, Topagoruk, Grandstand, and Kukpowruk formations (Tappan, 1962), representing the total Albian Stage. These occurrences, however, were based on much wider taxonomic parameters as amended by Tappan (1962). With the exception of *A. wenonahae* Tappan, 1960, most of the *Ammobaculites* taxa of somewhat similar form were included in *A. fragmentarius.* This approach tends to defeat the purpose of applied biostratigraphy. The dimensions, test and chamber shapes, and agglutinate size are all valid taxonomic parameters. When useful for differentiating strata (Arkell, 1956) and establishing more refined subdivisions of a stage, the other species (Tappan, 1962, synonymy list) are considered to be of significance.

Discussion. The average length of the test for the figured specimens is 1.00 mm, and the diameter of the three- to four-chambered coil is 0.25 mm. *Ammobaculites fragmentarius* occupies the same stratigraphic horizons in the Canadian Western Interior as *A. wenonahae* does in Alaska, which includes the Upper Albian (Grandstand Formation). In the Yukon Territory of the Canadian Arctic, *A. fragmentarius* appears to be restricted to the Middle Albian. *Ammobaculites wenonahae* is a much larger and coarser species, which, according to Tappan (1962), is a geographically restricted form.

Ammobaculites cf. *A. reophacoides* Bartenstein
Plate 3, figures 11, 12

Ammobaculites D4 Hecht, 1938, p. 19, Pl. 8, figs. 1–5.
Ammobaculites reophacoides Bartenstein, 1952, p. 297.

Material and occurrence. Hypotype GSC 34795 (Pl. 3, fig. 11) is from the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1c (GSC loc. C-25744), of Middle Albian age. Hypotype GSC 34794 (Pl. 3, fig. 12) is from the same field station, sample 1b (GSC loc. C-25745), of Middle Albian age. The range of the species, as shown in Table 1, col. 103, is from the glauconite to the lower silty shale member, representing Early to Middle Albian age. The species is represented consistently in the samples by two or three specimens per 100 grams.

Discussion. In the figured specimens, the diameter of the early stage of coiling appears to be constant at 0.16 mm. The length of the total test ranges from 0.42 to 0.57 mm, and the width of the uniserial portion is approximately 0.95 mm. The species most similar to this one is *Ammobaculites tyrrelli* Nauss var. *jolifouensis* Stelck *et al.*, 1956, from the upper Middle and Upper Albian of Alberta, although the latter has a greater number of uniserial chambers and so is longer and larger overall. *Ammobaculites reophacoides* is present in abundance in the underlying beds of Neocomian age (Chamney, 1969b) and is possibly the ancestral stock for both the Albian species referred to above. The reason for detailed species diagnosis within the *Ammobaculites* is to provide additional meaningful indices for subdividing the Albian within the less favourable marine environments of the paralic zone of epicontinental basins. Additional data from more specimens of the present species might permit diagnosis of a new species. That species would then provide an index for the Lower Albian with an overlapping range of *A. fragmentarius* for the Middle Albian. A similar overlap of *A. fragmentarius* would occur with *A.*

tyrrelli Nauss var. *jolifouensis* and *A. wenonahae* for the Upper Albian.

Family Textulariidae Ehrenberg, 1839
Genus *Textularia* Defrance, 1824
Textularia ex gr. *T. topagorukensis* Tappan
Plate 3, figures 13 (*a* and *b*), 14

Textularia topagorukensis Tappan, 1957, Pl. 66, figs. 8, 9; 1962, p. 141, Pl. 33, figs. 7–11; Stelck, 1973, Pl. 3, figs. 22, 23.
Spiroplectammina koveri Tappan, 1957, p. 205, Pl. 66, figs. 1, 2.

Material and occurrence. Hypotypes GSC 34796 and 34797 (Pl. 3, figs. 13, 14) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species is restricted to the siltstone and upper silty shale members of Middle Albian age (*see* Table 1, col. 30). This stratigraphic interval yielded only a few specimens, except for the top of the siltstone member, where they are more common, three to five specimens having been recovered per 100 g of sample. The type species in Alaska, as reported by Tappan (1962), occurs in the Torok and Topagoruk formations of Early? to Middle Albian age; specimens were recovered rarely from the Upper Albian of the Grandstand Formation. Stelck (1973) reports the species from the Upper Albian in the *Miliammina manitobensis* Zone of northeastern British Columbia.

Discussion. The length of the test for the figured specimens is 0.37–0.44 mm and the maximum width is 0.18–0.25 mm. The sutures are slightly angled downward toward the outer periphery, somewhat similar to those of *T. rollaensis* Stelck and Wall from beds of Cenomanian age in Alberta. The remainder of the features and dimensions are comparable with *T. topagorukensis*. *Textularia topagorukensis,* as described by Stelck (1973) in British Columbia, is slightly irregular in the late stage of the biserial chamber arrangement, similar to the present species. This feature is taken to the extreme in the *Pseudobolivina (Bimonilina)* taxa (Textfig. 4).

Genus *Pseudobolivina* Wiesner, 1931
Pseudobolivina sp.
Plate 3, figures 15 (*a* and *b*), 16

Material and occurrence. Hypotypes GSC 34798 and 34799 (Pl. 3, figs. 15, 16) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species is restricted to the uppermost siltstone member and the lowermost part of the upper silty shale member of Middle Albian age (Table 1, col. 75).

Discussion. The length of the figured specimens is 0.33–0.40 mm and the maximum width is 0.14–0.20 mm. These dimensions place the present species in the smaller size range of the Alaskan Texturlariidae. There is some evidence for a possible morphological series between forms of *Textularia,* which show some irregularity in the late biserial chamber arrangement, and the extreme forms of *Pseudobolivina. Siphotextularia andersoni* McGill and Loranger, 1961, in the Lower Albian of the Anderson Plain, District of Mackenzie, is possibly an intermediate form between the irregular chamber arrangement of the late stage of some *Textularia* and the extreme overlap of the terminal chambers in *Pseudobolivina.*

Family Ataxophragmiidae Schwager, 1877
Genus *Verneuilinoides* Loeblich and Tappan, 1949
Verneuilinoides tailleuri Tappan
Plate 3, figures 17, 18

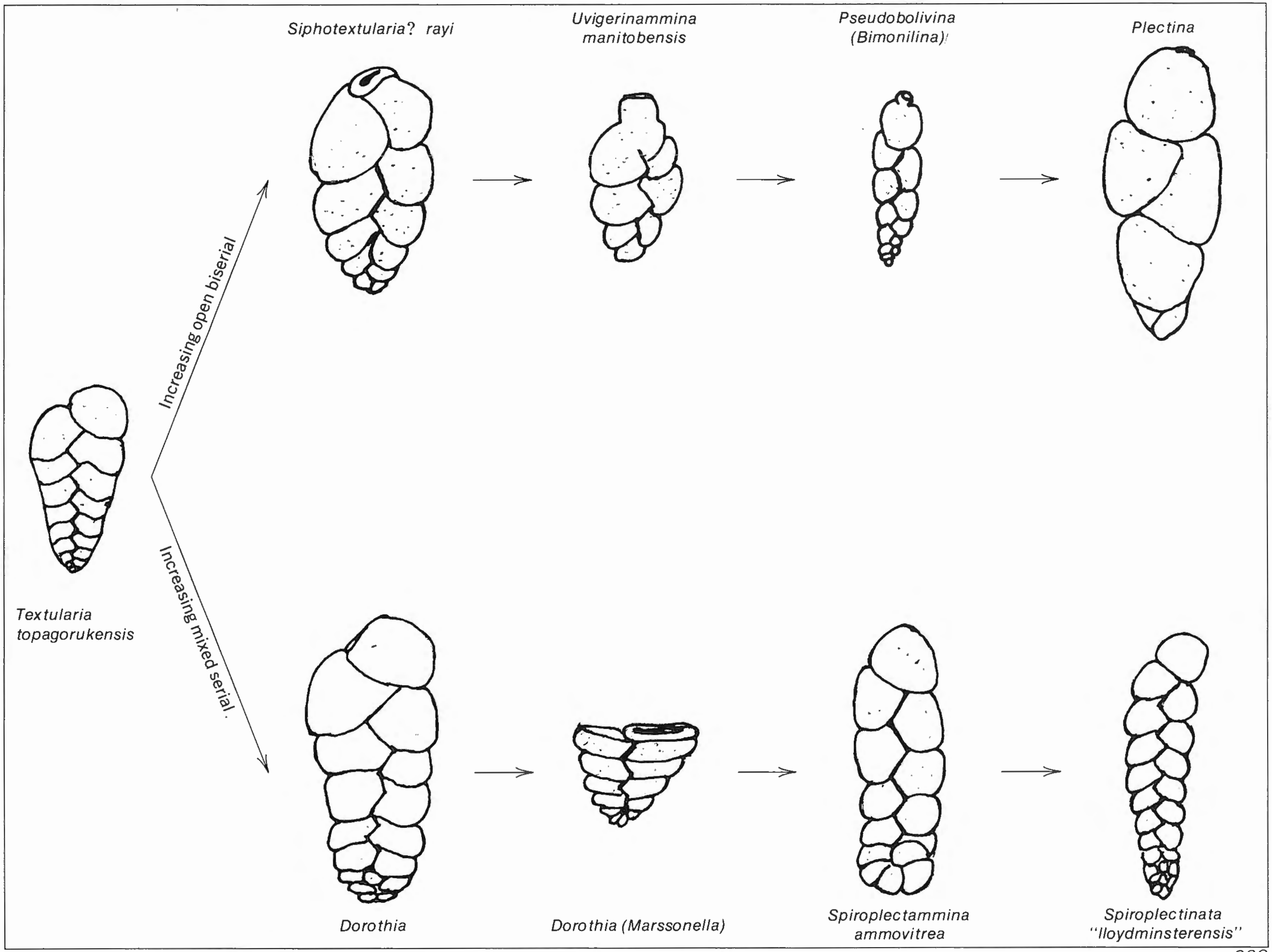
Verneuilinoides tailleuri Tappan, 1957, p. 208, Pl. 66, figs. 19–22; Stelck, 1973, Pl. 3, figs. 29–34.
Dorothia chandlerensis Tappan, 1957, p. 209, Pl. 66, figs. 29, 30.
Gaudryina tailleuri (Tappan), Tappan, 1962, p. 149, Pl. 35, figs. 8–16.

Material and occurrence. Hypotype GSC 34800 (Pl. 3, fig. 17) is from the uppermost part of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2e (GSC loc. C-25731), of Late Albian age. Hypotype GSC 34801 (Pl. 3, fig. 18) is from the siltstone member, field station MJ 118-62, sample la (GSC loc. C-25740), of Middle Albian age. The species occurs, as shown in Table 1, col. 4, in the lower silty shale, siltstone, and upper silty shale members, which are of Middle and Late Albian ages. The abundance of the species increases upward in the stratigraphic sequence from a few individuals per sample to five or six per 100 g at the top in the Upper Albian beds. The type species in Alaska, as reported by Tappan (1962), is restricted to the Fortress Mountain and Torok formations of ?Aptian and older Albian age. A critical review (Chamney, 1972) of *V. borealis* Tappan, 1957, might show that some of the small, narrow forms included in this taxon compare favourably with the more inflated chamber forms of the present species. The range of *V. tailleuri* thus would be extended into the Upper Albian, as it is in the Yukon and in northeastern British Columbia (Stelck, 1973). *Dorothia chandlerensis* is placed in synonymy with *V. tailleuri* by Tappan (1962).

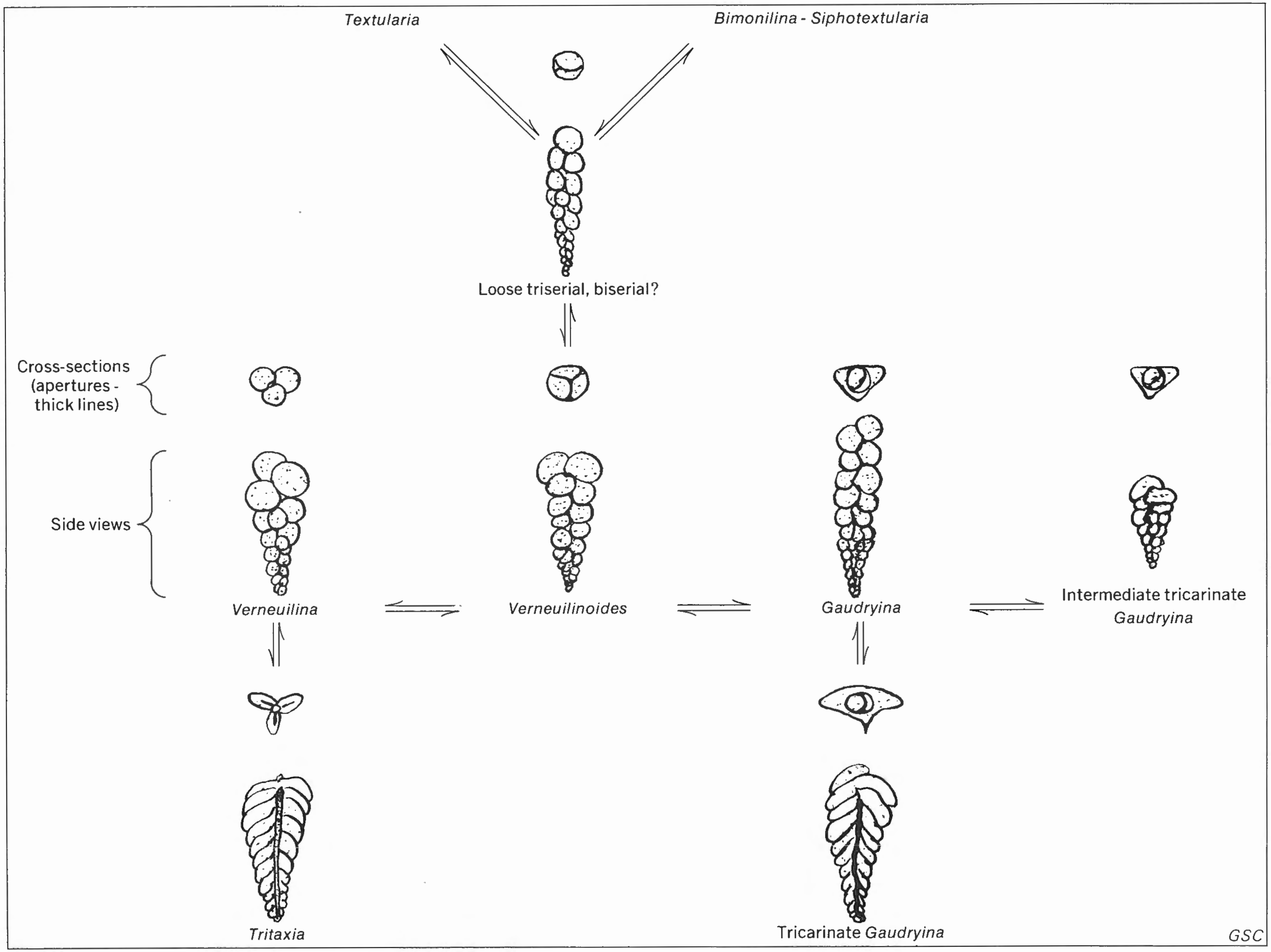
Discussion. The hypotypes are 0.50–0.70 mm long, and the test is a constant maximum 0.16 mm wide. This places the present species within the middle range in the size of the type species. The genus *Verneuilinoides* was established for the purpose of distinguishing the rounded test from the triangular test of *Verneuilina,* but the new genus made it more difficult to recognize *Verneuilina* as distinct from *Gaudryina* and *Dorothia.* The state of preservation encountered in the coarser clastic sediments of the Cretaceous, in the Canadian Western Interior and Arctic geological provinces, has compounded the difficulties. Textfigure 5 is designed to portray diagrammatically the problems in taxonomy for taxa exhibiting a transitional or morphological series. The general guide for diagnosis should be the obvious change in the test shape from the quadriserial and triserial early stage to a later biserial stage for *Gaudryina.* When there is difficulty in detecting this change in the test shape, resulting from the change in chamber arrangement even for loosely arranged chambers in the later stage, the assignment to *Verneuilinoides* should be retained. It might be preferable not to dilute the better established taxa of *Verneuilina* and *Gaudryina* by including transitional forms of an intermediate taxa.

Genus *Tritaxia* Reuss, 1860
Tritaxia solea n. sp.
Plate 3, figures 19(*a*–*c*)–21

Material and occurrence. Holoype GSC 34802 (Pl. 3, fig. 19) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of



Textfigure 4. Diagnosis of *Textularia* and related biserial forms.



Textfigure 5. Diagnosis of *Verneuilinoides* as a transitional form.

Middle Albian age. Paratypes GSC 34803 and 34804 (Pl. 3, figs. 20, 21) are from the upper silty shale member, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species, shown in Table 1, col. 64, is from the lower silty shale, siltstone, and upper silty shale members, of Middle Albian age. No *Tritaxia* have been reported from the Cretaceous in Alaska. Several related forms have been reported from the Albian Clearwater Formation in Alberta and northeastern British Columbia (Stelck *et al.,* 1956), and they are known also to be present in the Albian of the eastern Arctic Plain in the Anderson River area.

Description. Test triserial and triangular, early stage restricted narrow, later stage flaring, wide tricarinate, periphery with subacute angles, test with somewhat excavated sides; wall finely agglutinated, original test wall smoothly finished; five to seven triserial sets of chambers in the wide later stage, chambers broad, moderately high, and slightly compressed; sutures fairly distinct, depressed, and curved downward toward the periphery; aperture terminal and approximately centred.

Length of the holotype is 0.66 mm and the maximum width of the test is 0.44 mm. The paratypes range from 0.60 to 0.75 mm long, and the maximum width is 0.35–0.44 mm.

Discussion. Specimens of the present species must be examined wet with incident lighting in order to see the initial and final chamber arrangements. *Gaudryina subcretacea* Cushman is a much larger form and is triangular and tricarinate, but it exhibits a minute, quadriserial initial stage and two or three chambers arranged biserially in the final stage (*see* Textfig. 5). *Tritaxia pyramida* Reuss var. *diminuta* Stelck *et al.,* 1956, and *T. athabascensis* Mellon and Wall, 1956, from the Albian in the Canadian Western Interior, are not the tricarinate forms and are much smaller in all dimensions.

Genus *Gaudryina* d'Orbigny, 1839
Gaudryina subcretacea Cushman
Plate 4, figure 1 (*a* and *b*)

Gaudryina subcretacea Cushman, 1936, p. 5, Pl. 1, fig. 11; Tappan, 1943, p. 490, Pl. 78, figs. 28, 29; Frizzell, 1954, p. 71, Pl. 5, fig. 22; Tappan, 1962, p. 149, Pl. 36, figs. 5, 6.

Material and occurrence. Hypotype GSC 34805 (Pl. 4, fig. 1) is from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample lc (GSC loc. C-25738), of Middle Albian age. The species occurs in the lower silty shale, the siltstone, and the upper silty shale members of Middle Albian age (Table 1, col. 26). The type species was described originally from the Washita Group (Duck Creek Formation) of Middle Albian age in the Gulf Coast area. The hypotypes reported by Tappan (1962) were from the Torok and Topagoruk formations, which are Early to Middle Albian in age. This implies a slightly greater range than that of the present species.

Discussion. The length of the present species is 1.30 mm and the maximum width is 0.54 mm. This is a rather large size compared with those in Alaska. The illustrations do not show clearly the aperture as a low arch at the base of the terminal chamber face. Only by examination when the specimens are wet, with incident lighting, can this feature be demonstrated. The location of the aperture is one of the primary criteria for diagnosis from similar triangular, tricarinate forms of the *Tritaxia.*

Gaudryina barrowensis Tappan
Plate 4, figure 2 (*a* and *b*)

Gaudryina barrowensis Tappan, 1960, p. 292, Pl. 1, figs. 7–9; 1962, p. 145, Pl. 34, figs. 16–18.
Verneuilina sp. A Wickenden, 1951, p. 35, Pl. 1A, fig. 8.

Material and occurrence. Hypotype GSC 34806 (Pl. 4, fig. 2) is from the glauconite member, Martin House Formation, field station MJ 115-62, sample 5 (GSC loc. C-25759), of Early Albian age. The species is restricted to the lower part of the glauconite member and represents the transitional Albian/Aptian and the Early Albian ages (Table 1, col. 137). The types reported by Tappan (1962) in Alaska are confined to the Torok Formation of ?Aptian and Early Albian age. *Verneuilina* sp. A Wickenden is considered to be conspecific and was reported from the upper part of the Loon River Formation of Early Albian age.

