PROVINCE OF ALBERTA
Research Council of Alberta Report No. 75
University of Alberta, Edmonton, Alberta

Middle Albian Foraminifera from Athabasca and Peace River Drainage Areas of Western Canada

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EDMONTON
PRINTED BY A. SHNITKA, QUEEN'S PRINTER
1956

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FOREWORD

The Research Council of Alberta publishes the following report as the fourth in a series dealing with the microfaunal dating of the oil- and gas-bearing Cretaceous sequence of Alberta. (The first three reports in the series are Research Council of Alberta Reports Nos. 68, 70, and Part I of No. 72). Continuing exploration of various Lower Cretaceous horizons demands a more comprehensive exposition of paleontological data for the discrimination of potentially productive sands.

These studies are based on surface collections made by the senior writers in 1947 under assignment from Imperial Oil Limited, Calgary, and on collections made by W. G. Bahan while mapping for Bear Oil Company along the lower Athabasca river in 1949. Research on these collections was conducted by the senior authors at Stanford University and later at the University of Alberta. The junior authors carried out research on the collections at the University of Alberta. The primary results of these studies were developed as academic theses at Stanford University and at the University of Alberta.

Financial assistance toward the project was granted to C. R. Stelck through an Imperial Oil graduate fellowship and the Eric Knight Jordan fellowship at Stanford University. W. G. Bahan received financial assistance from Bear Oil Company and L. J. Martin was accorded financial assistance by Canadian Gulf Oil Company. Technical assistance was received from the staff of the Research Council of Alberta at Edmonton. Megafaunal collections include those made by the Research Council of Alberta, Imperial Oil Limited, Pacific Petroleums, and Stanolind Oil and Gas Company, deposited in the Museum of the Department of Geology at the University of Alberta.

Valuable discussions have been held with Drs. R. T. D. Wickenden and J. A. Jeletzky of the Geological Survey of Canada on problems related to Middle Albian biostratigraphy of Western Canada.

Middle Albian Foraminifera from Athabasca and Peace River Drainage Areas of Western Canada

ABSTRACT

Fifty-nine species and subspecies of Foraminifera—of which ten are new—from the Clearwater, Grand Rapids and Joli Fou formations of the lower Athabasca drainage and from the lower part of the Fort St. John group of the upper Peace River area are figured and described. Microfaunal zones are equated to megafaunal sequences of the Middle Albian substage of the Lower Cretaceous. The calcareous foraminiferal fauna of the lower Clearwater formation is found also in the lower Moosebar shale of northeastern British Columbia and in the Wilrich member of the Spirit River formation in northwestern Alberta. The upper Clearwater formation is correlated with the Falher member of the Spirit River formation and with the Cummings member of the Mannville formation of east-central Alberta. The Harmon shale of northwestern Alberta is correlated with that part of the Fort St. John group immediately overlying the Gates sandstone. The Joli Fou microfauna is correlated with that of the Lower Shale member of the Colorado group of central and eastern Alberta, southern Saskatchewan and southwestern Manitoba. The foraminiferal assemblages indicate a transgressive shallow epicontinental sea with brackish margins.

INTRODUCTION

A boreal flooding of the northern part of the North American continent during Middle Albian (late Lower Cretaceous) time brought marine faunas of Asiatic and European affinities into Western Canada. The flooding covered much of what is now the Mackenzie, Peace, Athabasca and North Saskatchewan River drainages. Transgression from the Arctic inundation was progressive and shore-line facies of the Middle Albian sea are found at different stratigraphic levels. Correlation is dependent on the contained megafossils and Foraminifera within the Fort St. John group of strata of northeastern British Columbia, northern Alberta, and within equivalent strata in the Northwest Territories of Canada.

Over these areas the ammonite genera *Sonneratia, Puzosia, Cleoniceras, Beudanticeras, Lemuroceras, Gastroplites* and *Dipoloceras* act as age indicators. *Sonneratia, Puzosia, Cleoniceras* and *Beudanticeras* have wide distribution throughout the world; *Lemuroceras* is Tethyan and *Gastroplites* is a local American form with some Palearctic connections and a rare occurrence in England.