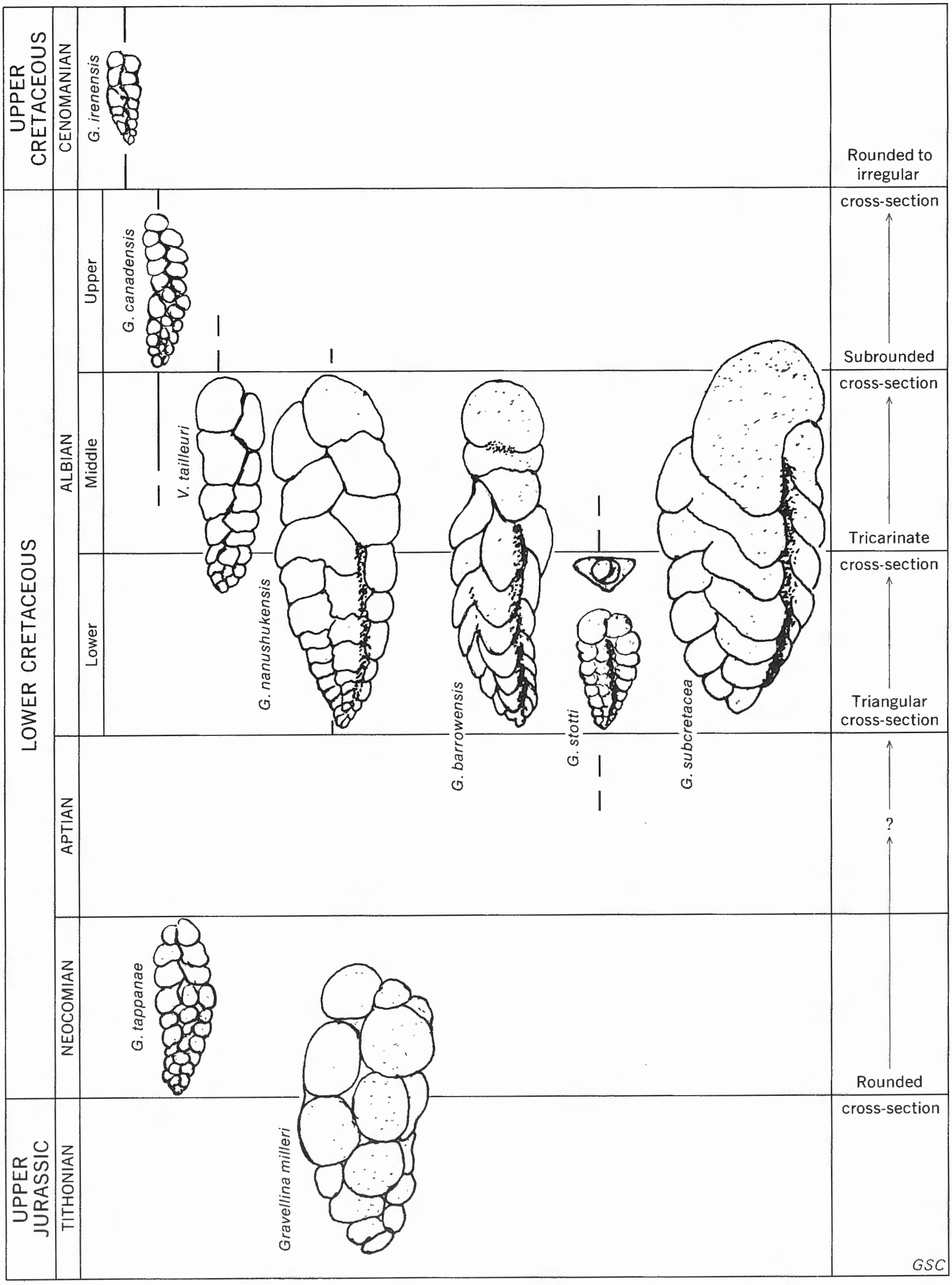
Discussion. The hypotype is 0.84 mm long and, at maximum, 0.29 mm wide. The early quadriserial to triserial stage is moderately flared from a rounded end, and the sides of the test become subparallel in the later biserial stage. The distinctive test features are the rather sharp angles and the triangular section, with the aperture as a low arch at the base of the terminal chamber. The elongate, triangular, subparallel-sided form distinguishes it from the elongate subdued triangular form of *G. nanushukensis* with its obvious biserial late stage. *Gaudryina barrowensis* is one of the oldest forms having a triangular section to make its appearance in the stratigraphic sequence (Textfig. 6). It is thus an important biostratigraphic marker for differentiating strata of Neocomian and Albian ages.

Gaudryina nanushukensis Tappan
Plate 4, figures 3(*a*–*c*)–5

Gaudryina sp. B Wickenden, 1951, p. 44, Pl. 1B, fig. 7.
Gaudryina nanushukensis Tappan, 1951a, Pl. 1, figs. 8–11; 1951b, Sheet 3, fig. 21 (12a–b); 1962, p. 148, Pl. 34, figs. 11–15.

Material and occurrence. Hypotypes GSC 34807 and 34897 (Pl. 4, figs. 3, 4) are from field station MJ 118-62, sample 2b (GSC loc. C-25734), in the upper silty shale member. Hypotype GSC 34898 (Pl. 4, fig. 5) is from the same field station, sample 1d (GSC loc. C-25737) of the siltstone member. All samples are from the Arctic Red Formation of Middle Albian age. Tappan (1962) reports the recovery of *G. nanushukensis* in Alaska from the Topagoruk and Grandstand formations, indicating a range in age from Middle to Late Albian. Wickenden (1951) described *Gaudryina* sp. B from the Harmon Shale Member of the Peace River Formation in northeastern British Columbia and northwestern Alberta. The Peace River Formation is stratigraphically below the gastroplitid ammonites of Late Albian age and above the *Lemuroceras* spp. zones of Early Albian age. *Gaudryina nanushukensis* occurs in the Aptian to Upper Albian strata (*see* Table 1, col. 6). The acme of occurrence is in the middle part of the Middle Albian, where each 100 g of sample contained more than 20 specimens.

Discussion. The figured hypotypes are 0.50–0.94 mm long and 0.14–0.25 mm wide; the average diameter of the agglutinated



Textfigure 6. *Gaudryina* and related forms: test shapes and suggested biochronological significance.

quartz grains is 0.014 mm. These specimens compare favourably with the figured paratype of Tappan (1962, Pl. 34, fig. 11). The remainder of the figured specimens from Alaska, with the exception of Tappan's figure 14, are larger in all dimensions and exhibit five to six pairs of chambers in the late biserial stage compared with an average of only three pairs of chambers in the Yukon specimens. The progressive reduction of chambers in the late biserial stage in this taxon appears to be coincident with the increase in distance south and east away from the permanent boreal marine source in Alaska. The extreme reduction of the biserial stage is discussed further in the diagnosis of *Gaudryina stotti* n. sp.

There appears to be some relationship between the test shape of the *Gaudryina* taxa and the biochronology. A general morphological series from rounded to tricarinate forms has been observed in Upper Albian to Upper Jurassic strata. This is indicated by the change from the more rounded forms of the *G. tailleuri* (Tappan) to the tricarinate *G. subcretacea* Cushman. *Gaudryina nanushukensis* represents a form in the middle to upper part of the morphological series and more or less the middle to upper part of the time span represented by this series. In Europe, the most extreme tricarinate form of this taxa is *G. dividens* Grabert, which represents Aptian to Early Albian age. The peak of the tricarinate form was developed earlier in Europe than in the boreal realm of Arctic America. There are many similar examples of diachronous microfaunal facies relationships between these two areas.

The black mineral material (?carbon) outlining the sutures and scattered over parts of the test surface on many specimens is not only of interest as to its origin but is significant for recognition of the species. Even deformed and altered specimens retain the black mineral material and are commonly referred to by workers in the Arctic areas as the "black sutured" *Gaudryina.*

Gaudryina stotti n. sp.
Plate 4, figures 6(*a–c*)–8

Material and occurrence. Holotype GSC 34808 (Pl. 4, fig. 6) is from the siltstone member, field station MJ 118-62, sample 1c (GSC loc. C-25738). Paratypes GSC 34809 and 34810 (Pl. 4, figs. 7, 8) are from the upper silty shale member of the same field station, samples 2a and 2b (GSC loc. C-25735 and C-25734). All samples are from the Arctic Red Formation of Middle Albian age. The local teilzone of *G. stotti* n. sp. ranges from the Albian/Aptian transitional interval to the upper part of the Middle Albian (*see* Table 1, col. 65). The species is abundant only in the uppermost range, where more than 20 specimens per 100 g of sample were recovered in beds of Middle Albian age.

Description. Test small, short, consisting primarily of the early triserial stage flaring rapidly from the pointed base in a pyramid shape (only the final two chambers form the late biserial stage); periphery subangular to angular, sides slightly excavated; wall finely arenaceous with considerable cement, surface rather smoothly finished and having variable, small amounts of black mineral material (?carbon) over the surface and along the sutures; the smaller specimens have greater amounts of silica than quartz grains, thus becoming slightly translucent pyramids; chambers numerous, five to eight whorls of three chambers each and the final one or two chambers representing the late biserial stage; sutures fairly distinct, slightly depressed, straight across the angles; aperture a low slit at the inner base of the ultimate chamber.

Length of the holotype is 0.437 mm and maximum width is 0.250 mm. The paratypes are 0.25–0.44 mm long and 0.14–0.26 mm wide. The average diameter of the agglutinated quartz grains is 0.013 mm.

Discussion. There appears to be a relationship between *G. stotti* n. sp. and *G. nanushukensis* Tappan. In the area under investigation, they are about equally abundant in the assemblages where they were recovered. But to the north and west, in the direction of the more permanent boreal marine source of the Lower Cretaceous, *G. nanushukensis* sensu stricto is the dominant form and *G. stotti* n. sp., of the form similar to the figured paratype of *G. nanushukensis* Tappan (1962, Pl. 34, fig. 14), is rare. To the south and east of the Yukon into northeastern British Columbia, *G. stotti* becomes the dominant form and *nanushukensis* rare to absent. The extremely short, pyramidal, translucent form of *G. stotti* in the latter geological province is not at all similar to *G. nanushukensis.*

The name for the present species was published inadvertently through internal service determinations as *Gaudryina ("stottei")* (Chamney, 1971b); it was intended for internal reporting to hold this potentially new species for future research.

Mention has been made under discussion of *G. nanushukensis* (Textfig. 6) of the usefulness of morphological series of the *Gaudryina* taxa as very general biochronological indicators. Some small specimens of *G. stotti* n. sp. exhibit a form of preservation with excavated sides of the triserial, pyramid stage as an indication of the tricarinate forms of the younger Upper Albian. But the majority of the test angles retain the subrounded edges and flat sides that place the form in the morphological series indicative of Early to Middle Albian age.

Gaudryina canadensis Cushman
Plate 4, figures 9–11

Bigenerina angulata Cushman, 1927, p. 131, Pl. 1, fig. 10.
Gaudryina canadensis Cushman, 1943, p. 28, Pl. 6, figs. 7, 8; 1946, p. 34, Pl. 6, fig. 24; Tappan, 1962, p. 146, Pl. 35, figs. 1–7.
Gaudryina hectori Nauss, 1947, p. 335, Pl. 48, figs. 6a–b.
Gaudryina sp. A Wickenden, 1951, p. 36, Pl. 1A, fig. 9.

Material and occurrence. Hypotype GSC 34811 (Pl. 4, fig. 9) is from the lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 5 (GSC loc. C-25747), of Middle Albian age. Hypotypes GSC 34812 and 34813 (Pl. 4, figs. 10, 11) are from the lower and the upper silty shale members–field stations MJ 117-62, sample lb (GSC loc. C-25745), and MJ 118-62, sample 2b (GSC loc. C-25734), respectively. The ranges of the species are shown in Table 1 as *Gaudryina* cf. *G. canadensis* (col. 68) and as *Gaudryina canadensis* (col. 88). Difficulty in diagnosis of poorly preserved specimens requires this distinction (*see* Textfig. 5). The occurrence of *G. canadensis* in the study-area is restricted to the lower silty shale, siltstone, and upper silty shale members of Middle Albian age. The range of *Gaudryina* cf. *G. canadensis* is much greater and includes all of the rock-unit members, representing ages from Aptian to the latest Middle Albian. It is one of the most common species in this Lower Cretaceous sequence of strata, but it does not occur in great quantity in any one sample. The average recovery per 100 g of sample is six specimens. This species was described originally by Cushman (1927) from the "Lower Cretaceous" in western Canada.

Nauss (1947) described the present species as *Gaudryina hectori* in Alberta from the basal Lloydminster Shale (Joli Fou Formation) of latest Middle Albian age. *Bigenerina angulata* Cushman, 1927, reported by Nauss (1947, distribution chart), is considered to be conspecific with the present species. He reported it from both the Joli Fou Formation equivalent and the Cummings member of the Mannville Group. The latter rock-unit is the "Clearwater Formation" equivalent of Early Albian age. Wickenden (1951) reported the present species as *Gaudryina* sp. A from the Loon River Formation in northern Alberta of Early to Middle Albian age. Tappan (1962) described the species in Alaska from the Topagoruk and Grandstand formations of Middle and Late Albian ages. The species is more abundant in the Grandstand Formation and its lateral equivalents; this extends the species range in Alaska into the Upper Albian.

Discussion. The average length of the test for all hypotypes is 0.55 mm and the width is 0.14 mm. The early triangular stage is followed by approximately six sets of biserially arranged chambers, with a slightly larger, single, terminal chamber bearing the aperture as a low, indistinct arch at the base.

Generic diagnosis can be difficult because the relatively weak test wall is subject to distortion in preservation. Diagenetic addition of silica and other minerals adds to the difficulty. When the specimens are examined dry, with reflected lighting, the external appearance of the straight-sided forms is somewhat similar to *Textularia topagorukensis* (*see* Textfig. 5). When they are examined wet, with incident lighting, the multiserial early stage can usually be resolved. The bent forms indicate the change in chamber arrangement from triserial to biserial stages at the point of flexure.

Family Rzehakinidae Cushman, 1933
Genus *Psamminopelta* Tappan, 1957
Psamminopelta bowsheri Tappan
Plate 4, figures 12 (*a* and *b*), 13 (*a* and *b*)

Psamminopelta bowsheri Tappan, 1957, p. 211, Pl. 67, figs 11–18, 22–24; 1962, p. 157, Pl. 37, figs. 11–22.

Material and occurrence. Hypotypes GSC 34814 and 34815 (Pl. 4, figs. 12, 13) are from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample 1e (GSC loc. C-25736), of Middle Albian age. The species is restricted (Table 1, col. 78) to the uppermost part of the siltstone member; only a few specimens occur per 100 g of sample. Tappan (1962) described this species in Alaska from the upper part of the Topagoruk Formation and from the Grandstand Formation, indicating a range in age from the late Middle Albian to Late Albian. The species has been recorded also from subsurface boreholes in northwestern Alberta and northeastern British Columbia, and it has been recovered from the top of the Fort St. John Group, at the base of the Fish Scale Marker beds (Chamney, 1973). Originally it was assigned to *Rzehakina,* prior to the publication of the genus *Psamminopelta* Tappan, 1957. As *Rzehakina,* the taxon served as an index for the top of the Lower Cretaceous Series (Upper Albian).

Discussion. The maximum diameter for the figured specimens is 0.56–0.58 mm, and the minimum is 0.33–0.44; the average thickness is 0.09 mm. There are five to six visible coils, of two chambers each. The Alaskan species are slightly larger but have fewer coils. *Psamminopelta bowsheri* is approximately three times the size of, and has a greater number of coils than, *P. subcircularis* Tappan.

Psamminopelta subcircularis Tappan
Plate 4, figures 14, 15 (*a* and *b*)

Psamminopelta subcircularis Tappan, 1957, p. 213, Pl. 67, figs. 8–10; 1962, p. 158, Pl. 37, figs. 8–10.

Material and occurrence. Hypotypes GSC 34816 and 34817 (Pl. 4, figs. 14, 15) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2e (GSC loc. C-25731), of Late Albian age. The species, as shown in Table 1, col. 8, is confined to the top of the section and is of Late Albian age. Only a few specimens were recovered from each 100 g of sample material. The types described by Tappan (1962) in Alaska are from the Torok, Tuktu, Topagoruk, and Grandstand formations, indicating a range in age from Early? to Late Albian. The species has a greater age range than *P. bowsheri* but, in the Yukon, appears to be restricted to the younger Albian. To the south, where it has been recorded in the Canadian Western Interior, it is associated with the *Miliammina manitobensis* zone of Late Albian age.

Discussion. The maximum diameter of the hypotypes is 0.31–0.33 mm and the minimum is 0.20–0.25 mm; test thickness (diameter of tubes) is 0.05 mm. The species is only one-third as large as *P. bowsheri* and has fewer chambers. It has a maximum of four coils, of two chambers each. The agglutinated grains in the test wall are in greater proportion than the cement, thus masking the sutures and in particular the terminal partitions of each chamber. It is difficult to distinguish *P. subcircularis* from elongate forms of *Ammodiscus* when examining dry specimens with reflected lighting.

Family Trochamminidae Schwager, 1877
Genus *Trochammina* Parker and Jones, 1959
Trochammina stelcki n. sp.
Plate 4, figures 16 (*a* and *b*), 17 (*a–c*)

Material and occurrence. Paratype GSC 34818 (Pl. 4, fig. 16) is from the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1b (GSC loc. C-25745), of Middle Albian age. Holotype GSC 34819 (Pl. 4, fig. 17) is from the lower silty shale member, field station MJ 116-62, sample 5 (GSC loc. C-25747), of Middle Albian age. In occurrence, the species ranges from the lower silty shale member to the basal beds of the upper silty shale member, of Middle Albian age (*see* Table 1, col. 25). The acme of occurrence is within the basal beds of the upper silty shale member, where quantities greater than 20 specimens per 100 g of sample were recovered.

Description. Test trochoid, low spire, some specimens compressed, periphery lobate, subrounded to subacute; wall finely agglutinated, probably with a 'chitinous' base as seen in some worn specimens with a red-brown lining; chambers numerous, increasing gradually in size, seven to nine in the final whorl;

sutures depressed, curved on the dorsal side, radial on the ventral side; aperture on arch at the base of the final chamber face extending into the ventral side.

The minimum diameter of the holotype is 0.5 mm, and the thickness is 0.17 mm. The minimum diameter of the paratypes ranges from 0.45 to 0.60 mm; the average thickness is 0.20 mm.

Discussion. The specimens from the younger Albian of the upper silty shale member appear to have slightly more inflated chambers and are more loosely coiled. Thus, the lobate periphery, with exaggerated curved sutures on the dorsal side, looks like an ornate, trochoid spire. The holotype selected is an intermediate form between the closely coiled and the loosely coiled forms. There does not seem to be any species comparable to this distinctive form with its lobate periphery.

Trochammina rainwateri Cushman and Applin
Plate 4, figures 18, 19

Trochammina rainwateri Cushman and Applin, 1946, p. 75, Pl. 13, fig. 9; Tappan, 1962, p. 153, Pl. 39, figs. 7–12.
Trochammina webbi Stelck and Wall, 1954, p. 33, Pl. 2, fig. 11.

Material and occurrence. Hypotypes GSC 34820 and 34821 are from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample 1c (GSC loc. C-25738), of Middle Albian age. The range of occurrence of the species (*see* Table 1, col. 13) is from the lower silty shale member to the upper silty shale member, all of Middle Albian age. Three to four specimens per 100 g of sample were recovered within the interval. *Trochammina rainwateri* Cushman and Applin was described originally from the upper part of the Woodbine sand of Cenomanian age in northern Texas. The species was reported by Tappan (1962) in Alaska from the Topagoruk and Grandstand formations and their lateral equivalents of Middle and Late Albian age.

Discussion. The minimum diameter of the hypotypes ranges from 0.30 to 0.35 mm, and the average thickness is 0.15 mm. The Yukon specimens are similar to the smaller forms from the older Albian in the Tuktu Formation in Alaska (Tappan, 1962, Pl. 39, figs. 9, 10).

Family Nodosariidae Ehrenberg, 1839
Genus *Lenticulina* Lamark, 1804
Lenticulina fysta n. sp.
Plate 5, figures 1 (*a–c*), 2

Material and occurrence. Holotype GSC 34822 (Pl. 5, fig. 1) is from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample 1a (GSC loc. C-25740). Paratype GSC 34823 (Pl. 5, fig. 2) is from the same field station and rock-unit, sample 1b (GSC loc. C-25739). Both are of Middle Albian age. The species, of Middle Albian age, is present from the basal shale of the upper silty shale member to the siltstone member (Table 1, col. 51).

Description. Test free, small, lenticular with slight elongation of the ultimate chamber, planispiral, umbilicus indistinct, periphery acute to subacute with a faint keel on some specimens; chambers broad and low, six to seven in the final whorl, the ultimate chamber face of some specimens showing a slightly flattened triangular shape; sutures distinct, curved, and slightly depressed; wall calcareous, perforate, surface smooth; aperture radiate, at the peripheral angle.

The maximum diameter of the holotype is 0.437 mm; the minimum diameter is 0.26 mm. The maximum diameters of these specimens range from 0.32 to 0.50 mm and the minimum diameters range from 0.21 to 0.28 mm. The thickness measurements are not significant because most specimens are compressed to some degree in preservation.

Discussion. The dimensions of and the number of chambers in the smaller specimens are somewhat similar to those of *L. topagorukensis* Tappan from Alaska. The other taxonomic features, such as the sutures, keel, and chamber shape, are not comparable. The slight elongation of the ultimate chamber suggests a tendency toward an evolute growth stage. In this respect, there is some similarity with *L. ingenua* (Berthelin), reported from the older Albian, from the Torok Formation, in Alaska (Tappan, 1962).

Lenticulina redunca n. sp.
Plate 5, figures 3–5(*a–c*)

Lenticulina bayrocki Mellon and Wall, Tappan, 1962, p. 161, Pl. 40, fig. 3 (not *Lenticulina bayrocki* Mellon and Wall, 1956).

Material and occurrence. Paratypes GSC 34825 and 34826 (Pl. 5, figs. 3, 4) are from the glauconite member, Martin House Formation, field station MJ 116-62, sample 2a (GSC loc. C-25757), of Early Albian age. Holotype GSC 34824 (Pl. 5, fig. 5) is from sample 2d of the same field station and rock-unit (GSC loc. C-25754). The species occurs from the glauconite member to the basal shale of the upper silty shale member, Martin House and Arctic Red formations, respectively (Table 1, col. 52); this indicates a range in age from Early to Middle Albian. Tappan's figured specimen (1962, Pl. 40, fig. 3) was reported from the Grandstand Formation in Alaska, which is of Late Albian age.

Description. Test free, large, many specimens robust, lenticular, planispiral, umbilical area covered by coalescing limbate sutures, periphery subacute; chamber broad and low, seven or eight in the final whorl; sutures limbate, curved, thickened; wall calcareous, perforate, with adhering foreign material producing a roughened surface in some specimens; aperture radial, at the peripheral angle.

The maximum diameter of the holotype is 0.87 mm, and the minimum is 0.26 mm. The maximum diameters of the paratypes range from 0.51 to 0.9 mm, and the minimum diameters range from 0.38 to 0.44 mm; the thickness of the test for figure 3 is 0.37 mm.

Discussion. The pronouncedly curved, limbate sutures and chamber shape of *L. redunca* n. sp. and *L. bayrocki* Mellon and Wall of Tappan (1962, Pl. 40, fig. 3) differ from *L. bayrocki* Mellon and Wall sensu stricto. The petaloid design formed by the meeting of the chambers in the umbilical area in Tappan's *L. bayrocki* (1962, Pl. 40, fig. 2) is more representative of *L. macrodisca* (Reuss) and *L. bayrocki* sensu stricto. In some specimens of the latter two species, as many as four chambers of the inner coil are visible in the umbilical area. The two occurrences of the present species in the coarser clastic rock-units suggest a preference for a nearshore environment.

Lenticulina macrodisca (Reuss)
Plate 5, figure 10 (*a–c*)

Cristellaria (Cristellaria) macrodisca Reuss, 1863, p. 78, Pl. 9, fig. 5.
Lenticulina macrodisca (Reuss), Tappan, 1962, p. 162, Pl. 40, figs. 5–8.

Material and occurrence. Hypotype GSC 34831 (Pl. 5, fig. 10) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The species is present in the siltstone and upper silty shale members of Middle Albian age (Table 1, col. 33). The species described by Tappan (1962) in Alaska is from the Fortress Mountain, Topagoruk, and Grandstand formations, and it represents a range in age from Early to Late Albian. In the Canadian Western Interior, *L. bayrocki* and forms similar to *L. macrodisca* are associated with assemblages of the *Saracenaria trollopei* zone of Early Albian age.

Description. Test large, lenticular, robust, planispiral with relatively large biumbilical area, possibly representing a large proloculus, slightly depressed and usually covered, faint keel in first part of the final coil; wall calcareous, perforate, smooth, some specimens badly corroded; chambers low, gradually enlarging as added, seven to nine visible chambers in final coil; sutures curved, somewhat thickened, flush; aperture radial, at the peripheral angle of the ultimate chamber, many specimens broken at the tip, indicating a possible short, fragile neck.

The maximum diameter of the hypotypes is 0.75 mm and the minimum is 0.56 mm; test thickness is 0.34 mm.

Discussion. The large, covered umbilical area and the thick, translucent, recurved sutures are significant enough in the present species to differentiate it from *L. bayrocki* Mellon and Wall, 1956, not *L. bayrocki* Mellon and Wall (Tappan, 1962). The umbilical area of *L. macrodisca* is not covered as is that of *L. redunca* n. sp., in which the sutures are thickened and very curved.

Lenticulina cf. *L. macrodisca* (Reuss)
Plate 5, figures 6 (*a* and *b*), 7

Cristellaria (Cristellaria) macrodisca Reuss, 1863, p. 78, Pl. 9, fig. 5.
Lenticulina macrodisca (Reuss), Tappan, 1962, p. 162, Pl. 40, figs. 5–8.

Material and occurrence. Figured specimens GSC 34827 and 34828 (Pl. 5, figs. 6, 7) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species, as shown in Table 1, col. 53, is restricted to the upper silty shale member of Middle Albian age. *Lenticulina macrodisca* (Reuss) is from the Fortress Mountain, Topagoruk, and Grandstand formations in Alaska, and it represents the total Albian Stage.

Discussion. The maximum diameter of the present species is 0.45 mm; the minimum is 0.31 mm. Thickness is 0.21 mm. A maximum of 10 planispiral chambers are visible in the final coil. The species differs from *L. macrodisca* in having a restricted umbilical area and a faint keel (?preservation) and in being smaller.

Lenticulina bayrocki Mellon and Wall
Plate 5, figure 11

Lenticulina bayrocki Mellon and Wall, 1956, p. 20, Pl. 2, figs. 1, 2.
Lenticulina sp. A Wickenden, 1951, p. 37, Pl. 1A, figs. 14, 16 (not 15).

Material and occurrence. The figured specimen is the holotype from the Research Council of Alberta as described from the basal beds of the Clearwater Formation of Alberta. These beds are dated by the presence of *Lemuroceras* sp. as Early Albian.

Description. Adult test medium size, compressed, planispiral, or becoming slightly trochoid, thus showing the earlier chambers on one side only; peripheral margin distinct, bordered by a rim; test, a spherical proloculus with 12 or 13 subsequent chambers, 8 or 9 in the last whorl; chambers distinct, gradually increasing in size, last one or two very slightly inflated; sutures distinct, thickened, arcuate, slightly raised except ultimate one, which is depressed; wall calcareous, finely perforate; aperture radiate, a small round opening on the terminal face at the peripheral angle; colour white.

Maximum diameter of holotype, 0.74 mm; thickness, 0.3 mm. Holotype locality: Socony-Vacuum Oil Sands Well No. 27 (Sec. 27, Tp. 91, Rge. 10, W4th Meridian), Alberta, Canada, between depths of 73 and 81 ft, 20 to 28 ft above the base of the Clearwater Formation. Holotype: University of Alberta Paleontological Type Collection. Horizon: Rare in the basal shales of the Clearwater Formation.

Remarks. The basal Clearwater species figured here is similar to the *forme typique* of *Cristellaria gaultina* Berthelin from the Albian of France, except that the French species has developed a distinct flange that is lacking in the Clearwater species. The latter is described, therefore, as a new species, and the adult test may tend to become slightly trochoid in the manner of those forms described under the generic name *Darbyella.*

Locally, this form is identical to Wickenden's *Lenticulina* sp. A from the lower Falher Formation. It is present also in the central and upper parts of the Clearwater Formation, type section (Martin, 1954).

Discussion. The test form of *L. bayrocki* Mellon and Wall s.s. is evolute, as evidenced by the presence of up to four visible chambers in the umbilical area of the penultimate whorl. *Lenticulina macrodisca* (Reuss) has only a single whorl, and the umbilical area consists of a large, inflated proloculum, as illustrated by Tappan (1962). The other taxonomic features of these two species are similar, in particular the fingerlike pattern formed by the converging chambers in the prolocular area, flush sutures, and slightly necked aperture. The periphery of *L. bayrocki* is flattened slightly opposite each chamber, giving the appearance of an incipient keel. *Lenticulina macrodisca* displays this feature on some specimens but only within the first third of the whorl. It is important to distinguish these two species for, although *L. macrodisca* is common throughout the Albian of Europe and the area under investigation, *L. bayrocki* has been established by Stelck *et al.* (1956) as being restricted to the Early Albian. *Lenticulina bayrocki* is thus useful for obtaining a finer biochronological subdivision of the Albian.

Lenticulina fusa n. sp.
Plate 5, figures 8 (*a–c*), 9

Material and occurrence. Holotype GSC 34829 (Pl. 5, fig. 8) and paratype GSC 34830 (Pl. 5, fig. 9) are from the upper part of the basal sandstone member, Martin House Formation, field station MJ 115-62, sample 3a (GSC loc. C-25764), of

Early Albian age. The new species, as shown in Table 1, col. 73, occurs in all rock-units from the Aptian to the Middle Albian. It is common in the glauconite member and the basal part of the upper silty shale member, where the recovery is about six specimens per 100 g of sample. Column 138 of the distribution chart lists forms that compare favourably with the present species but were referred previously to *L. erecta* (Perner).

Description. Test free, medium size, lenticular to spindle-shaped, particularly with specimens that have developed large, biumbonate plugs; wall calcareous, perforate, surface smooth; chambers relatively numerous, low, about nine per whorl, periphery weakly keeled; sutures gently curved, limbate in part; aperture radiate at the peripheral angle.

The maximum diameter of the holotype is 0.50 mm; the minimum is 0.38 mm. The maximum diameter of the paratypes ranges from 0.49 to 0.69 mm, and the minimum from 0.36 to 0.56 mm; average thickness is 0.25 mm.

Discussion. The rather pronounced umbilical plug on some specimens is most distinctive, but this feature, like the degree of the limbate suture development, seems to be variable. Specimens with a more subdued umbilical plug and limbate sutures approach the form *L. erecta* (Perner) but are smaller. It is possible that the present species is the parent stock from which the younger (Late Albian to Cenomanian) *L. erecta* (Perner) was derived.

Lenticulina topagorukensis Tappan
Plate 5, figures 12 (*a–c*), 13

Lenticulina topagorukensis Tappan, 1960, p. 292, Pl. 1, figs. 16–19; 1962, p. 163, Pl. 40, figs. 9–12; not North and Caldwell, 1964, Pl. 3, fig. 3.

Material and occurrence. Hypotypes GSC 34832 and 34833 (Pl. 5, figs. 12, 13) are all from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Early to Middle Albian age. The species occurs in the lower silty shale, siltstone, and upper silty shale members, all of Middle Albian age (Table 1, col. 32). It is most abundant in the basal part of the upper silty shale member, where up to five specimens were obtained from 100 g of sample. In Alaska, the species occurs in the Torok and Topagoruk formations of Early? and Middle Albian age (Tappan, 1962).

Discussion. The maximum diameter of this species is 0.16–0.52 mm; the minimum is 0.15–0.25 mm. Except for the rather small size, the taxonomic features appear to compare favourably with the type specimen.

Genus *Astacolus* Montfort, 1808
Astacolus sp.
Plate 6, figures 1(*a–c*)–3

Material and occurrence. Figured specimens GSC 34834 and 34835 (Pl. 6, figs. 1, 2) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. Figured specimen GSC 34836 (Pl. 6, fig. 3) is from the same rock-unit and field section, sample 2a (GSC loc. C-25735), of Middle Albian age. The species occurs in the lower silty shale, siltstone, and upper silty shale members of Middle Albian age (Table 1, col. 34). Only a few specimens were recovered, averaging one or two per 100 g of sample. In general, *Astacolus* is more common in the older Albian in Alaska (Tappan, 1962), from the Torok and Topagoruk formations and, rarely, from the Grandstand Formation.

Discussion. The length of the figured specimens ranges from 0.50 to 0.63 mm, and the diameter of the coil averages 0.30 mm, with a thickness of 0.15 mm. There are five chambers in the early stage of coiling and four to five in the late evolute stage. Generic diagnosis becomes rather subjective when dealing with taxonomic parameters such as the degree of uncoiling and the cross-section shape from round to oval to flat (*see* Textfig. 7). The present specimens tend to uncoil in the final three to five chambers with backswept sutures that, in some mature specimens, do not extend to the early stage of coiling. These specimens have become astacoline but are not sufficiently flattened in cross-section to be referred to *Planularia* or *Vaginulinopsis.* In addition, the cross-section is not sufficiently ovoid to become *Marginulinopsis.* Assignment to *Astacolus* is based upon the well-developed planispiral coil and the few uniserial chambers with backswept sutures.

Genus *Saracenaria* Defrance, 1824
Saracenaria valanginiana Bartenstein and Brand
Plate 6, figures 4(*a–c*)–6

Lenticulina (Saracenaria) valanginiana Bartenstein and Brand, 1951, p. 291, Pl. 13, figs. 364, 365.
Saracenaria sp. D Hetch, 1938, p. 15, Pl. 12, figs. 3–5.
Saracenaria valanginiana Bartenstein and Brand, Tappan, 1962, p. 166, Pl. 42, figs. 7, 8.

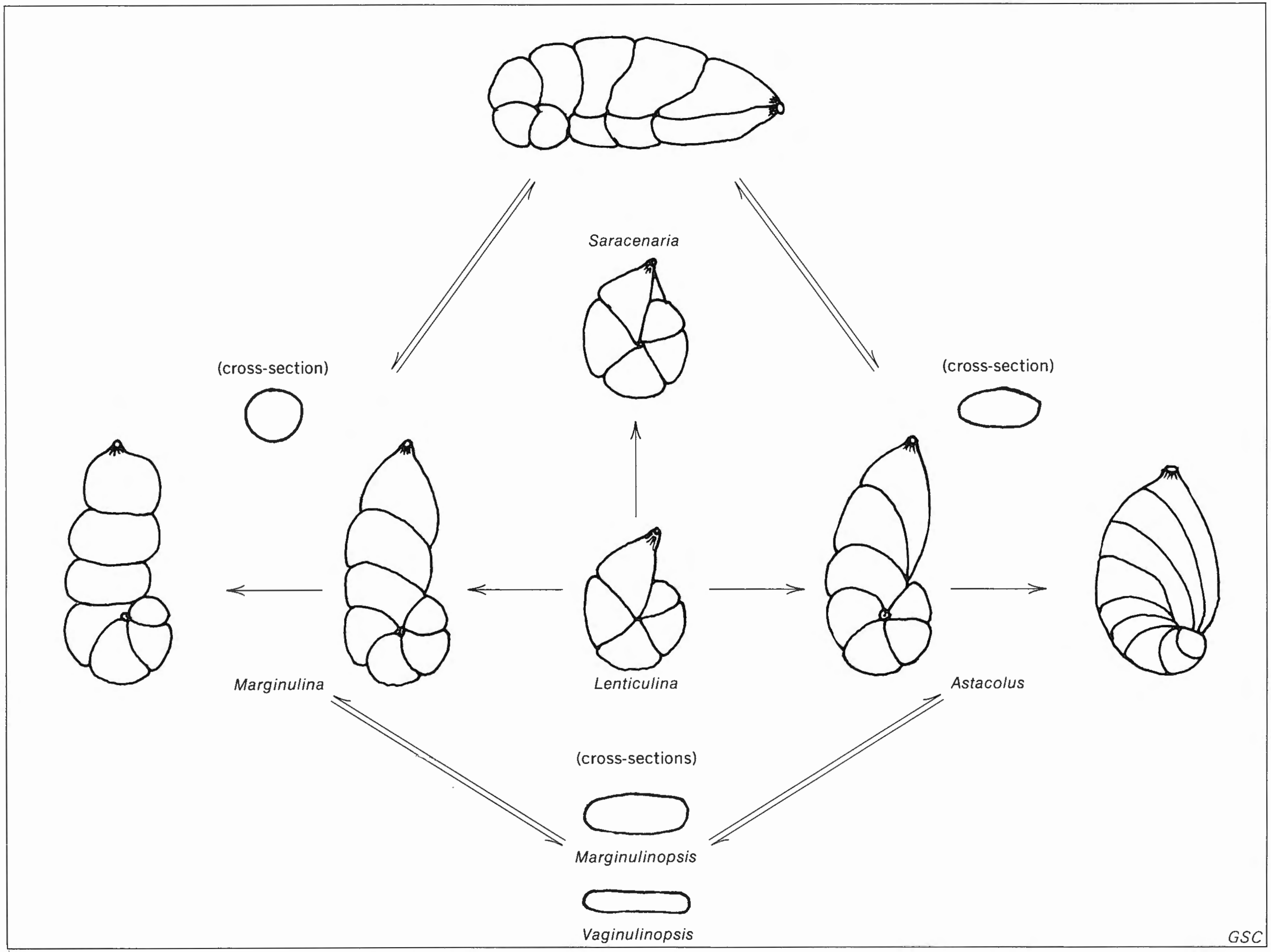
Material and occurrence. Hypotype GSC 34837 (Pl. 6, fig. 4) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. Hypotypes GSC 34838 and 34839 (Pl. 6, figs. 5, 6) are from the same rock-unit and field station, sample 2c (GSC loc. C-25733), of Middle Albian age. The species occurs in the siltstone and upper silty shale members of Middle Albian age (Table 1, col. 24). Column 119 shows that *Saracenaria* aff. *S. valanginiana* occurs in the basal siltstone and glauconite members and basal beds of the lower silty shale member, the ages of which range from Aptian to Early Albian.

Discussion. The maximum length of the hypotypes ranges from 0.40 to 0.58 mm, and the diameter of the coil ranges from 0.23 to 0.32 mm (average thickness, 0.20 mm). There are five to six chambers in the early coiling stage and two to three in the evolute stage with the sutures curved back to the early coil; the triangular face of the ultimate chamber is very distinctive.

Saracenaria grandstandensis Tappan
Plate 6, figures 7 (*a–c*), 8

Saracenaria grandstandensis Tappan, 1960, p. 292, Pl. 2, figs. 8–10; 1962, p. 164, Pl. 41, figs. 3–5.
Saracenaria sp. C Stelck and Wall, 1956 (*in* Stelck *et al.*, 1956), p. 52, Pl. 3, figs. 30, 31.

Material and occurrence. Hypotype GSC 34840 (Pl. 6, fig. 7) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. Hypotype GSC 34841 (Pl. 6, fig. 8) is from



Textfigure 7. Morphological series of *Lenticulina* and related taxa.

the same rock-unit and field station, sample 2a (GSC loc. C-25735), of Middle Albian age. The species is restricted to the upper silty shale member of Middle Albian age (Table 1, col. 23). The type species described by Tappan (1962) in Alaska is "characteristic of the Grandstand Formation and more rarely occurs in the underlying Topagoruk Formation." *Saracenaria* sp. C Stelck and Wall is considered to be conspecific with the present species. It was described from the Clearwater Formation in Alberta, of Early Albian age.

Discussion. The length of the hypotypes is 0.30–0.42 mm, and the diameter of the early, planispiral coil is 0.13–0.17 mm (average thickness, 0.09 mm). There are four chambers in the early open, arcuate coil, followed by four chambers in the evolute stage, with a somewhat convex, triangular, apertural face on the ultimate chamber. The present species has a somewhat more definite early coil similar to the paratype of Tappan (1962, Pl. 42, fig. 8).

Saracenaria porcupinensis n. sp.
Plate 6, figures 9 (*a–c*), 10

Saracenaria trollopei Mellon and Wall, Tappan, 1962, p. 165, Pl. 41, figs. 6–8 (not *Saracenaria trollopei* Mellon and Wall, 1956).

Material and occurrence. Holotype GSC 34842 (Pl. 6, fig. 9) is from the upper part of the glauconite member, Martin House Formation, field station MJ 116-62, sample 2d (GSC loc. C-25754), of Early Albian age. Paratype GSC 34843 (Pl. 6, fig. 10)* is from the same sample. The species is restricted to the glauconite member, except for questionable fragmentary remains from the basal siltstone member of Aptian age (Table 1, col. 128). The species is rare, the greatest abundance being two to three specimens per 100 g of sample.