The English occurrence of *Gastroplites* is found in the uppermost *cristatum* subzone of the Middle Albian substage of the Gault formation. *Gastroplites* then serves as a marker for the top of the Middle Albian in Canada. The genus *Lemuroceras* is found in the *mammillatum* subzone in Madagascar, thereby serving as a marker for the base of the Middle Albian in Western Canada. *Gastroplites cantianus* Spath, the English occurrence of the genus, is found at the very top of the Peace River sandstone on the upper Peace river and *Dipoloceras* cf. *fredericksburgense* Scott occurs in the base of the overlying shales. The Middle Albian-Upper Albian boundary, therefore, is very closely approximated by the "Commotion" formation-Shaftesbury formation contact in northeastern British Columbia.

Lemuroceras cf. *indicum* Spath, *Cleoniceras* cf. *subbayleyi* Spath occur in the lower part of the Loon River formation of the Peace River and Liard River areas, placing the Middle Albian-Lower Albian boundary within the lower part of that formation.

On the basis of these ammonite datings the microfauna of the Middle Albian is recognized in the Moosebar formation and Commotion formation correlatives of northeastern British Columbia; from the Loon River and Peace River formations (Spirit River and Peace River formations of Workman *et al.*, 1954) of northwestern Alberta; from the McMurray, Clearwater, Grand Rapids and Joli Fou formations of northeastern Alberta; and from the Cummings member of the Mannville formation and basal Lloydminster shale of east-central Alberta.

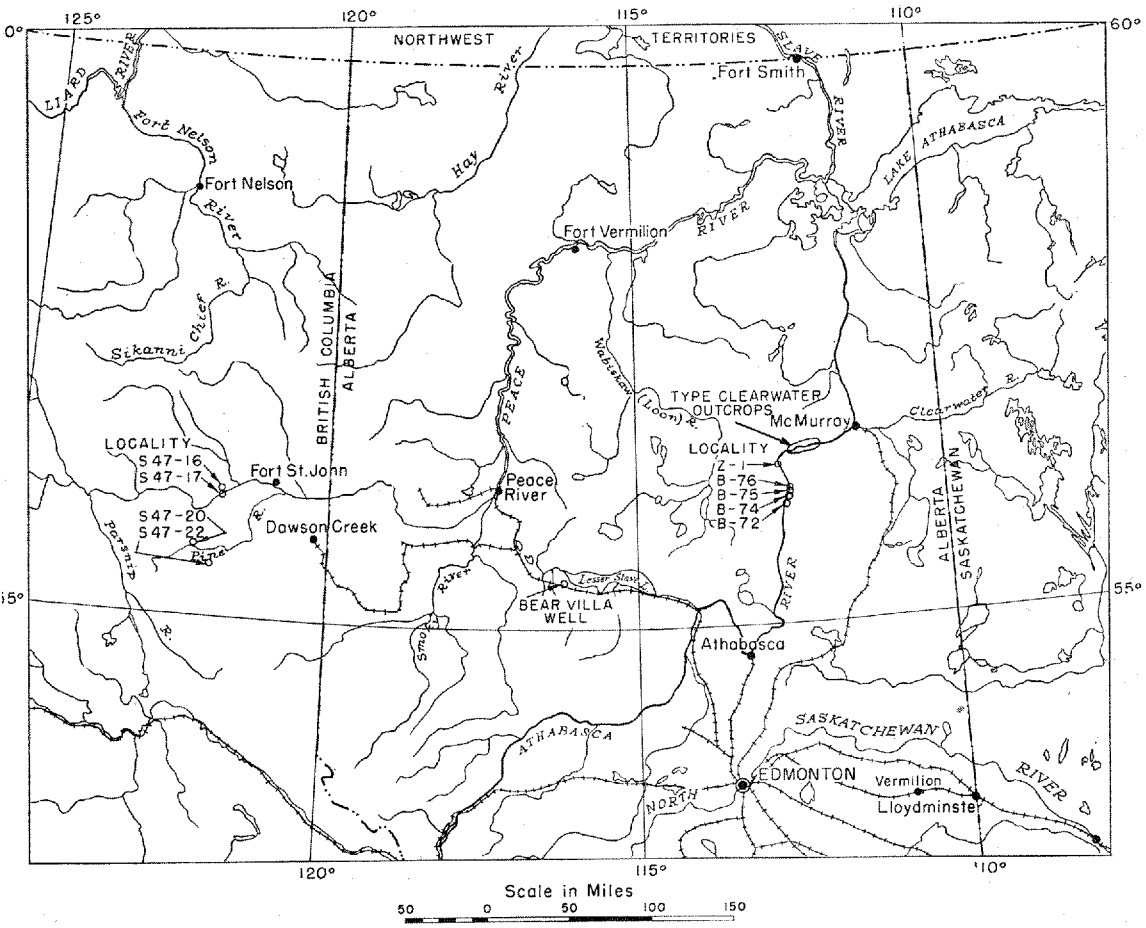
The microfaunas of the Moosebar, Loon River and Clearwater formations are dominantly calcareous; the remainder of Western Canadian Middle Albian foraminiferal suites are arenaceous. The calcareous microfaunas show European and Texan affinities, but the arenaceous forms are in large measure provincial or previously undescribed.