Description. Test medium size, early stage open, planispiral coil of two or three chambers followed by two or three chambers in the late evolute stage; chambers inflated, increasing rapidly in size as added, ultimate chamber with pronounced triangular face and rounded angles; sutures oblique, dipping toward the inner periphery, depressed in the late evolute stage and not touching the early coil; wall calcareous, perforate, surface originally smooth; aperture radiate, at the peripheral angle.

Total test length of the holotype is 0.77 mm, and the maximum width is 0.43 mm. The range of length for the paratypes is from 0.40 to 0.80 mm, and the maximum width is 0.27–0.45 mm.

Discussion. The rapid increase in chamber size and the simple, open, early coil distinguishes the present species from *S. trollopei* Mellon and Wall, 1956.

Saracenaria trollopei Mellon and Wall
Plate 6, figure 11

Saracenaria trollopei Mellon and Wall, 1956, p. 25, Pl. 2, figs. 26, 27; Stelck *et al.*, 1956, p. 50, Pl. 1, figs. 4, 5; Pl. 3, fig. 21 (not *Saracenaria trollopei* Mellon and Wall, Tappan, 1962).

Material and occurrence. Hypotype GSC 34844 (Pl. 6, fig. 11) is from the glauconite member, Martin House Formation, field station MJ 115-62, sample 5 (GSC loc. C-25759), of Early Albian age. The species is restricted to the glauconite member of Early Albian age (Table 1, col. 129). It occurs as a few specimens per 100 g of sample. The holotype, described by Mellon and Wall (1956) in Alberta, is from the Clearwater Formation of Early Albian age. The species is reported also from the Moosebar Formation in British Columbia (Stelck, 1950). The hypotype from Alaska, described by Tappan (1962), is referred here to *Saracenaria porcupinensis* n. sp. The reasons for such assignment are given in that discussion.

Discussion. The length of the hypotypes ranges from 0.56 to 0.60 mm, the coil diameter is 0.26 mm, and the maximum test thickness is 0.20 mm. There are four to five inflated chambers in the early coil with depressed sutures and four to five inflated chambers in the late, evolute (uniserial) stage with sutures becoming nearly horizontal. The ultimate chamber of the type specimens is somewhat reduced in size. Sutures are curved slightly until the last chamber. There, they become straight.

Saracenaria cf. *S. trollopei* Mellon and Wall
Plate 6, figure 12

Saracenaria trollopei Mellon and Wall, 1956, p. 25, Pl. 2, figs. 26, 27.

Material and occurrence. The figured specimen GSC 34899 is from field station MJ 116-62, sample 2a (GSC loc. C-25757), glauconite member, Martin House Formation, of Early Albian age. The range of the species, shown in Table 1, col. 129, is the same as *S. trollopei* s.s., which is restricted to Early Albian age.

Discussion. The length of the figured specimen is 0.60 mm and the diameter of the coil is 0.25 mm. The present specimens differ from *S. trollopei* by having more diagonal sutures in the late, evolute stage. As a result, the ultimate chamber approaches a central position and increases in size.

Genus *Marginulinopsis* Silvestri, 1904
Marginulinopsis umiatensis Tappan
Plate 7, figures 1(*a–c*)–3

Marginulinopsis umiatensis Tappan, 1951a, p. 2, Pl. 1, figs. 6–7b; 1951b, Sheet 3, fig. 21 (13); 1962, p. 168, Pl. 43, figs. 5–7.

Material and occurrence. Hypotype GSC 34845 (Pl. 7, fig. 1) is from field station MJ 118-62, sample 1a (GSC loc. C-25740), basal part of the siltstone member, Arctic Red Formation, of Middle Albian age. Hypotypes GSC 34846 and 34847 (Pl. 7, figs. 2, 3) are from field station MJ 118-62, sample 2a (GSC loc. C-25735), basal upper silty shale member, Arctic Red Formation, of Middle Albian age. In Alaska, this species ranges from the Topagoruk Formation into the Tuktu Formation (Tappan, 1962). The latter appears to be a southern facies of the Grandstand Formation, so that the age includes both Middle and Late Albian. In the Yukon, the species occurs in the siltstone member and the basal shale of the upper silty shale member of Middle Albian age (Table 1, col. 54). Column 80 shows specimens compared to the present species that extend the range into the older Lower Albian of the basal lower silty shale member. Only two or three specimens per 100 g of sample were recovered.

Discussion. The length of the test is 0.30–0.50 mm and the maximum width is 0.19–0.33 mm. *Marginulinopsis umiatensis* differs from *Marginulina planiuscula* (Reuss) in having a horizontal suture in the late evolute stage with the terminal chamber so enlarged that its width approximates the diameter of the early coiled stage. The unweathered test wall has fine ribs parallel to the periphery over the initial coil. When the ultimate chamber is not expanded and resting on the initial coiled stage, the form approaches that of *M. planiuscula* (Reuss).

Marginulinopsis cf. *M. umiatensis* Tappan
Plate 7, figures 4–6

Material and occurrence. Figured specimen GSC 34848 (Pl. 7, fig. 4) is from the upper silty shale member, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. Figured specimens GSC 34849 and 34850 (Pl. 7, figs. 5, 6) are from the lower silty shale member, field station MJ 116-62, sample 3 (GSC loc. C-25735), of Early Albian age. The age range of the species is from Early to Middle Albian (Table 1, col. 80). The acme of occurrence is in the basal part of the lower silty shale member, where it is common at 6 to 10 specimens per 100 g of sample. In Alaska, the species has been recovered from the Topagoruk Formation and the Grandstand Formation equivalents of Middle and Late Albian ages.

Discussion. The figured specimens are 0.437–0.625 mm long, and there are only two chambers in the late uniserial stage. The ribs are very subdued, possibly as a result of compression. Without the ribs and with a circular outline in cross-section, the present species would compare to the diagnosis of *Marginulina planiuscula* (Reuss).

Marginulinopsis jonesi (Reuss)
Plate 7, figures 7(*a* and *b*)–9

Cristellaria (Marginulina) jonesi Reuss, 1863, p. 61, Pl. 5, fig. 19.
Lenticulina (Marginulinopsis) robusta jonesi (Reuss), Bartenstein, 1956, p. 515, Pl. 2, fig. 55.
Marginulinopsis jonesi (Reuss), Tappan, 1962, p. 167, Pl. 42, figs. 1–6.

Material and occurrence. Figured hypotypes GSC 34851 to 34853 (Pl. 7, figs. 7–9) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The specimens reported from Alaska by Tappan (1962) are characteristic of the Grandstand Formation of Late Albian age, but they also occur rarely in the underlying Topagoruk Formation of Middle Albian age. Of the present specimens, the most common, mature, and distorted forms are shown on Plate 7, figures 7, 8, and 9, respectively. The species is present from the siltstone member to the lower part of the upper silty shale member of Middle Albian age (Table 1, col. 38). Only one or two specimens were recovered per 100 g of sample.

Discussion. Marginulinopsis jonesi differs from *Marginulina gatesi* Tappan, 1957, in having the evenly spaced, longitudinal ribs as ornamentation. Some unfigured hypotypes have a slight triangular apertural face similar to some specimens of *M. gatesi.* The length of the test for the figured specimens ranges from 0.44 to 0.53 mm, and the average diameter of the coil is 0.24 mm; the length of the two evolute chambers is 0.32 mm. These dimensions are similar to those of the type specimens.

Marginulinopsis collinsi Mellon and Wall
Plate 7, figures 10(*a* and *b*)–17

Marginulinopsis collinsi Mellon and Wall, 1956, p. 20, Pl. 2, figs. 1–4; Stelck *et al.*, 1956, p. 44, Pl. 1, fig. 3; Pl. 3, figs. 19, 20; Tappan, 1962, p. 166, Pl. 42, figs. 10–15.

Material and occurrence. Hypotypes GSC 34854 and 34855 (Pl. 7, figs. 10, 11) are from the lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 3 (GSC loc. C-25753), of Early to Middle Albian age. The species is recovered from the glauconite member and the basal beds of the lower silty shale member of Early Albian age (Table 1, col. 125). Only two or three specimens per 100 g of sample were recovered from these beds. In Alberta and northeastern British Columbia, the species is recovered from the Clearwater Formation and the lower part of the Moosebar Formation. It is conspecific with *Marginulina* sp. A Wickenden, 1951, from the Falher Formation. The species is of Early Albian age throughout the Canadian Western Interior.

Discussion. Diagnosis of the species is made difficult by slight variations in chamber number, number of ribs, and suture angle. It is useful to attempt finer speciation of this taxon because *M. collinsi* has been established in the Western Interior and Arctic Canada as a biochronological index species of the ammonite zone *Lemuroceras* or *Beudanticeras* of Early Albian age. The diagnostic morphologic criteria for *M. collinsi* s.s. should be three to four chambers in the uniserial stage, oblique sutures extending toward the coil, six to seven visible ribs (12 to 14 total) confined to the test surface between the initial coil and the ultimate chamber, aperture radial and offset to peripheral angle, and dimensions approaching a total test length of 0.65 mm and a maximum width of 0.30 mm.

Slight variations in these criteria make the forms very similar to *M. jonesi* (Reuss) Tappan (1962, Pl. 42, figs. 2, 6). Figured hypotypes by Tappan (1962) for *M. collinsi* (with the exception of Pl. 42, fig. 11) do not conform to the type description. They exhibit up to five chambers in the initial coil, as many as five chambers in the uniserial stage, and only four to five visible ribs continuing over the total test surface. *Marginulinopsis collinsi* s.s. represents the Lower Albian, and *M. jonesi* s.s. represents younger beds in the Albian.

Genus *Marginulina* d'Orbigny, 1826
Marginulina planiuscula (Reuss)
Plate 8, figure 1(*a* and *b*)

Cristellaria planiuscula Reuss, 1863, p. 71, Pl. 7, fig. 51; Berthelin, 1880, p. 53, Pl. 3, fig. 25.
Marginulina planiuscula (Reuss) Tappan, 1962, p. 170, Pl. 43, figs. 8–11.

Material and occurrence. Hypotype GSC 34856 (Pl. 8, fig. 1) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The local teilzone of *M. planiuscula* is restricted to the basal shale of the member (Table 1, col. 39). Tappan (1962) reports this species from the Topagoruk to the Grandstand formations, indicating a range from Middle to Upper Albian.

Discussion. The figured hypotype is 0.312 mm long and 0.167 mm wide. The specimen is compressed, simulating that of the genus *Marginulinopsis.* The figured specimen falls within the smallest size range for the described types from Alaska (Tappan, 1962). With reference to the discussion of *Marginulinopsis* cf. *M. umiatensis* Tappan, there appears to be a morphological series between these two taxa (Textfig. 7).

Marginulina gatesi Tappan
Plate 8, figure 2 (*a–c*)

Marginulina gatesi Tappan, 1957, p. 215, Pl. 68, figs. 7, 8; 1962, p. 169, Pl. 43, figs. 12, 13.

Material and occurrence. Hypotype GSC 34857 (Pl. 8, fig. 2) is from the basal part of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of late Middle Albian age. Column 55 of Table 1 shows the species ranging above and below the siltstone member, all within the Middle Albian, with a common occurrence of 6 to 20 specimens per 100 g of sample. The type species from Alaska was reported (Tappan, 1962) to be characteristic of the Grandstand Formation of Late Albian age, but it was also recovered from the Topagoruk Formation of Middle Albian age.

Discussion. The figured hypotype falls within the smallest size range of the described species, being 0.312 mm long and having only two chambers added in the late evolute stage. These features distinguish it from the similarly ribbed *Marginulinopsis collinsi* Mellon and Wall and from the *Marginulinopsis reticulosa* ten Dam, which has more subdued ribbing.

Marginulina cephalotes (Reuss)
Plate 8, figures 3(*a* and *b*)–6

Cristellaria cephalotes Reuss, 1863, p. 67, Pl. 7, figs. 5, 6.
Vaginulinopsis cephalotes (Reuss) ten Dam, 1950, p. 39, Pl. 3, fig. 9.
Marginulina cephalotes (Reuss) Tappan, 1962, p. 168, Pl. 43, figs. 14–17.

Material and occurrence. Hypotypes GSC 34858 to 34861 (Pl. 8, figs. 3–6) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, samples 2b and 2a (GSC locs. C-25734, C-25735, and C-25740). The total stratigraphic range of this species in the Middle Albian is the lower silty shale, the siltstone, and the upper silty shale members (Table 1, col. 22). It has a common occurrence of 6 to 10 specimens per 100 g of sample in the basal shale of the upper silty shale member. Tappan (1962) reports recovery of this species in Alaska from the Fortress Mountain to the Grandstand formations, of Aptian? to Late Albian age. This range is much greater than that indicated in the Yukon and adjacent interior Arctic mainland provinces.

Discussion. The figured hypotypes range in length from 0.35 to 0.50 mm and in width from 0.14 to 0.21 mm. These dimensions fall within the smaller range of the described hypotypes in Alaska.

Genus *Vaginulina* d'Orbigny, 1826
Vaginulina mountjoyi n. sp.
Plate 8, figures 7(*a–c*), 8

Vaginulina cf. *V. plana* (Reuss), 1863; Tappan, 1962, p. 177, Pl. 46, fig. 11.

Material and occurrence. Holotype GSC 34862 (Pl. 8, fig. 7) is from the basal upper silty shale, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. Paratype GSC 34863 (Pl. 8, fig. 8) is from the same sample. This species is restricted to the upper part of the siltstone member and the lower part of the upper silty shale member, within the Middle Albian (Table 1, col. 36).

Description. Test medium size, sides flat, moderately tapered from a globular proloculus offset from the second chamber commencing the uniserial stage, with a faint keel along the straight peripheral edge; wall smooth with faint, scattered visible perforations; chambers long, narrow, slightly wider at the peripheral edge but quite uniform in width, the globular proloculus followed by six chambers; sutures depressed, curved in the evolute coiling stage, straight in the late uniserial stage, and angled toward the early coiling stage with a slight nodular development at the junction with the peripheral keel; aperture at the peripheral angle, radial striations not visible.

The length of the holotype is 0.437 mm, and the maximum width is 0.150 mm. The paratypes are 0.40–0.45 mm long and 0.10–0.16 mm wide.

Discussion. The present species is considered to be conspecific with *Vaginulina* cf. *V. plana* Reuss, of Tappan, 1962. The species is a distinctive, delicate form and has more chambers in the late stage than has Tappan's *Vaginulina* cf. *V. plana* from Alaska. The species is named for E.W. Mountjoy, McGill University, previously with the Geological Survey of Canada.

Genus *Nodosaria* Lamarck, 1812
Nodosaria nana Reuss
Plate 8, figures 9(*a* and *b*), 10

Nodosaria nana Reuss, 1860, p. 179, Pl. 1, fig. 6; Noth, 1951, p. 55, Pl. 2, fig. 29; Tappan, 1962, p. 174, Pl. 34, fig. 1.

Material and occurrence. Hypotypes GSC 34864 and 34865 (Pl. 8, figs. 9, 10) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, samples 2a and 2b (GSC locs. C-25734 and C-25735), of Middle Albian age. The species occurs in the siltstone and upper silty shale members of Middle Albian age (Table 1, col. 42). It is common at the base of the latter member, where 6 to 10 specimens per 100 g of sample occur. *Nodosaria nana* is reported by Tappan (1962) from the Torok Formation of Alaska, but it is likely a contaminant from the overlying Topagoruk Formation.

Discussion. The figured hypotypes range in length from 0.44 to 0.51 mm and in maximum width from 0.10 to 0.18 mm. These specimens fall within the size range for the described types. The species was described originally from the Gault in Germany (Lower Cretaceous, undifferentiated). The figured hypotype differs from *Dentalina inepta* Reuss, 1846, by having a more central aperture and fewer ribs.

Nodosaria doliiformis Eichenberg
Plate 8, figure 11(*a* and *b*)

Nodosaria (Dentalina) doliiformis Eichenberg, 1933, p. 7, Pl. 7, fig. 6.
Nodosaria doliiformis Eichenberg, Tappan, 1962, p. 173, Pl. 45, figs. 13, 14.

Material and occurrence. Hypotype GSC 34866 (Pl. 8, fig. 11) is from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample 1d (GSC loc. C-25737), of Middle Albian age. The species occurs in the siltstone member and basal beds of the upper silty shale member of Middle Albian age (Table 1, col. 83). Two to three specimens per 100 g of sample were recovered. The age of *N. doliiformis* in northern Germany is given as Albian, undifferentiated; in Alaska it occurs in the Torok Formation of inferred Early to Middle Albian age (Tappan, 1962).

Discussion. Length of the partial test of the figured hypotype is 0.66 mm and width is 0.09 mm. These dimensions compare favourably with the type species, assuming that at least one additional chamber was present originally.

Nodosaria sp.
Plate 8, figure 12 (*a* and *b*)

Material and occurrence. Hypotype GSC 34867 is from the basal lower silty shale member, Arctic Red Formation, field station MJ 116-62, sample 3 (GSC loc. C-25753). It is associated with the *Marginulinopsis collinsi* Zone of Early Albian age. The species is present across the boundary of the Martin House and Arctic Red formations, all within the Lower Albian *Beudanticeras (Lemuroceras)* sp. Zone (Table 1, col. 122).

Discussion. The length of the figured specimen is 0.94 mm and the maximum width is 0.275 mm. The species compared in part with *Nodosaria proboscidea* Reuss, as illustrated by Cushman and Deaderick, 1944, *non* Mellon and Wall, 1956. The present specimen has fewer chambers and more ribs, and the chambers increase in size more gradually than do those of *N. proboscidea*.

Genus *Dentalina* d'Orbigny, 1826
Dentalina dettermani Tappan
Plate 9, figures 1, 2

Material and occurrence. Hypotype GSC 34868 (Pl. 9, fig. 1) is from the middle part of the lower silty shale member, Arctic Red Formation, field station MJ 117-62, sample 1a (GSC loc. C-25746), of Middle Albian age. Hypotype GSC 34869 (Pl. 9, fig. 2) is from the glauconite member, Martin House Formation, field station MJ 116-62, sample 2d (GSC loc. C-25754), of Early Albian age. The species ranges from the uppermost part of the Middle Albian to the lowermost part of the Lower Albian (Table 1, col. 50). Occurrences are limited to a few specimens, averaging two or three per 100 g of sample. The stratigraphic range of *D. dettermani* is from the Fortress Mountain Formation to the Grandstand Formation in Alaska, which indicates an age from Early? to Late Albian (Tappan, 1962).

Discussion. The figured hypotypes range in chamber length from 0.49 to 0.55 mm and in maximum chamber width from 0.25 to 0.32 mm. The figured specimens are smaller in all dimensions than those of the described types.

Dentalina duplexa n. sp.
Plate 9, figures 3–5

Material and occurrence. Holotype GSC 34870 (Pl. 9, fig. 3) is from the basal part of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. Paratypes GSC 34871 and 34872 (Pl. 9, figs. 4, 5) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The species occurs from slightly below to slightly above the siltstone member, all of Middle Albian age (Table 1, col. 44). It reaches its acme of occurrence in the basal beds of the upper silty shale member, from which five or six specimens were recovered from 110 g of sample.

Description. Test large, arcuate, elongate, uniserial, commonly occurring as single chambers, with a maximum of two chambers remaining joined due to poor preservation; chambers subglobular, enlarging gradually from a globular proloculus, ultimate chamber increasing in height; wall calcareous, perforations rare, much mineralization with calcite and pyrite replacement and in-filling, original wall smooth, with 18 or more fine, subdued ribs; sutures distinct, very constricted, oblique, angles variable, greater angle in some specimens when the ultimate chamber is slightly offset; aperture terminal, elongate, faint radial striations, extreme off-centre position.

The average length of the ultimate chamber is 0.34 mm, and the width is 0.30 mm. The length of the two joined chambers of the holotype is 0.51 mm, and the maximum width is 0.24 mm.

Discussion. The constricted nature of the sutures contributes to the ease of breakage along the total uniserial test. No complete tests were recovered; commonly, a maximum of two chambers remains together. The broken chambers appear to have been transported with attendant abrasion of the fine ribs. Diagenetic mineralization of calcite and pyrite also are evident. Except for the centred aperture of these specimens, they could be compared to *Dentalina dettermani* Tappan, 1957.

Genus *Citharina* d'Orbigny, 1839
Citharina cf. *C. acuminata* (Reuss)
Plate 9, figure 6 (*a* and *b*)

?*Vaginulina acuminata* Reuss, 1863, p. 49, Pl. 4, fig. 1; Eichenberg, 1933, p. 187, Pl. 23, fig. 11; Eichenberg, 1934, p. 26, Pl. 5, fig. 2.
?*Citharina acuminata* (Reuss) Bartenstein and Brand, 1951, p. 298.
Citharina cf. *C. acuminata* (Reuss) Tappan, 1962, p. 180, Pl. 47, figs. 7, 8.

Material and occurrence. Hypotype GSC 34873 is from the basal beds of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species ranges stratigraphically from the upper part of the siltstone member to the base of the upper silty shale (Table 1, col. 37). The figured hypotypes from Alaska by Tappan (1962) are reported from the Torok and Topagoruk formations of Early? to Middle Albian age. The species is rare in the Yukon, and other than the more nearly complete figured specimen, only questionable fragments have been recovered.

Discussion. The partial test of the figured hypotype is 0.88 mm long and a maximum of 0.27 mm wide. The present specimens fall within the lower size range of the original description. But had the early and late parts of the test been intact, it might have reached the average dimensions for the species.

Genus *Tribrachia*
Tribrachia sp. 1
Plate 9, figure 11 (*a–c*)

Material and occurrence. Figured specimen GSC 34878 (Pl. 9, fig. 11) is from the basal beds of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species occurs in the shales overlying and underlying the siltstone member of Middle Albian age (Table 1, col. 71). Not more than two specimens per 200 g of sample were recovered.

Discussion. The figured specimen is 0.35 mm long and 0.22 mm wide. The chambers consist of a proloculus followed by four triangular to trifoliate, uniserial chambers. The aperture is terminal and radiate. On the basis of the extreme trifoliate and collapsed chambers of *Tribrachia,* these specimens are distinguished from the overlapping and 'convex' triangular form of *Tristix.*

Tribrachia sp. 2
Plate 9, figure 12 (*a–c*)

Material and occurrence. Figured specimen GSC 34879 (Pl. 9, fig. 12) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The species is very rare; only the illustrated partial specimen was recovered (Table 1, col. 49).

Discussion. The figured specimen has a length of 0.75 mm and a maximum width of 0.29 mm. The proloculus is followed by four triangular, uniserial chambers, sides somewhat excavated but not as trifoliate as *Tribrachia* sp. 1. Aperture is terminal, centred, and radiate.

Family Glandulinidae Reuss, 1860
Genus *Globulina* d'Orbigny, 1839
Globulina prisca Reuss
Plate 9, figures 7 (*a–c*), 8

Globulina prisca Reuss, 1863, p. 79, Pl. 9, fig. 8; Cushman, 1946, p. 97, Pl. 40, figs. 15–17; Frizzell, 1954, p. 104, Pl. 14, fig. 24; Bartenstein, 1956, p. 529; Tappan, 1962, p. 184, Pl. 47, figs. 25, 26; Neagu, 1965, p. 36, Pl. 7, figs. 3–5.

Material and occurrence. Hypotypes GSC 34874 and 34875 (Pl. 9, figs. 7, 8) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The species, as shown in Table 1, col. 45, is restricted to the basal beds of the upper silty shale member. The species was described originally from the Albian of Europe, and it also occurs in the Gault of England. Tappan (1962) reported the species in Alaska from the Topagoruk to the Grandstand formations, thus extending the range into the Upper Albian.

Discussion. The length of the hypotypes ranges from 0.24 to 0.26 mm and the width from 0.115 to 0.170 mm, which places the figured specimens in the smallest range of the topotype material. A maximum of three strongly overlapping chambers is visible. Some difficulty is encountered in distinguishing this species from *G. lacrima canadensis* Mellon and Wall, 1956, described from the Lower Albian Clearwater Formation in Alberta. These latter forms are slightly wider and larger than the present species. Insufficient numbers and poor preservation of the specimens recovered from this section prevent a more complete diagnosis.

Family Polymorphinidae d'Orbigny, 1839
Genus *Sigmomorphina* Cushman & Ozwa, 1928
Sigmomorphina sp.
Plate 9, figures 9 (*a–c*), 10

Material and occurrence. Figured specimens GSC 34876 and 34877 (Pl. 9, figs. 9, 10) are from the basal beds of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species is restricted to rare occurrences in the lower beds of the upper silty shale member (Table 1, col. 46).

Discussion. The figured specimens are 0.29–0.31 mm long, 0.20–0.25 mm wide, and approximately 0.14 mm thick. Specimens consist of a proloculus and a maximum of three pairs of visible chambers.

Family Turrilinidae Cushman, 1927
Genus *Neobulimina* Cushman and Wickenden, 1928
Neobulimina cf. *N. subcretacea* (Cushman)
Plate 9, figures 13–15

Virgulina subcretacea Cushman, 1936, p. 46, Pl. 7, fig. 2; 1937c, p. 2, Pl. 1, figs. 4, 5.
Neobulimina subcretacea (Cushman) Tappan, 1962, p. 186, Pl. 48, figs. 7–10.

Material and occurrence. Hypotypes GSC 34880 to 34882 (Pl. 9, figs. 13–15) are from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, samples 2c and 2b (GSC locs. C-25733 and C-25734), of Middle Albian age. The species is restricted to the lower part of the upper silty shale member and reaches a maximum occurrence of approximately six specimens per 100 g of sample (Table 1, col. 20). *Neobulimina subcretacea* (Cushman) was described originally from the Lower Cretaceous Goodland limestone of Texas. Tappan (1962) reports *N. subcretacea* in Alaska from the Torok, Topagoruk, and Grandstand formations, thus indicating a range in age from Early? to Late Albian.

Discussion. The length of the hypotypes ranges from 0.26 to 0.33 mm; the maximum width appears to be constant at 0.09 mm. Specimens are calcareous and very granular in surface appearance; originally they were mistaken for agglutinated forms. Some diagenetic alteration of the test wall has taken place, contributing to this appearance. The dimensions compare favourably with those of the type species.

Family Osangulariidae Loeblich and Tappan, 1964
Genus *Globorotalites* Brotzen, 1942
Globorotalites alaskensis Tappan
Plate 9, figures 16 (*a–e*), 17 (*a–c*)

Globorotalites alaskensis Tappan, 1957, p. 220, Pl. 69, figs. 11–13; 1962, p. 190, Pl. 55, figs. 6–9.

Material and occurrence. Hypotypes GSC 34883 and 34884 (Pl. 9, figs. 16, 17) are from the basal beds of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species is restricted to the basal beds of the upper silty shale member, where it is abundant. As many as 10 specimens per 100 g of sample were recovered (Table 1, col. 57). The type species from Alaska ranges through the Torok, Topagoruk, and Grandstand formations, which suggests an age from Early? to Late Albian (Tappan, 1962). The most common occurrence is in the Upper Albian Grandstand Formation.

Discussion. The minimum diameter of the hypotypes ranges from 0.25 to 0.28 mm, and the average thickness is 0.09 mm. These dimensions fall within the median size range of the type species. The dorsal side is flat, the ventral side is strongly convex and umbilicus central. There are six to seven dextrally coiling chambers in the final whorl on the dorsal side and six chambers visible on the ventral side. An interiomarginal, slitlike aperture extends from the umbilicus but becomes indistinct towards the periphery (Textfig. 8).

Globorotalites ex gr. *G. alaskensis* Tappan
Plate 10, figure 1 (*a–f*)

Material and occurrence. The figured specimen GSC 34885 (Pl. 10, fig. 1) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The species is restricted to the basal beds of the upper silty shale member (Table 1, col. 57), and there are commonly six specimens per 100 g of sample.

Description. Test trochoid, flat on the dorsal (spiral) side, strongly convex and small, centrally umbilicate on the ventral side, periphery subrounded; wall calcareous, very finely perforate, surface smooth. The final two or three chambers increase rapidly in size, with more pronounced oblique sutures extending back along the periphery; there are eight to nine chambers in the final sinistrally coiled whorl. Sutures nearly indistinct on the dorsal side, very distinct and straight on the ventral side, slightly depressed; aperture interiomarginal, indistinct due to a very reduced umbilical area, more distinct as a low slit at the base of the apertural face on some specimens.

The maximum diameter of the coil is 0.30 mm, the minimum diameter is 0.24 mm, and the thickness is 0.09 mm.

Discussion. Compared with *G. alaskensis* Tappan, this species is larger in all dimensions, has more chambers, and shows opposite coiling direction.

Globorotalites rotaliformis (McGill and Loranger)
Plate 10, figure 2 (*a–c*)

Eponides rotaliformis McGill and Loranger, 1961, p. 524, Pl. 4, figs. 13–15.

Material and occurrence. The hypotype GSC 34886 (Pl. 10, fig. 2) is from the basal beds of the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The species occurs, as shown in Table 1, col. 59, in the glauconite and upper silty shale members, and thus it is present in both the Lower Albian part of the Martin House Formation and the Middle Albian part of the Arctic Red Formation. It occurs rarely, only one specimen having been recovered per 100 g of sample. The holotype in the Norman Wells area, District of Mackenzie, was described from the Sans Sault Group, of Albian (undifferentiated) age.

Description. Test trochoid, flat to slightly convex on the dorsal side, convex on the ventral side, periphery subrounded; wall calcareous, finely perforate, surface originally smooth; the final two or three chambers increasing rapidly in size and becoming more oblique spirally with slight extension back along the periphery, seven to eight chambers coil sinistrally in the final whorl; sutures originally distinct, and those of the final whorl slightly thickened and oblique on the dorsal side, radial, slightly thickened and depressed on the ventral side; aperture somewhat indistinct as a result of the reduced umbilical area but evident as a low slit along the base of the apertural face.

The maximum diameter is 0.208 mm and the minimum diameter is 0.18 mm. The thickness of the slightly biconvex form is 0.09 mm.

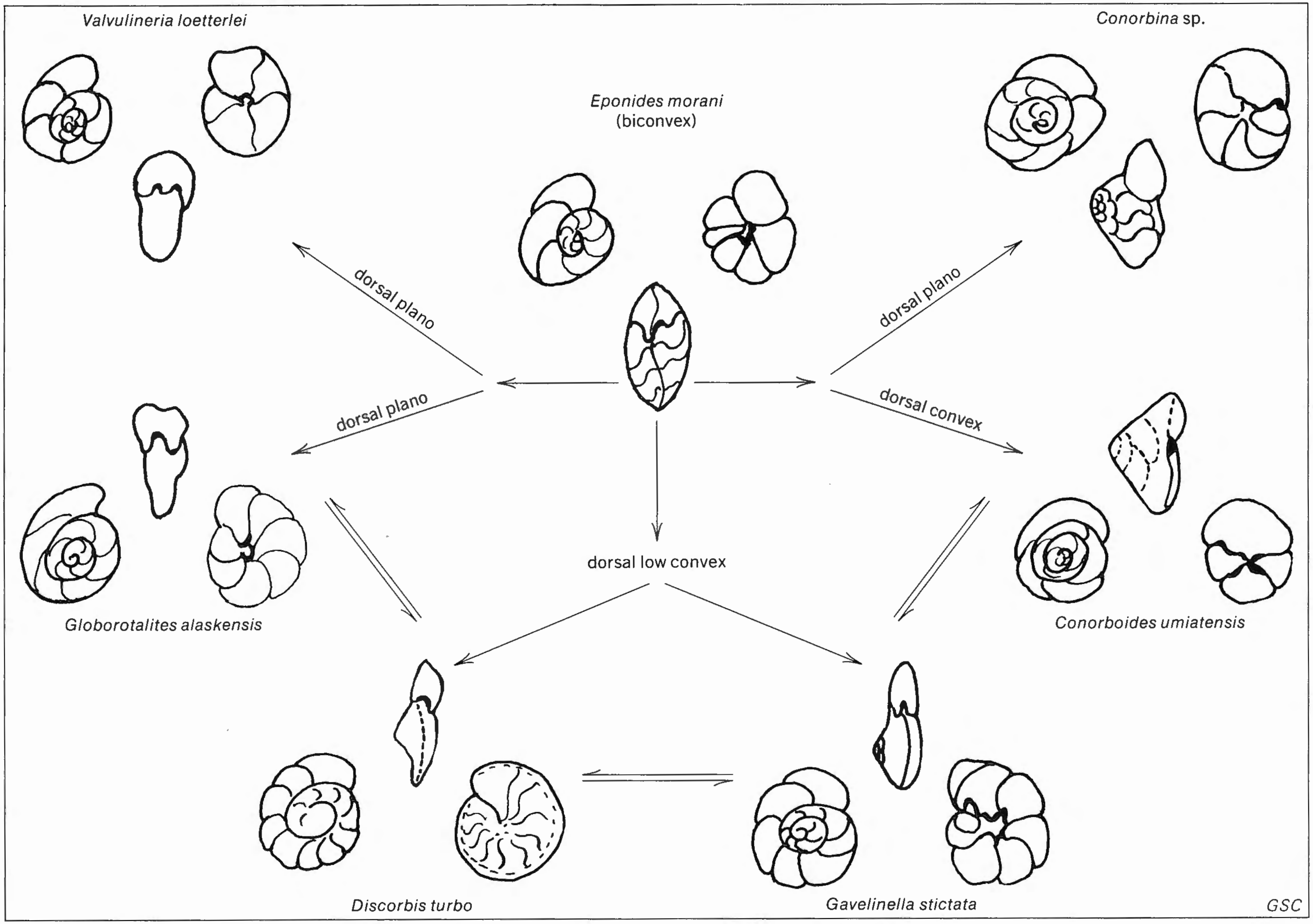
Discussion. The flat to slightly convex dorsal side of *G. rotaliformis* (McGill and Loranger) and the very strong convex ventral side distinguish this genus from all of the other problematical taxa compared in Textfigure 8.

Family Valvulineriidae Brotzen, 1942
Genus *Valvulineria* Cushman, 1926
Valvulineria loetterlei (Tappan)
Plate 10, figures 3 (*a–f*), 4 (*a–c*)

Gyroidina loetterlei Tappan, 1940, p. 120, Pl. 19, fig. 10; 1943, p. 512, Pl. 82, fig. 9; Frizzell, 1954, p. 124, Pl. 18, fig. 41.
Valvulineria loetterlei (Tappan) ten Dam and Schijfsma, 1944, p. 143; Tappan, 1962, p. 194, Pl. 54, figs. 1–4.
Gyroidina sp. A Wickenden, 1951, p. 41, Pl. 1A, fig. 30.
Gyroidina cf. *G. nitida* (Reuss) Stelck *et al.*, 1956, p. 33, Pl. 1, figs. 11–13; Pl. 2, figs. 7–9.

Material and occurrence. Hypotype GSC 34887 (Pl. 10, fig. 3) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734). Hypotype GSC 34888 is from the siltstone member, Arctic Red Formation, field station MJ 118-62, sample 1d (GSC loc. C-25737). Both samples are of Middle Albian age. The stratigraphic range of the species is from the siltstone member to the middle part of the upper silty shale member, of Middle to Late? Albian age (Table 1, col. 56 and 21). A maximum abundance occurs at the base of the upper silty shale member, where more than 10 specimens per 100 g of sample were recovered. Tappan (1962) reports the species from the Torok, Topagoruk, and Grandstand formations in Alaska, indicating a range in age of from Early? to Late Albian, with an acme of occurrence in the Middle Albian. Stelck *et al.* (1956) considered the species "a good index of Middle Albian age in northwest Canada." At that time, the *Lemuroceras* Zone, in the Clearwater Formation, was considered to be of Middle Albian age, but it is agreed now that these ammonites indicate the late part of the Lower Albian. *Valvulineria loetterlei* was described originally from the Lower Cenomanian Grayson Formation in Texas, but it ranged stratigraphically lower into strata of Late Albian age. In Europe, V. *gracillima* ten Dam of the Albian in the Netherlands, England, and France appears to be a coeval taxon.

Discussion. The maximum diameter of the hypotypes ranges from 0.25 to 0.32 mm and the minimum diameter from 0.17 to 0.25 mm; the range in thickness is from 0.09 to 0.15 mm. The dorsal side (6.5 chambers in the final whorl) is flat to slightly convex, and the ventral side (6.5 chambers) is considerably convex and has a slight depression in the umbilical area. The aperture is normally indistinct but can be reconstructed from



Textfigure 8. Diagnosis of minute, trochoid, calcareous foraminifers of the Albian. Dorsal (coil) side is left figure of paired dorso-ventral views, edge view below or above. Apertures indicated by thickened black lines on ventral and edge views.

well-preserved specimens to extend from the ventral edge of the periphery part way on the ventral side; the apertural flap is seldom completely preserved. It differs from the European Albian marker, *V. gracillima* ten Dam, in being smaller in all dimensions, a general characteristic of the boreal microfauna. The periphery is more broadly rounded, with less exaggeration of the ultimate chambers in cross-sectional view. The hypotype (Pl. 10, fig. 4) is from the older Albian and is sinistrally coiled, thus differing from the type species and from the hypotype (Pl. 10, fig. 3; Textfig. 8).

Family Discorbidae Ehrenberg, 1838
Genus *Conorbina* Brotzen, 1936
Conorbina sp.
Plate 11, figure 1 (*a–g*)

Material and occurrence. Figured specimen GSC 34890 (Pl. 11, fig. 1) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian stage. The species occurs in both the siltstone and upper silty shale members of Middle Albian age (Table 1, col. 60). One or two specimens per 100 g of sample is the maximum quantity recovered.

Description. Test small, planoconvex to low conical, periphery subacute, umbilical area open. All of the three dextrally coiled whorls and nine chambers of the final whorl are visible from the dorsal side; only the final whorl with its nine chambers is visible on the ventral side. Wall calcareous, very finely perforated, surface originally smooth; chambers of greater breadth than height, and very little increase in size in the final whorl; sutures nearly tangential in the last few chambers, curving back at the periphery in the older chambers, radial and curved on the ventral side; aperture on the ventral side under the umbilical chamber margin.

The maximum diameter of the holotype is 0.27 mm, the minimum diameter is 0.20 mm, and thickness is approximately 0.09 mm; it thus falls within the average size for *Conorbina* spp. of Alaska.

Discussion. Confusion has existed in past diagnoses of small calcareous species having coiled dorsal and involute ventral chamber arrangements. Textfigure 8 is designed to compare taxa with this group for morphological identification. The present specimens are assigned to the genus *Conorbina* primarily on the position of the aperture but also on the numerous ventral chambers having curved sutures and the conical dorsal spire.

Family Anomalinidae Cushman, 1927
Genus *Gavelinella* Brotzen, 1942
Gavelinella stictata (Tappan)
Plate 10, figure 5 (*a–e*)

Discorbis stictata Tappan, 1951a, p. 4, Pl. 1, fig. 18a–c; 1951b, Sheet 3, fig. 21 (10a–c).
Discorbis norrisi Mellon and Wall, 1956, p. 15 (not Pl. 2, figs. 9–11); Stelck *et al.*, 1956, p. 30. Pl. 2, figs. 4–6.
Gavelinella stictata (Tappan) 1951, Tappan, 1962, p. 198, Pl. 57, figs. 1–10.

Material and occurrence. Hypotype GSC 34889 (Pl. 10, fig. 5) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2b (GSC loc. C-25734), of Middle Albian age. The species occurs in both the siltstone and the upper silty shale members of Middle Albian age (Table 1, col. 61). A few specimens only were recovered—an average of one to two per 100 g of sample. The type specimens reported by Tappan (1962) in Alaska were recovered from the Torok, Topagoruk, and Grandstand formations, predominantly from the Grandstand. This indicates a range in age from Early? to Late Albian. *Discorbis norrisi* Mellon and Wall, 1956 is conspecific with the present species. *Discorbis norrisi* was first reported from the Middle? Albian Loon River Formation in Alberta and was described from the Lower Albian Clearwater Formation.

Discussion. The maximum diameter of the figured specimen is 0.25 mm, the minimum diameter is 0.18 mm, and the maximum thickness is 0.08 mm. It is slightly convex on the dorsal side and moderately convex on the ventral side, with an obvious offset arrangement of the ultimate chamber on the ventral side. The slitlike aperture on the ventral side is at the base of the ultimate chamber in an archlike re-entrant near the test periphery and extends inward to the umbilical area. The present specimens are smaller than those from Alaska and Alberta. All other taxonomic criteria, as diagrammed in Textfigure 8, compare favourably with the topotype material.

Gavelinella awunensis Tappan
Plate 11, figure 2 (*a–g*)

Gavelinella awunensis Tappan, 1960, p. 296, Pl. 2, figs. 15, 16; 1962, p. 197, Pl. 56, figs. 1–7.

Material and occurrence. Hypotype GSC 34891 (Pl. 11, fig. 2) is from the upper silty shale member, Arctic Red Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. The stratigraphic range of the species is from the basal beds of the lower silty shale member to the upper silty shale member, indicating both Early and Middle Albian ages (Table 1, col. 62). It is associated with the *Marginulinopsis collinsi* Zone of the Clearwater Formation assemblage in its lowest stratigraphic occurrence. Two to three specimens per 100 g of sample were recovered. The specimens reported in Alaska by Tappan (1962) were recovered from the Torok and Topagoruk formations, indicating a range from Lower to Middle Albian; the acme of occurrence was in the older Torok Formation.