The calcareous Foraminifera are dominantly members of the families Lagenidae and Rotaliidae with the principal genera *Saracenaria, Discorbis, Marginulinopsis, Lenticulina,* and *Pseudonodosaria.* The arenaceous faunas of the Middle Albian are mainly members of the Lituolidae, Verneuilinidae, Valvulinidae, and Silicinidae with the principal genera *Haplophragmoides, Ammobaculites, Gaudryina, Eggerella,* and *Miliammina.*

The gross faunal assemblages represent the onlapping of a shallow epicontinental sea from the Arctic with littoral and brackish forms outlining the southern limits of the onlap.

FIGURE 1.

DRAINAGE AREAS OF PEACE AND ATHABASCA RIVERS, WESTERN CANADA

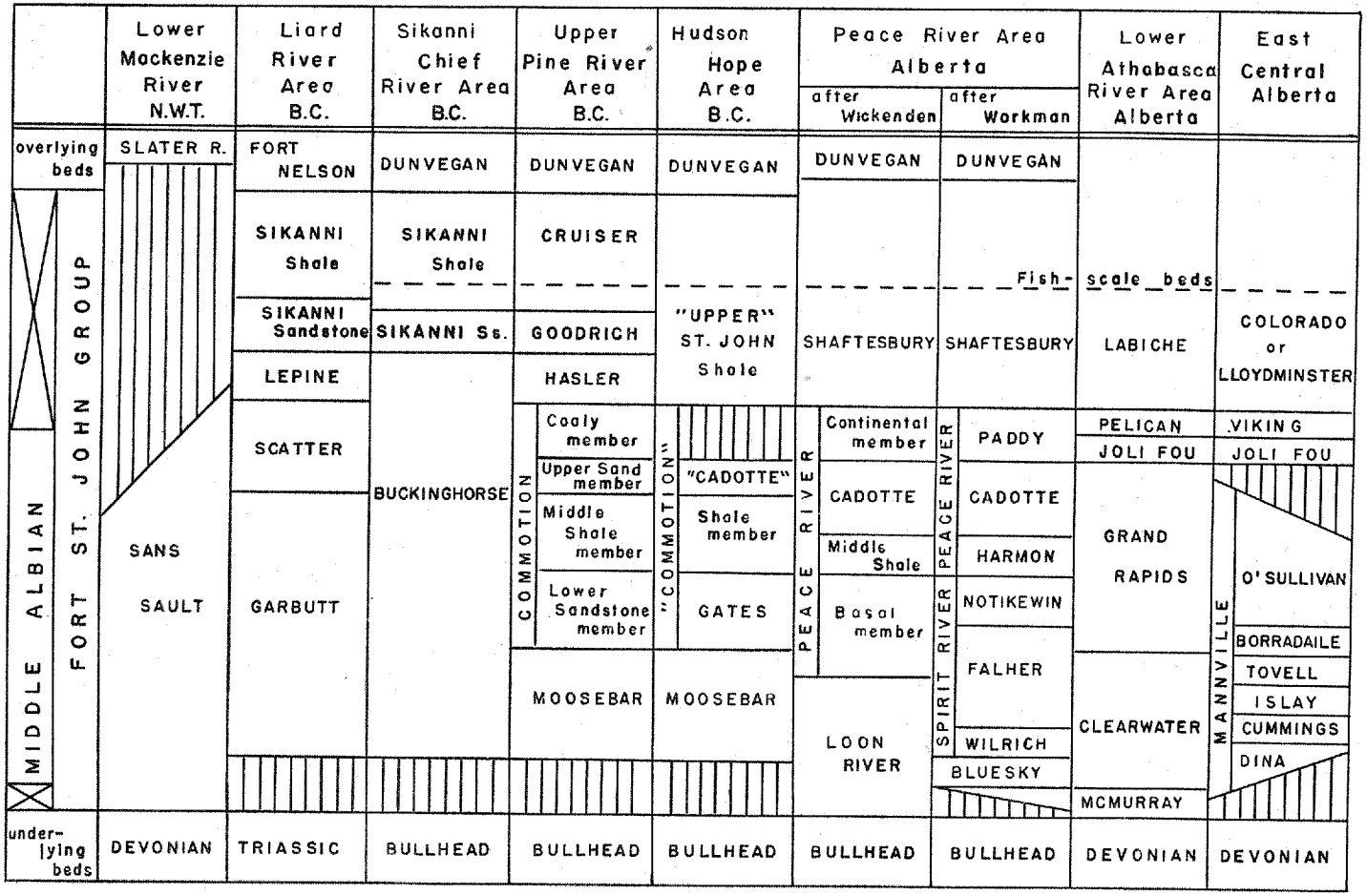


STRATIGRAPHY

The Middle Albian Foraminifera described in this paper come from a sequence of marine clastics known as the Fort St. John group which has optimum development in northeastern British Columbia and is absent or only partially represented in the southern part of Western Canada. Terminology of the Fort St. John group is complicated because of its large areal extent and relatively shallow conditions of deposition. The writers offer the following nomenclature chart to give a summary of the formations and members of the Fort St. John group (Fig. 2).

In the upper Pine River area of northeastern British Columbia the Fort St. John group consists of five formations with an aggregate thickness of around 4,000 feet. McLearn and Kindle (1950, p. 73) have elaborated on the lithology of these sections. Eastward and northward the sand tongues of the group fade out, reducing the

Figure 2: Terminology FORT ST. JOHN GROUP



aggregate thickness of the group to somewhat less than 2,000 feet in the Peace River area of Alberta. In northeastern Alberta, shoreline facies reappear in the section and give Fort St. John equivalents an aggregate thickness of around 1,000 feet. In east-central Alberta where the lower part of the group is largely continental, the aggregate thickness of the equivalent strata is around 800 feet.

For continuity of section the Peace River area of northeastern British Columbia and Alberta gives the more complete stratigraphic picture and the primary zonation by megafossils is largely obtained from this area.

Zonation by Megafossils

Megafossils assist in unravelling the stratigraphy of the Fort St. John group. A continuous sequence of strata in the Peace River area shows a succession of ammonites and pelecypods that have been known since the early days of geological exploration in Western Canada. McLearn (1944) uses the following succession for the Lower Cretaceous of northern Alberta:

Lower Cretaceous	*Neogastroplites, Posidonia nahwisi* *Gastroplites, Inoceramus cadottensis* *Lemuroceras, Beudanticeras affine* *Elliptio biornatus*

For the several thousand feet of strata involved in the Albian of the Peace River area, a tentative sequence of faunas from the top of the Albian to the base of the Fort St. John group is proposed as follows:

Upper Albian	*Neogastroplites wyomingensis* (Reeside and Weymouth) *Neogastroplites cornutus* (Whiteaves) *Neogastroplites selwyni* McLearn *Posidonia goodrichensis* McLearn *Posidonia moberliensis* McLearn *"Ophiura"* sp. *Gastroplites* cf. *liardense* (Whiteaves)
Middle Albian	*Inoceramus* cf. *comancheanus* Cragin *Gastroplites* cf. *cantianus* Spath *Gastroplites canadensis* (Whiteaves) *Lophidiaster* cf. *silentiensis* McLearn *Beudanticeras* (*"Lemuroceras"*) *mcconnelli* (Whiteaves) *Lemuroceras irenense* McLearn *Lemuroceras* cf. *indicum* (Spath)
Lower Albian	*Cleoniceras* cf. *subbayleyi* Spath *Sonneratia* cf. *kitcheni* Spath