Discussion. The maximum diameter of the figured specimen is 0.266 mm, the minimum diameter is 0.246 mm, and the thickness of the test is 0.08 mm. The present specimens fall within the smaller size range of the Alaskan topotype material. Tappan (1962) compares this species with *G. intermedia* (Berthelin) from the Albian of France. The Arctic specimens are smaller, more inflated, and more asymmetrical as a result of the more extreme dorsal convexity (Textfig. 8). Also, *G. tomarpensis* Brotzen from the Gault (Albian) of Sweden has fewer chambers and is more biconvex, similar in cross-sectional shape to *G. intermedia*. *Gavelinella awunensis* differs from the associated Middle Albian *G. stictata* by having a flattened ventral side and smaller, less robust but more numerous chambers in the final whorl.

Gavelinella sp.
Plate 11, figures 3(*a–d*), 4(*a–d*)

Material and occurrence. Figured specimen GSC 34893 (Pl. 11, fig. 4) is from the upper silty shale member, Arctic Red

Formation, field station MJ 118-62, sample 2a (GSC loc. C-25735), of Middle Albian age. Figured specimen GSC 34892 (Pl. 11, fig. 3) is from the glauconite member, Martin House Formation, field station MJ 115-62, sample 5 (GSC loc. C-25759), of Early Albian age. The stratigraphic range of the species is from the glauconite member to the upper silty shale member (Table 1, col. 67). The species occurs rarely. The Lower and Middle Albian occurrences are associated with the *Saracenaria trollopei* Zone and the *Gavelinella stictata* assemblages, respectively.

Description. Test small, planoconvex, sinistrally coiled, trochoid, tending to high convex shape in the first two whorls on the dorsal side, umbilicate, periphery subacute; wall calcareous, perforate, smooth, slightly translucent and shiny over the dorsal cone and umbilical plug. On the dorsal side, all chambers are visible in the last two of the three whorls, with nine to ten chambers in the final whorl and nine chambers on the ventral side, chambers increasing gradually in size as added. Sutures distinct, thickened, slightly depressed, slightly curved on the dorsal side, radial on the ventral side with a plugged umbilical area; aperture a ventral arch from the periphery and extending backward along the base of the ultimate and part of the penultimate chambers.

The maximum diameter is 0.26 mm, the minimum diameter is 0.21 mm, and the thickness of the test is approximately 0.09 mm. The range in minimum diameter for the paratypes is 0.19 to 0.25 mm.

Discussion. In comparison to the present species, *Gavelinella intermedia* (Berthelin) 1880, from the Albian of Europe, is not convex on the dorsal side and is open in the umbilical area on the ventral side, showing earlier whorls. Also, it has a greater number of chambers.

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Plates 1–11

Plate 1

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

Bathysiphon brosgei Tappan (p. 8)

Figures 1–3. Side views of hypotypes GSC 34758, 34759, and 34760; figure 1 from the siltstone member, Arctic Red Formation of Middle Albian age; figures 2 and 3 from the glauconite member, Martin House Formation of Lower Albian age.

Bathysiphon emacerata n. sp. (p. 9)

Figure 4. Side view of holotype GSC 34761, from the lower silty shale member, Arctic Red Formation of Middle Albian age.

Figure 5. Side view of paratype GSC 34762, from the glauconite member, Martin House Formation of Lower Albian age.

Bathysiphon strombotubulare n. sp. (p. 9)

Figure 6. Side view of holotype GSC 34763, from the basal sandstone member, Martin House Formation of Aptian age.

Figure 7. Side view of paratype GSC 34764, from the same sample.

Saccammina horrida n. sp. (p. 9)

Figure 8. Side view of paratype GSC 34765, from the lower silty shale member, Arctic Red Formation of Middle Albian age.

Figure 9. Side view of holotype GSC 34766, from the same sample.

Hippocrepina barksdalei (Tappan) (p. 9)

Figures 10, 11. Side views of hypotypes GSC 34767 and 34768, from the siltstone member, Arctic Red Formation of Middle Albian age.

Reophax vasiformis n. sp. (p. 10)

Figures 12–14. Side views of holotype GSC 34894 and paratypes GSC 34895 and 34896, from the upper silty shale member, Arctic Red Formation of Upper Albian age.

Ammodiscus rotalarius Loeblich and Tappan (p. 10)

Figures 15, 16. Side views of hypotypes GSC 34769 and 34770, from the upper silty shale member, Arctic Red Formation of Middle Albian age. Both figures: *a*, reflected light; *b*, oiled and incident light; *c*, camera lucida.

Ammodiscus crenulatus n. sp. (p. 10)

Figure 17. Side views of holotype GSC 34771, from the lower silty shale member, Arctic Red Formation of Lower Albian age; 17*b*, camera lucida drawing.

Figure 18. Side views of paratype GSC 34772, from the basal siltstone member, Martin House Formation of Aptian age; 18*b*, camera lucida drawing.

Ammodiscus mangusi (Tappan) (p. 10)

Figures 19, 20. Side views of hypotypes GSC 34773 and 34774, from the lower silty shale member, Arctic Red Formation of Lower Albian age; in each figure, *b* is a camera lucida drawing.

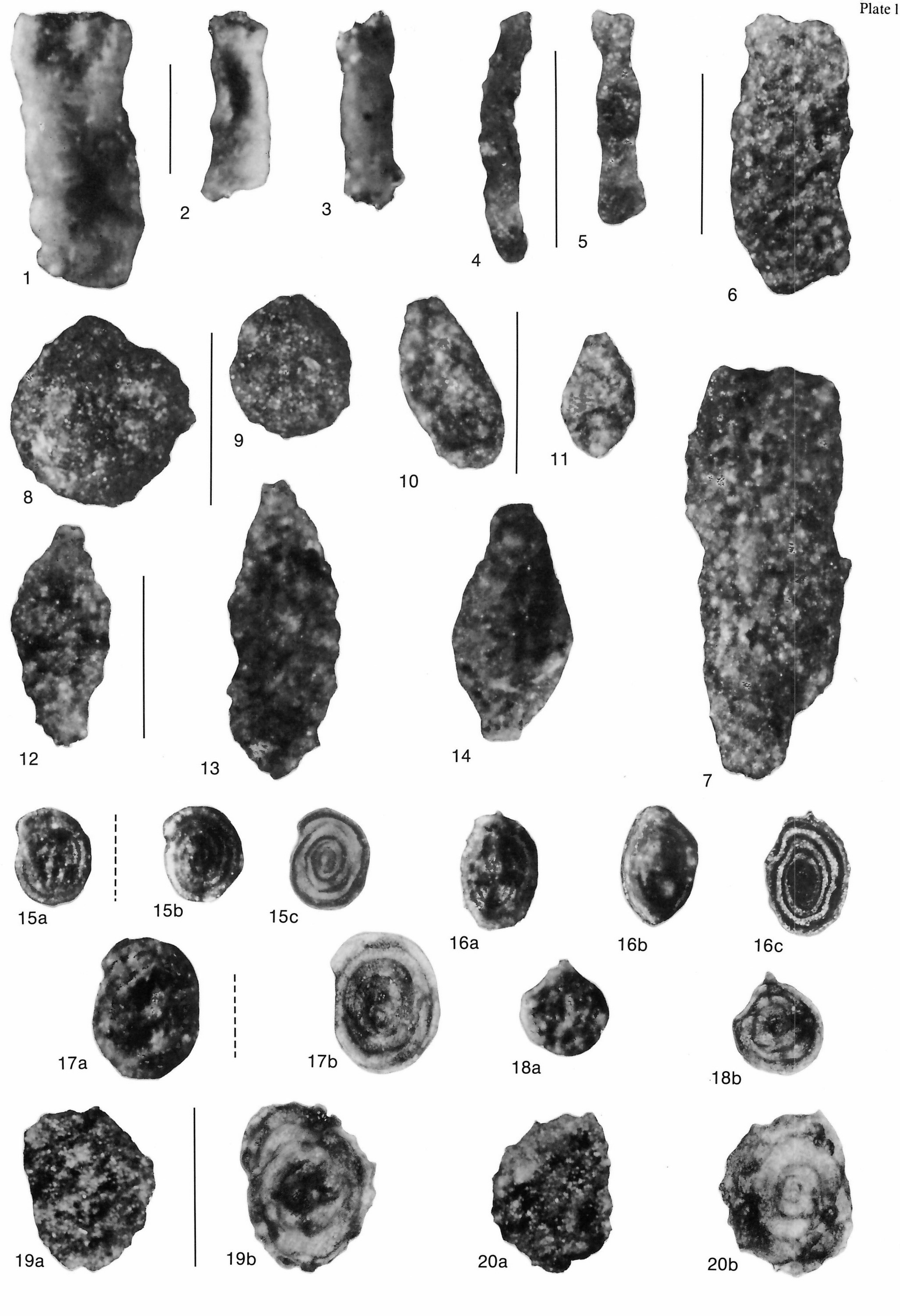
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Plate 2

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

Reophax cf. *R. incompta* Loeblich and Tappan (p. 11)

Figures 1–3. Side views of hypotypes GSC 34775–77, from the upper silty shale member, Arctic Red Formation of Middle Albian age.

Reophax fuscus n. sp. (p. 11)

Figure 4. Side view of holotype GSC 34778, from the lower silty shale member, Arctic Red Formation of Middle Albian age; 4*b*, camera lucida drawing.

Figure 5. Side view of paratype GSC 34779, from the upper silty shale member, field station MJ 118-62.

Figures 6, 7. Side views of paratypes GSC 34780 and 34781, from the glauconite member, Martin House Formation of transitional age from Aptian to Early Albian.

Haplophragmoides yukonensis n. sp. (p. 13)

Figure 8. Side views of holotype GSC 34882, from the siltstone member, Arctic Red Formation of Middle Albian age; 8*c*, camera lucida drawing.

Figure 9. Side views of paratype GSC 34883, from the upper silty shale member, Arctic Red Formation of Middle Albian age. Both figures 8 and 9: *a*, reflected light; *b*, oiled and incident light (highly retouched).

Haplophragmoides ex gr. *H. yukonensis* n. sp. (p. 13)

Figure 10. Side views of figured specimen GSC 34784, from the lower silty shale member, Arctic Red Formation of Early Albian age; 10*b*, oiled and incident lighting (retouched).

Plate 2

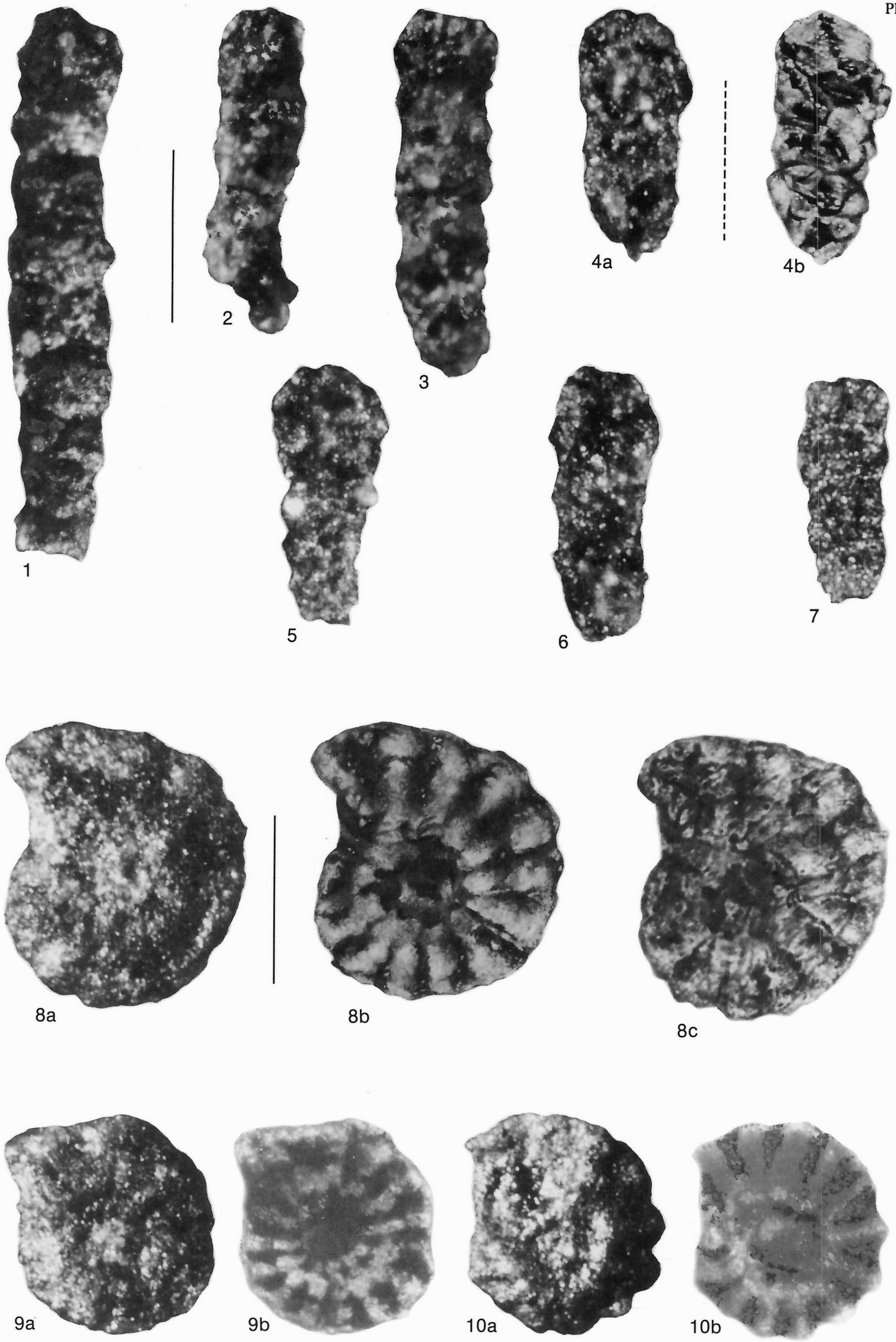

Plate 3

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

All specimens are from the Arctic Red Formation.

Haplophragmoides topagorukensis Tappan (p. 11)
Figures 1–3. Side views of hypotypes GSC 34785–87, from the upper silty shale and siltstone members, Middle Albian age; 2*b*, camera lucida drawing.

Haplophragmoides peelensis n. sp. (p. 13)
Figures 4, 5. Side views of holotype GSC 34788 and paratype GSC 34789, from the upper silty shale member of Middle Albian age.

Haplophragmoides linki Nauss (p. 13)
Figures 6, 7. Side views of hypotypes GSC 34790 and 34791, from the lower silty shale member of Middle Albian age; 6*b*, camera lucida drawing.

Haplophragmoides cf. *H. spissum* Stelck *et al.* (p. 14)
Figure 8. Side view of hypotype GSC 34792, from the lower silty shale member of Middle Albian age; 8*b*, camera lucida drawing.

Ammobaculites fragmentarius Cushman (p. 14)
Figures 9, 10. Side views of hypotypes GSC 34792 and 34793, from the upper silty shale and siltstone members, Middle Albian age; 9*b*, camera lucida drawing.

Ammobaculites cf. *A. reophacoides* Bartenstein (p. 14)
Figures 11, 12. Side views of hypotypes GSC 34795 and 34794, from the lower silty shale member of Middle Albian age.

Textularia ex gr. *T. topagorukensis* Tappan (p. 15)
Figures 13, 14. Side views of hypotypes GSC 34796 and 34797, from the upper silty shale member of Middle Albian age; 13*b*, camera lucida drawing.

Pseudobolivina sp. (p. 15)
Figures 15, 16. Side views of hypotypes GSC 34798 and 34799, from the upper silty shale member of Middle Albian age; 15*b*, camera lucida drawing.

Verneuilinoides tailleuri Tappan (p. 15)
Figures 17, 18. Side views of hypotypes GSC 34800 and 34801, from the upper part of the Arctic Red Formation.

Tritaxia solea n. sp. (p. 15)
Figure 19. Side and apertural views of holotype GSC 34802, from the upper silty shale member of Middle Albian age; 19*b* and 19*c*, camera lucida drawings.
Figures 20, 21. Side views of paratypes GSC 34803 and 34804, from the same member and of the same age as the holotype.

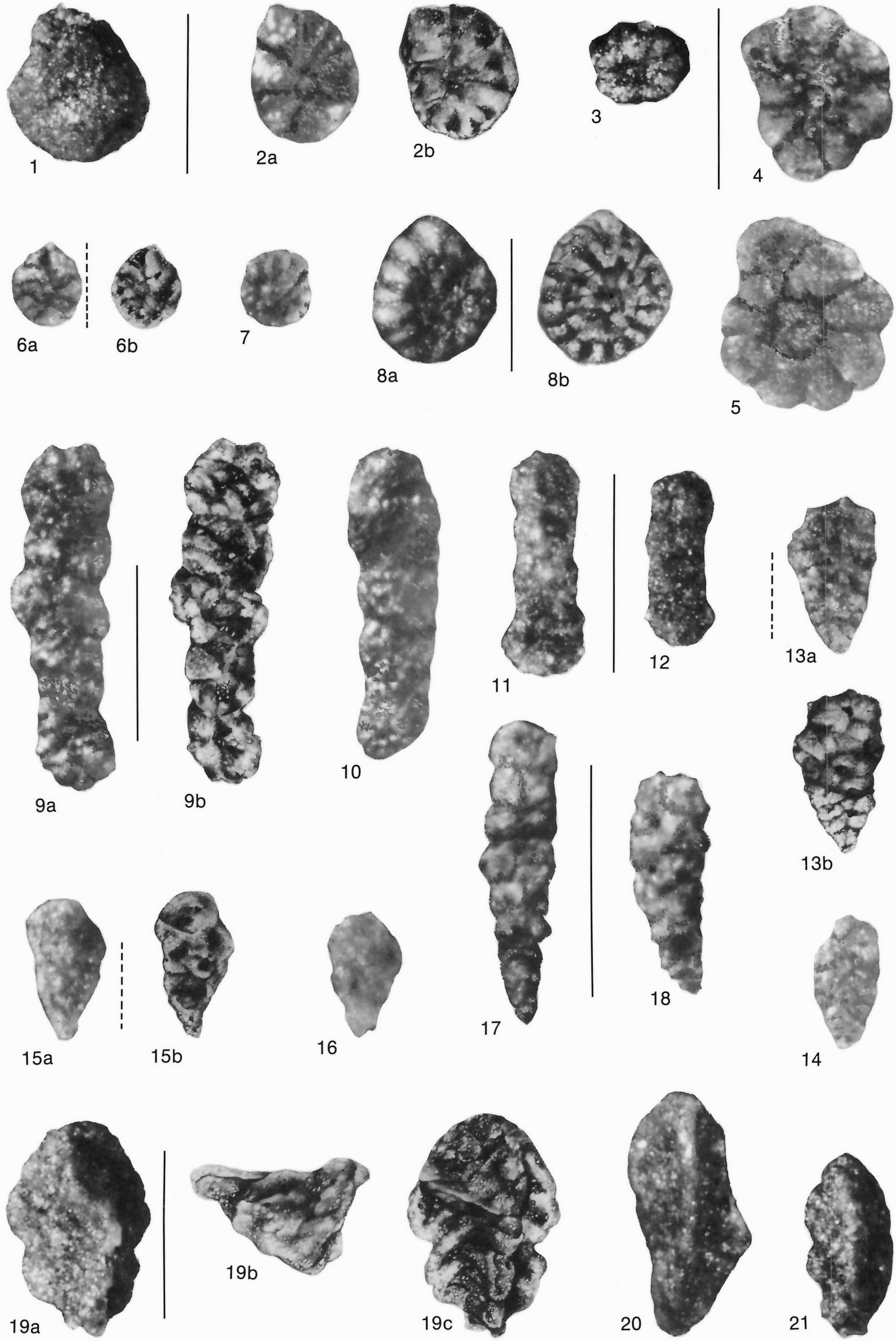
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Plate 4

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

All figured specimens are from the Arctic Red Formation unless otherwise specified.

Gaudryina subcretacea Cushman (p. 18)
Figure 1. Side views of hypotype GSC 34805, from the siltstone member, Middle Albian age; *1b*, camera lucida drawing.

Gaudryina barrowensis Tappan (p. 18)
Figure 2. Side view of hypotype GSC 34806, from the glauconite member, Martin House Formation of Early Albian age; *2b*, camera lucida drawing.

Gaudryina nanushukensis Tappan (p. 18)
Figure 3. Side and apertural views of hypotype GSC 34807, from the upper silty shale member of Middle Albian age; *3b* and *3c*, camera lucida drawings of side and apertural views.
Figures 4, 5. Side views of hypotypes GSC 34897 and 34898, from the upper silty shale and siltstone members, Middle Albian age.

Gaudryina stotti n. sp. (p. 20)
Figure 6. Side and apertural views of holotype GSC 34808, from the siltstone member, Middle Albian age; *6b* and *6c*, camera lucida drawings of apertural and side views.
Figures 7, 8. Side views of paratypes GSC 34809 and 34810, from the upper silty shale member of Middle Albian age.

Gaudryina canadensis Cushman (p. 20)
Figures 9–11. Hypotypes GSC 34811–13, from the lower silty shale and the upper silty shale members of Middle Albian age.

Psamminopelta bowsheri Tappan (p. 21)
Figures 12, 13. Side views of hypotypes GSC 34814 and 34815, from the siltstone member, Middle Albian age; *12b* and *13b*, camera lucida drawings.

Psamminopelta subcircularis Tappan (p. 21)
Figures 14, 15. Side views of hypotypes GSC 34816 and 34817, from the upper silty shale member of Late Albian age; *15b*, camera lucida drawing.

Trochammina stelcki n. sp. (p. 21)
Figures 16, 17. Views of paratype GSC 34818 and holotype 34819, from the lower silty shale member of Middle Albian age; figure 16, ventral views; *16b*, camera lucida drawing; figure 17, dorsal views; *17b* and *17c*, camera lucida drawings of dorsal and apertural views.

Trochammina rainwateri Cushman and Applin (p. 22)
Figures 18, 19. Dorsal views of figured specimens GSC 34820 and 34821, from the siltstone member, Middle Albian age.

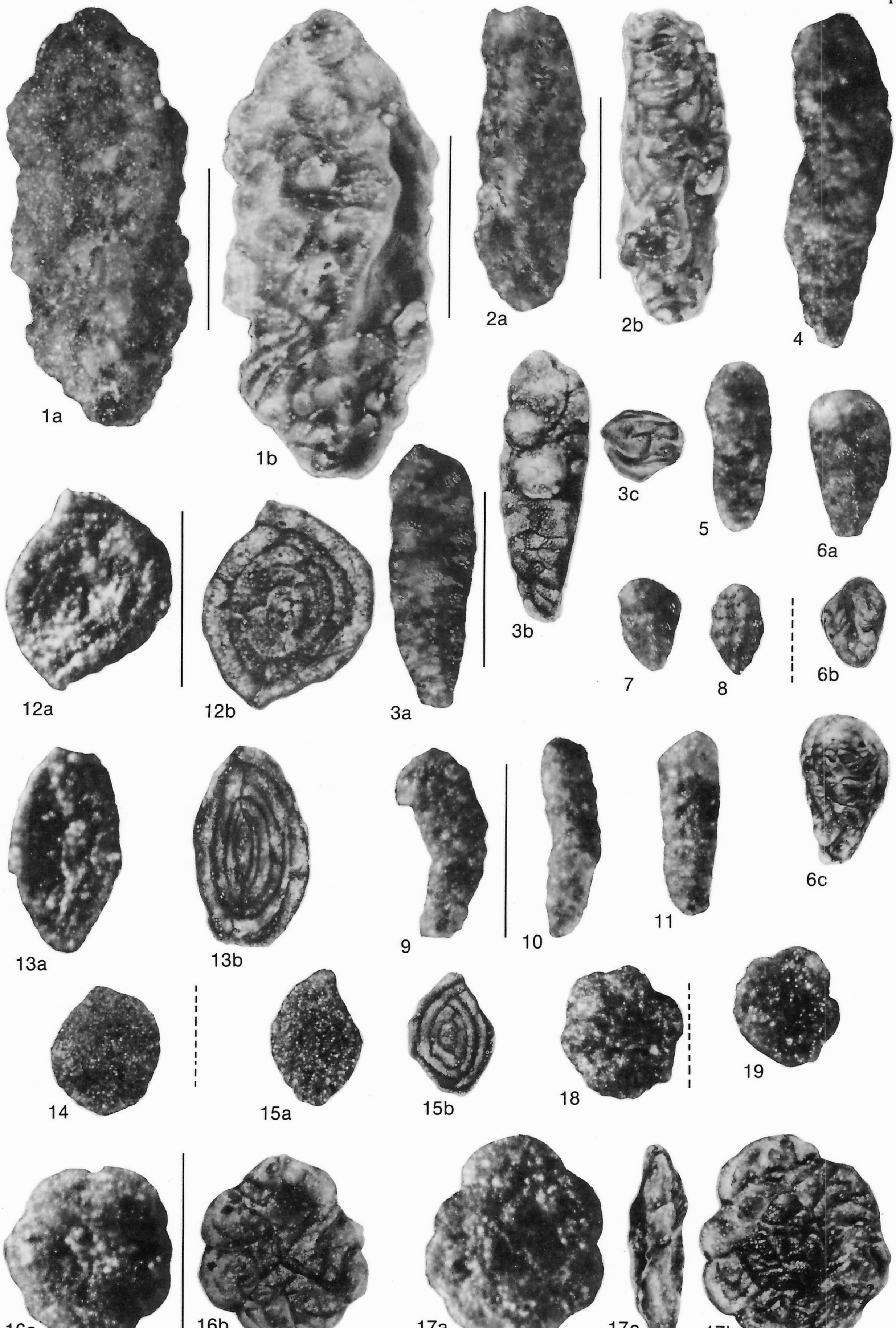
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Plate 5

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

Lenticulina fysta n. sp. (p. 22)
Figure 1. Side and apertural views of holotype GSC 34822, from the siltstone member, Arctic Red Formation of Middle Albian age; 1*b* and 1*c*, camera lucida drawings of side and apertural views.
Figure 2. Side view of paratype GSC 34823, from the siltstone member, Arctic Red Formation of Middle Albian age.

Lenticulina redunca n. sp. (p. 22)
Figures 3, 4. Side views of paratypes GSC 34825 and 34826, from the glauconite member, Martin House Formation of Lower Albian age.
Figure 5. Side and apertural views of holotype GSC 34824, from the glauconite member, Martin House Formation of Lower Albian age; 5*b* and 5*c*, camera lucida drawings of side and apertural views.

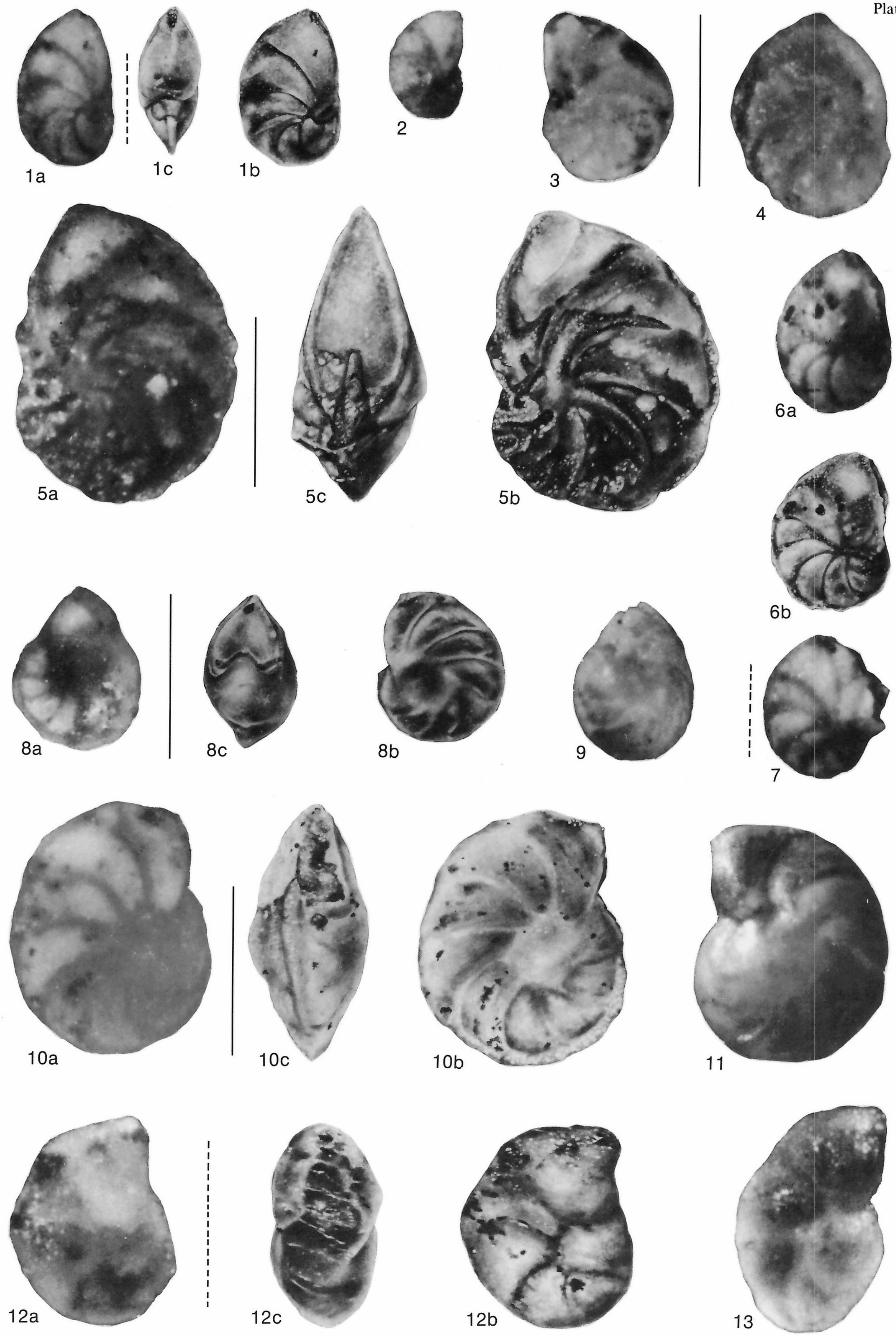
Lenticulina cf. *L. macrodisca* (Reuss) (p. 23)
Figures 6, 7. Side views of hypotypes GSC 34827 and 34828, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 6*b*, camera lucida drawing.

Lenticulina fusa n. sp. (p. 23)
Figure 8. Side and apertural views of holotype GSC 34829, from the upper part of basal sandstone member, Martin House Formation of Lower Albian age; 8*b* and 8*c*, camera lucida drawings.
Figure 9. Side view of paratype GSC 34830, from the upper part of the basal sandstone member, Martin House Formation of Lower Albian age.

Lenticulina macrodisca (Reuss) (p. 23)
Figure 10. Side and apertural views of hypotype GSC 34831, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 10*b* and 10*c*, camera lucida drawings.

Lenticulina bayrocki Mellon and Wall (p. 23)
Figure 11. Side view of holotype from the type collection of the Research Council of Alberta, basal Clearwater Formation of Lower Albian age.

Lenticulina topagorukensis Tappan (p. 24)
Figures 12, 13. Side and apertural views of hypotypes GSC 34832 and 34833, from the upper silty shale member, Arctic Red Formation of Early to Middle Albian age; 12*b* and 12*c*, camera lucida drawings.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12b
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Plate 6

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

Astacolus sp. (p. 24)
Figures 1–3. Side and apertural views of hypotypes GSC 34834–36, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 1*b* and 1*c*, side and apertural views, camera lucida drawings.

Saracenaria valanginiana Bartenstein and Brand (p. 24)
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Saracenaria grandstandensis Tappan (p. 24)
Figures 7, 8. Side and apertural views of hypotypes GSC 34840 and 34841, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 7*b* and 7*c*, camera lucida drawings of side and apertural views.

Saracenaria porcupinensis n. sp. (p. 26)
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Saracenaria trollopei Mellon and Wall (p. 26)
Figure 11. Side view of hypotype GSC 34844, from the glauconite member, Martin House Formation of Lower Albian age.

Saracenaria cf. *S. trollopei* Mellon and Wall (p. 26)
Figure 12. Side view of hypotype GSC 34899, from the glauconite member, Martin House Formation of Lower Albian age.

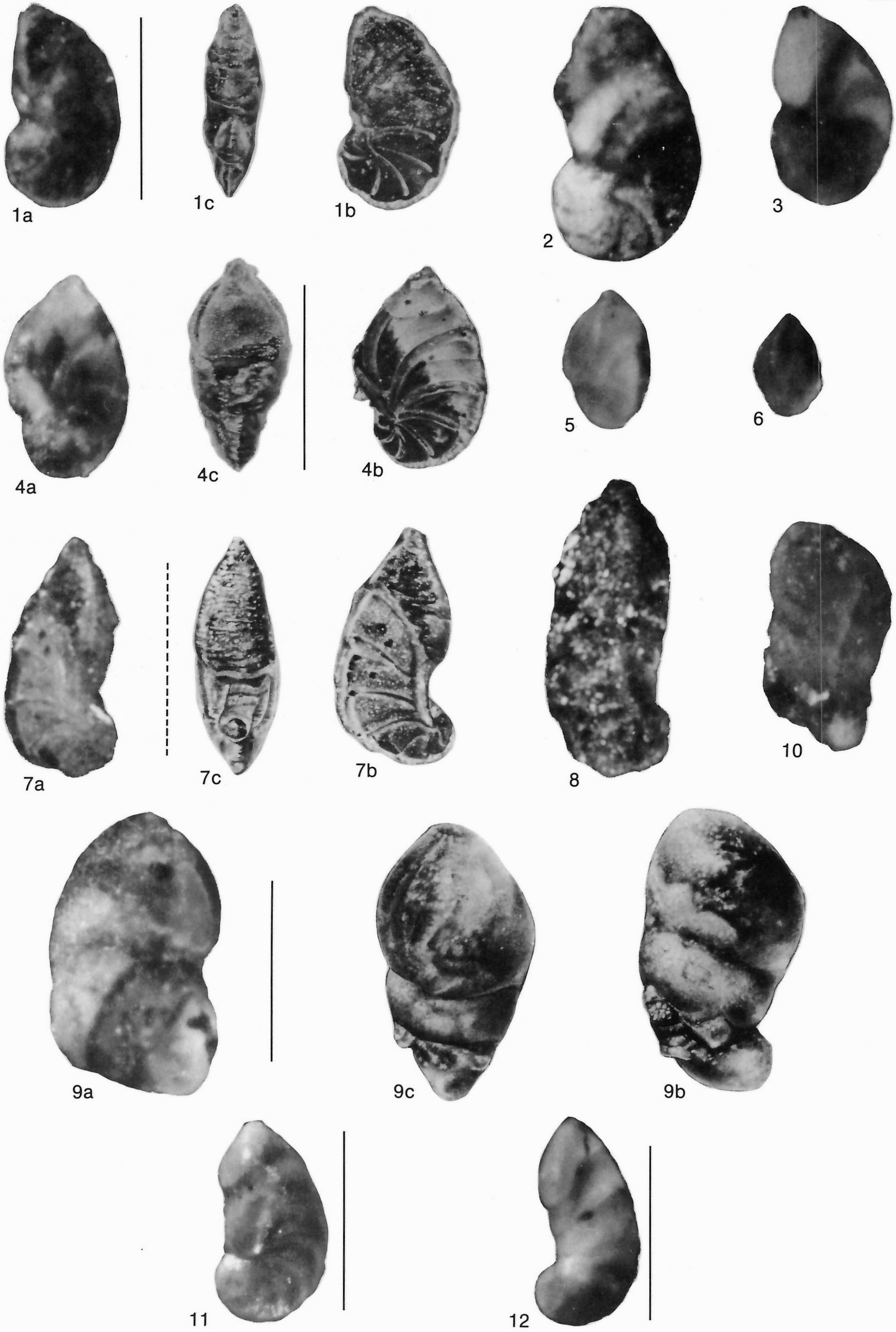
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Plate 7

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

Marginulinopsis umiatensis Tappan (p. 26)

Figure 1. Side and edge views of hypotype GSC 34845, from the basal part of the siltstone member, Arctic Red Formation of Middle Albian age; 1*b* and 1*c*, camera lucida drawings of side and edge views, respectively.

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Marginulinopsis cf. *M. umiatensis* Tappan (p. 27)

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Marginulinopsis jonesi (Reuss) (p. 27)

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Marginulinopsis collinsi Mellon and Wall (p. 27)

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Figure 12. Side view of holotype from the type collection of the Research Council of Alberta, described from 20 to 28 feet above the top of the Clearwater Formation of Lower Albian age.

Figures 13–17. Side views of paratypes from the type collection of the Research Council of Alberta, Clearwater and Moosebar formations of Lower Albian age.


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Plate 8

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

All samples are from the Arctic Red Formation.

Marginulina planiuscula (Reuss) (p. 27)
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Marginulina gatesi Tappan (p. 28)
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Marginulina cephalotes (Reuss) (p. 28)
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Vaginulina mountjoyi n. sp. (p. 28)
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Nodosaria nana Reuss (p. 28)
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Nodosaria doliiformis Eichenberg (p. 28)
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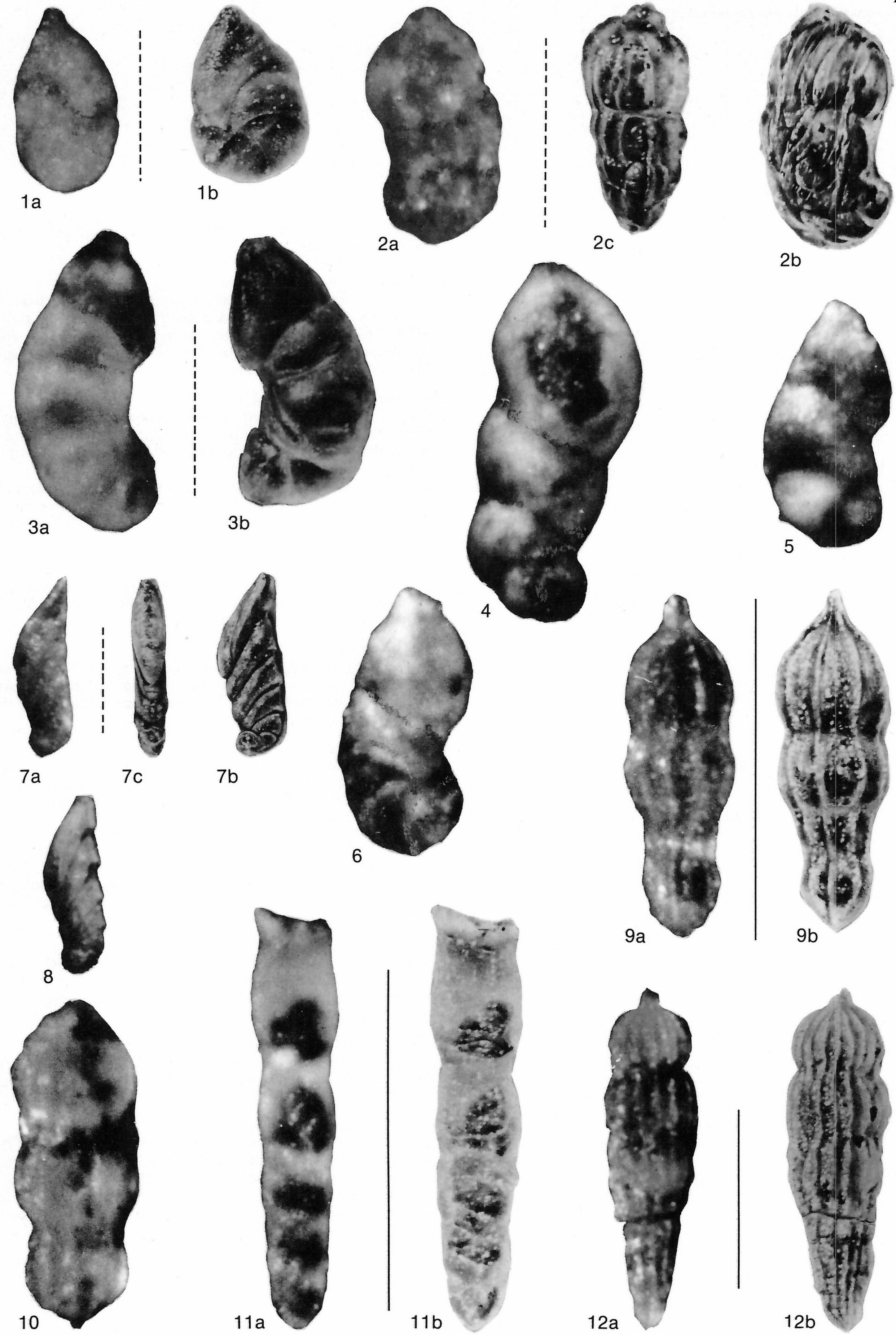
Nodosaria sp. (p. 29)
Figure 12. Side views of figured specimen GSC 34867, from the basal part of the lower silty shale member of Lower Albian age; 12*b*, camera lucida drawing.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12b

Plate 9

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

Dentalina dettermani Tappan (p. 29)
Figures 1, 2. Single chambers of hypotype GSC 34868, from the lower silty shale member, Arctic Red Formation of field station MJ 117-62, Middle Albian age, and hypotype GSC 34869, from the glauconite member, Martin House Formation of field station MJ 116-62, Lower Albian age.