The top of the Albian (top of the Lower Cretaceous) comes within the fish scale zone (see Fig. 2) in the Shaftesbury formation. *Neogastroplites wyomingensis* and *N. cornutus* come from the shale beds below the fish scales and above the Goodrich sands; *Neogastro-*

plites selwyni, Posidonia goodrichensis, and P. moberliensis come from the Goodrich and Sikanni sands; *"Ophiura"* sp. comes from the top of the Hasler and Buckinghorse formations; *Gastroplites* cf. *liardense* comes from the base of the Lepine formation. *Inoceramus* cf. *comancheanus* comes from the Joli Fou shale; *Gastroplites* cf. *cantianus* comes from the top of the Commotion equivalent on the upper Peace river; *Gastroplites canadensis* comes from the Cadotte formation and from the Harmon shale; *Lophidiaster* cf. *silentiensis* comes from the topmost beds of the Gates formation. *Beudanticeras ("Lemuroceras")* *mcconnelli* comes from the lower part of the Gates formation, from the Clearwater formation, and from the upper part of the Loon River formation. *Lemuroceras irenense* comes from the upper part of the Moosebar formation; *Lemuroceras indicum* and *Cleoniceras subbayleyi* come from the lower Loon River shale and *Sonneratia* cf. *kitcheni* from the Sans Sault group in the Arctic.

Zonation by Microfossils

The Middle Albian section of the Fort St. John group yields an excellent set of diagnostic Foraminifera that may be used for identification of stratigraphic horizon. Mellon and Wall (1956, Fig. 3) indicate a partial zonation of the Middle Albian in the McMurray area of Alberta. This sequence may now be extended somewhat as follows:

Joli Fou	[*Haplophragmoides gigas* zone
Grand Rapids	[Cadotte microfaunal zone [*Haplophragmoides multiplum* zone
Clearwater	[*Haplophragmoides gigas minor* zone [*Marginulinopsis collinsi* zone
Upper McMurray	[*Trochammina mcmurrayensis* zone

Lower McMurray—unnamed microfaunal zone

The distribution and significance of each of these zones of the Middle Albian of the Fort St. John group are discussed separately here.

TROCHAMMINA MCMURRAYENSIS Zone

The *Trochammina mcmurrayensis* zone may be defined as the uppermost part of the McMurray formation and the basal glauconitic sands of the Clearwater formation in the Socony-Vacuum Oil Sands Well No. 27. The zone is characterized by the following Foraminifera:

Ammodiscus sp.
Haplophrogmoides cf. *sluzari* Mellon and Wall
Haplophragmoides sp.
Miliammina sproulei Nauss var. *gigantea* Mellon and Wall
Trochammina mcmurrayensis Mellon and Wall
Trochammina ? sp.
Verneuilinoides ? sp.

This arenaceous fauna (illustrated by Mellon and Wall 1956, Plate I), reflects the brackish water conditions in the margins of the McMurray delta. A brackish megafauna is recorded (Russell, 1932) from the top of the McMurray formation which contains the following species:

Unio (Elliptio) biornatus Russell
Murraia naiadiformis Russell
Viviparus murraiensis Russell
Lioplacodes bituminis Russell
Goniobasis? multicarinata Russell
Melania multorbis Russell
Melampus athabascensis Russell
Astrate natosini MsLearn

Mellon and Wall (1956) assign a Middle Albian age to these faunas approximately equivalent to the horizon of *Lemuroceras* cf. *indicum*. The latter in Canada represents the *mammillatum* zone at the base of the Middle Albian of the Gault of England.