Dentalina duplexa n. sp. (p. 29)
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Citharina cf. *C. acuminata* (Reuss) (p. 29)
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Globulina prisca Reuss (p. 30)
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Globorotalites alaskensis Tappan (p. 30)
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Plate 9

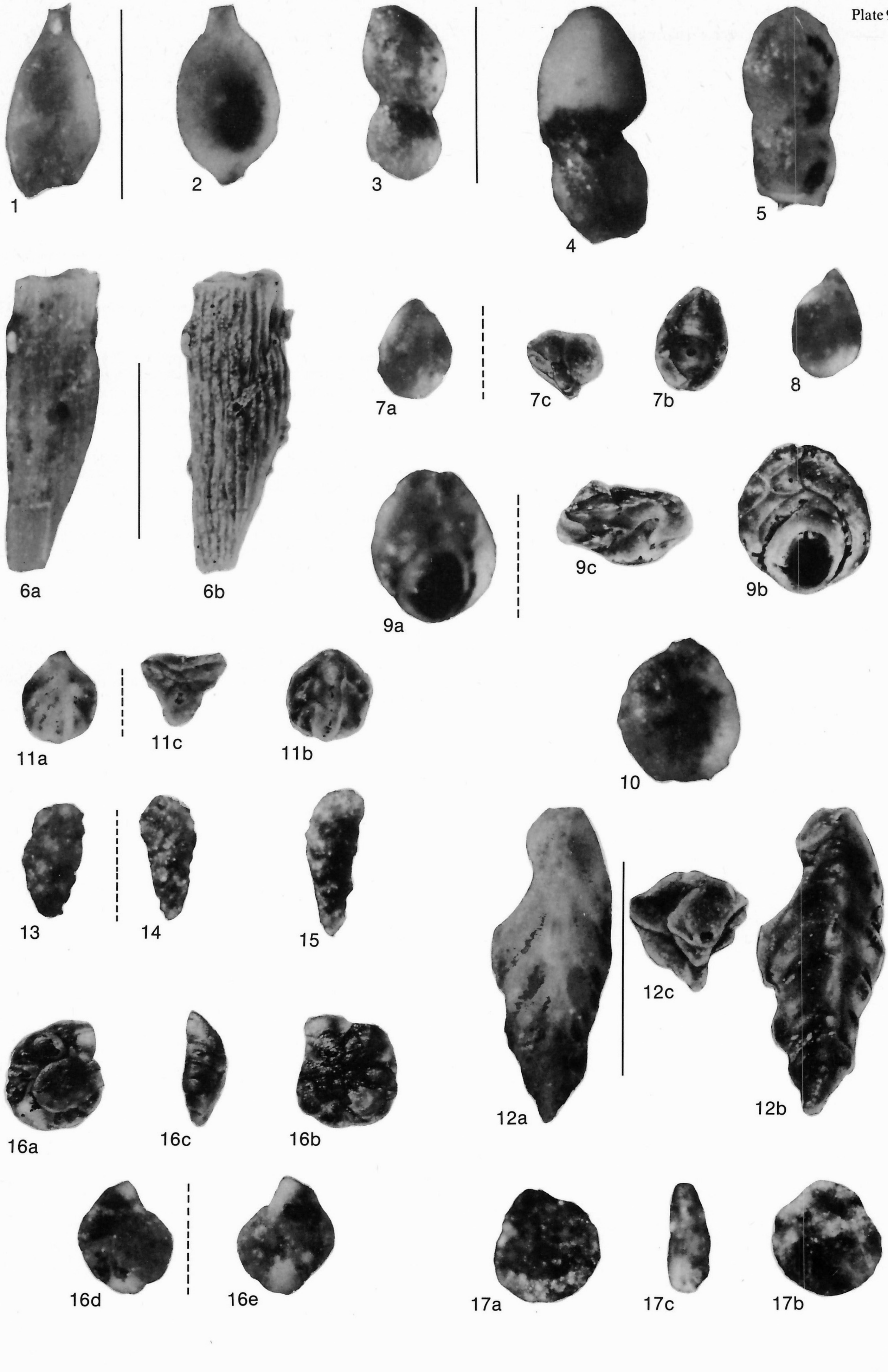

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Plate 10

Magnifications represented by graphic scales: solid line, 0.50 mm; broken line, 0.25 mm

All samples are from the Arctic Red Formation of Middle Albian age.

Globorotalites ex gr. *G. alaskensis* Tappan (p. 31)
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Globorotalites rotaliformis (McGill and Loranger) (p. 31)
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Gavelinella stictata (Tappan) (p. 33)
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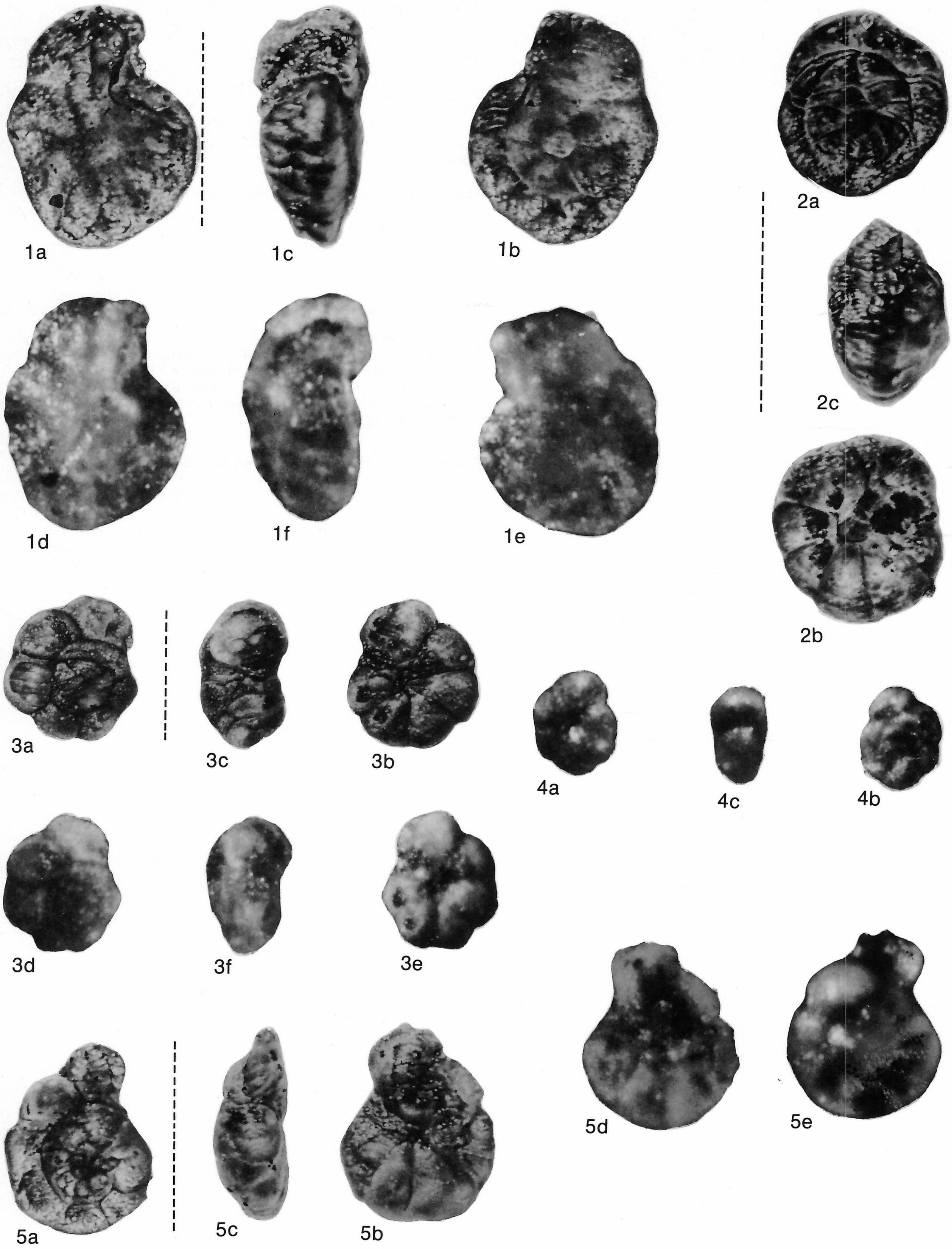
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Plate 11

Magnifications represented by graphic scale: broken line, 0.25 mm

Conorbina sp. (p. 33)

Figure 1. Views of figured specimen GSC 34890, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 1*a–c*, camera lucida drawings of dorsal, ventral, and edge views; *d–f*, photographs of the same views; *g*, ventral view, oiled specimen with incident lighting.

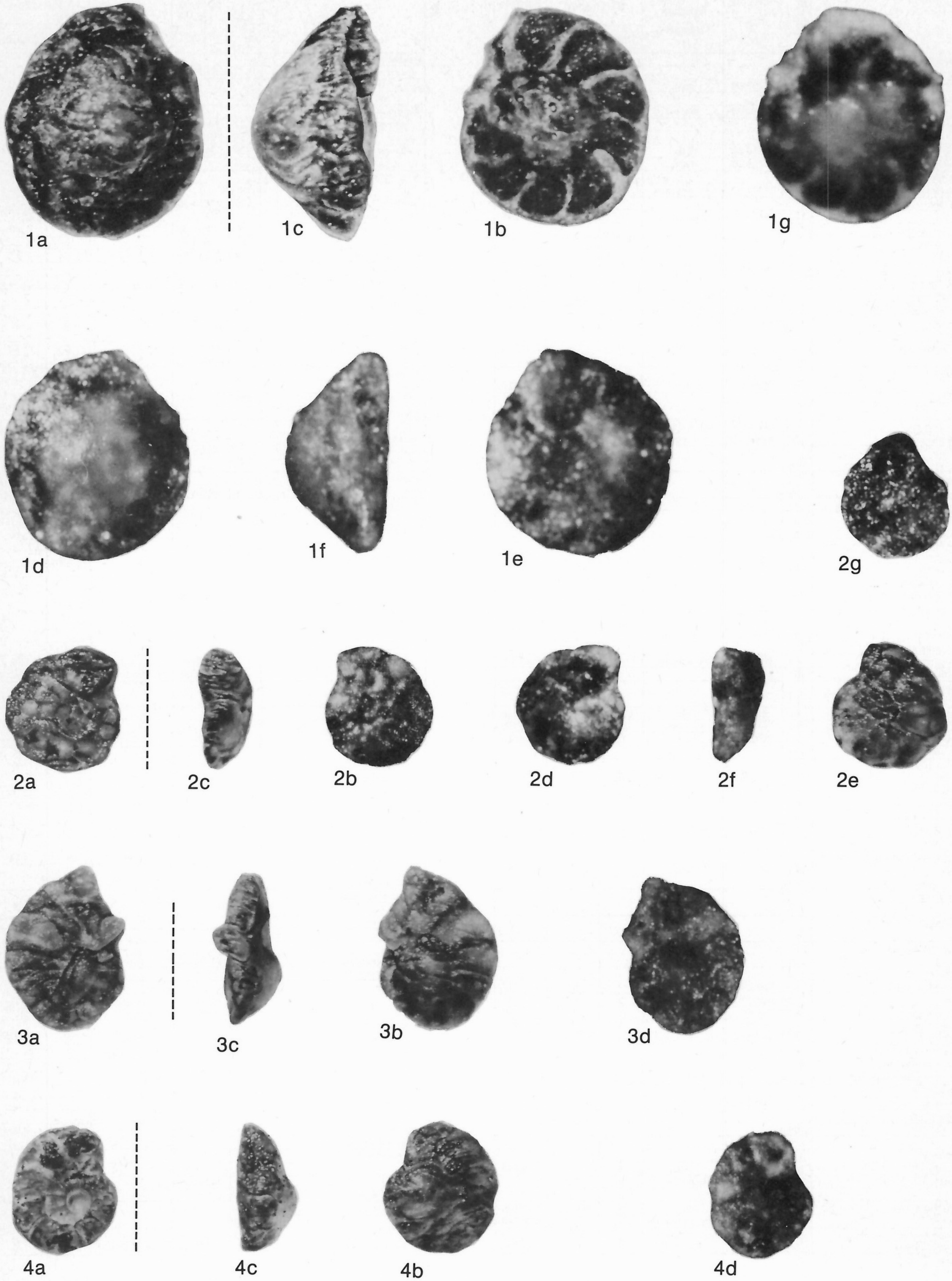
Gavelinella awunensis Tappan (p. 33)

Figure 2. Views of hypotype GSC 34891, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 2*a–c*, camera lucida drawings of ventral, dorsal, and edge views; *d–f*, photographs of the same views; *g*, ventral view of oiled specimen with incident lighting.

Gavelinella sp. (p. 33)

Figure 3. Views of figured specimen GSC 34892, from the glauconite member, Martin House Formation of Lower Albian age; 3*a–c*, camera lucida drawings of ventral, dorsal, and edge views; *d*, photograph of dorsal view.

Figure 4. Views of figured specimen GSC 34893, from the upper silty shale member, Arctic Red Formation of Middle Albian age; 4*a–c*, camera lucida drawings of ventral, dorsal, and edge views; *d*, photograph of ventral view.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Appendix — Species index

	Distribution Chart Column	Species GSC Type	Species Category	Illustration		Sample GSC Loc.
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spp.	66					
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cf. *A. reophacoides*	103	34794-95	hypo.	3	11, 12	C-25744
Ammodiscus						
spp.	91					
mangusi	111	34773-74	hypo.	1	19, 20	C-25750
rotalarius	7	34769-70	hypo.	1	15, 16	C-25735
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crenulatus n. sp.	116	34771-72	holo. and para.	1	17, 18	C-25750
Astacolus						
sp.	34	34834-36	fig. spec.	6	1, 2, 3	C-25734
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Bathysiphon						
spp.	15					
brosgei	82	34758-60	hypo.	1	1, 2, 3	C-25738
cf. *B. brosgei*	134					
emacerata n. sp.	98	34761-62	holo. and para.	1	4, 5	C-25741
strombotubulare n. sp.	112	34763-64	holo. and para.	1	6, 7	C-25767
Citharina						
spp.	40					
cf. *C. acuminata*	37	34873	hypo.	9	6	C-25735
recta	123					
Conorbina						
sp.	60	34890	fig. spec.	11	1	C-25735
Dentalina						
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duplexa n. sp.	44	34870-72	holo. and para.	9	3, 4, 5	C-25734
dettermani	50	34868-69	hypo.	9	1, 2	C-25746
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sp.	96					
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		34897-98				
subcretacea	26	34805	hypo.	4	1	C-25738
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stotti n. sp.	65	34808-10	holo. and para.	4	6, 7, 8	C-25738
? *Gaudryinella*	109					
Gavelinella						
spp.	63					
awunensis	62	34891	hypo.	11	2	C-25735
sp.	67	34892	fig. spec.	11	3, 4	C-25759
stictata	61	34889	hypo.	10	5	C-25734
cf. *G. intermedia*	140					
Globorotalites						
rotaliformis	59	34886	hypo.	10	2	C-25735
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umbilicatus	58					
cf. *G. umbilicatus*	41					
cf. *G. alaskensis*	57	34885	hypo.	10	1	C-25734
Globulina						
lacrima Reuss subsp. *canadensis*	95					
prisca	45	34874-75	hypo.	9	7, 8	C-25734
cf. *G. prisca*	121					
Glomospirella						
spp.	118					
Gyroidina or (*Serovaina* ?)						
spp.	107					
Haplophragmoides						
spp.	9					
multiplum	12					
yukonensis n. sp.	17	34882-83	holo. and para.	2	8, 9	C-25737
linki	10	34790-91	hypo.	3	6, 7	C-25744
cf. *H. spissum*	84	34792	hypo.	3	8	C-25747
topagorukensis	11	34785-87	hypo.	3	1, 2, 3	C-25731
peelensis n. sp.	18	34788-89	holo. and para.	3	4, 5	C-25734
sp. C. Stelck and Wall	108					
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H. gryzbowski	69					
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topagorukensis	32	34832-33	hypo.	5	12, 13	C-25735
fysta n. sp.	51	34822-23	holo. and para.	5	1, 2	C-25740
redunca n. sp.	52	34824-26	holo. and para.	5	3, 4, 5	C-25754
cf. *L. macrodisca*	53	34827-28	fig. spec.	5	6, 7	C-25735
Lenticulina						
fusa n. sp.	73	34829-30	holo. and para.	5	8, 9	C-25764
Lingulina						
cf. *L. rediviva*	47					
Marginulina						
cephalotes	22	34858-61	hypo.	8	3, 4, 5, 6	C-25734
gatesi	55	34857	hypo.	8	2	C-25735
planiuscula	39	34856	hypo.	8	1	C-25734
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Marginulinopsis						
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collinsi	125	34854-55	hypo.	7	10, 11	C-25753
collinsi and vars.		RCA		7	12–17	
jonesi	38	34851-53	hypo.	7	7, 8, 9	C-25734
umiatensis	54	34845-47	hypo.	7	1, 2, 3	C-25735
cf. *M. umiatensis*	80	34848-50	hypo.	7	4, 5, 6	C-25734
Neobulimina						
subcretacea	20	34880-82	hypo.	9	13, 14, 15	C-25733
Nodosaria						
cf. *N. concinna*	94					
doliiformis	83	34866	hypo.	8	11	C-25737
cf. *N. doliiformis*	43					
nana	42	34864-65	hypo.	8	9, 10	C-25734
sp.	122	34867	hypo.	8	12	C-25753
Planularia						
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Psamminopelta						
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bowsheri	78	34814-15	hypo.	4	12, 13	C-25736
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Pseudobolivina						
sp.	75	34798-99	hypo.	3	15, 16	C-25735
Pyrulina						
cf. *P. cylindroides*	145					
Quadrimorphina						
sp.	120					
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sp.	132					
Reophax						
spp.	87					
cf. *R. incompta*	27	34775-77	hypo.	2	1, 2, 3	C-25735
minuta	1					
cf. *R. minuta*	101					
troyeri	2					
fuscus n. sp.	105	34778-81	holo. and para.	2	4, 5, 6, 7	C-25734
vasiformis n. sp.	5	34894-96	holo. and para.	1	12, 13, 14	C-25731
Rectoglandulina						
cf. *R. kirschneri*	48					
Saccammina						
spp.	85					
horrida n. sp.	99	34765-66	holo. and para.	1	8, 9	C-25741
Saracenaria						
grandstandensis	23	34840-41	hypo.	6	7, 8	C-25734
cf. *S. spinosa*	74					
trollopei	129	34844	hypo.	6	11, 12	C-25759
valanginiana	24	34837-39	hypo.	6	4, 5, 6	C-25735
cf. *S. valanginiana*	119					
porcupinensis n. sp.	128	34842-43	holo. and para.	6	9, 10	C-25754
Sigmomorphina						
sp.	46	34876-77	fig. spec.	9	9, 10	C-25735
Siphotextularia						
cf. *S. andersoni*	31					
Spiroplectammina						
spp.	29					
cf. *S. koveri*	90					
Textularia						
spp.	143					
cf. *T. topagorukensis*	30	34796-97	hypo.	3	13, 14	C-25735
cf. *T. gravenori*	142					
Tribrachia						
sp. 2	49	34879	hypo.	9	12	C-25734
sp. 1	71	34878	hypo.	9	11	C-25735
Trochammina						
rainwateri	13	34820-21	hypo.	4	18, 19	C-25738
stelcki n. sp.	25	34818-19	holo. and para.	4	16, 17	C-25747
Tritaxia						
solea n. sp.	64	34802-04	holo. and para.	3	19, 21	C-25734,
						C-25735
Valvulineria						
sp.	130					
loetterlei	56	34887-88	hypo.	10	3, 4	C-25734
cf. *V. loetterlei*	21					
Verneuilinoides						
sp.	77					
tailleuri	4	34800-01	hypo.	3	17, 18	C-25731
cf. *V. borealis*	76					
Vaginulina						
sp.	35					
cf. *V. kochi*	35					
mountjoyi n. sp.	36	34862-63	holo. and para.	8	7, 8	C-25735

GSC