The Foraminifera of this zone have not been recognized as yet from outside the McMurray area although some of the microfaunal elements, such as an unnamed *Verneuilinoides*? do persist into the overlying Clearwater formation. The megafauna, however, is more widely known and appears in the lower part of the Mannville formation as far south as the Edmonton area (Ajax Atim No. 2 Well in Lsd. 11, Sec. 3, Tp. 54, Rge. 26, W. 4th Meridian, and Texaco-McColl Majeau Lake No. 1 Well in Lsd. 12, Sec. 1, Tp. 57, Rge. 3. W. 5th Meridian). Deep water to the west of the McMurray area at this time carried the marine equivalent of this zone. Within the lower part of the Loon River formation marine equivalents of the McMurray formation are assumed to extend throughout the lower Peace and Mackenzie River drainages, giving a connection with the Arctic Ocean. Marine flooding at this time did not reach south of central Alberta and it is improbable that any brackish or marine equivalents of the *T. mcmurrayensis* zone are present east of Alberta.

MARGINULINOPSIS COLLINSI Zone

The *Marginulinopsis collinsi* faunal zone extends from the top of the basal glauconitic sand of the Clearwater formation of type section, to about 110 feet above the base of the formation (165 feet below the top.) The zone is characterized by the following microfossils:

Ammobaculites humei Nauss
Ammodiscus sp.
Bathysiphon sp. B (this report)
Dentalina sp. B (this report) — rare
Discorbis norrisi Mellon and Wall
Discorbis cf. *D. turbo* (d'Orbigny) — rare
Eggerella sp. A (this report)
Globulina lacrima Reuss var. *canadensis* Mellon and Wall

Gyroidina cf. *G. nitida* (Reuss)
Haplophragmoides gigas Cushman var. *minor* Nauss
Haplophragmoides sluzari Mellon and Wall
Haplophragmoides sp. A (this report)
Lenticulina bayrocki Mellon and Wall
Marginulinopsis collinsi Mellon and Wall
Marginulinopsis collinsi var.
Miliammina subelliptica Mellon and Wall
Nodosaria aff. *N. proboscidea* Reuss
Patellina elliotti n. sp.
Pseudonodosaria clearwaterensis Mellon and Wall
Quadrimorphina albertensis Mellon and Wall
Quadrimorphina sp.
Saracenaria projectura n. sp.
Saracenaria trollopei Mellon and Wall
Saracenaria trollopei var.
Saracenaria sp. A (this report)
Saracenaria sp. B (this report)
Saracenaria sp. C (this report)
Tritaxia athabascensis Mellon and Wall
Vaginulina sp.
Verneuilinoides ? sp.

This dominantly calcareous fauna reflects the deepening of the water as the Clearwater sea advanced over the McMurray delta to enter west-central Saskatchewan. In Alberta no Middle Albian calcareous fauna has been reported southwest of the Redwater oil field (40 miles northeast of Edmonton). The deepening waters brought an additional megafauna that carries the following species in the Athabasca River area:

Beudanticeras affine (Whiteaves)
Beudanticeras glabrum (Whiteaves)
Beudanticeras mcconnelli = *Lemuroceras mcconnelli* (Whiteaves)
Lemuroceras cf. *belli* McLearn
Entolium irenense McLearn
Pecten alcesianus McLearn
Camptonectes matonabbei McLearn
Brachidontes athabaskensis McLearn
Nucula athabaskensis McLearn
Inoceramus dowlingi McLearn
Arctica limpidiana McLearn
Thracia kissoumi McLearn
Yoldia kissoumi McLearn
Goniomya matonabbei McLearn
Psilomya peterpondi McLearn
Psilomya elongatissima McLearn
Protocardia alcesiana McLearn
Onestia onestae (McLearn)

Tellina dowlingi McLearn
Turnus lacombi McLearn

A large number of the above megafossils range upward into the *Haplophragmoides gigas minor* microfaunal zone and in the case of the brackish-tolerant forms, the two zones seem to coalesce in the marginal extensions of the Clearwater sea.

The microfauna of the *M. collinsi* zone has a widespread distribution and several of the forms are similar to those found in the Gault formation of England and in the Walnut formation of Texas. The following elements are common to both the lower Moosebar shale of the Pine River area of British Columbia and the lower Clearwater shale of the Athabasca River area:

Globulina lacrima Reuss var. *canadensis* Mellon and Wall
Gyroidina cf. *G. nitida* (Reuss)
Marginulinopsis collinsi var.
Pseudonodosaria clearwaterensis Mellon and Wall
Quadrimorphina albertensis Mellon and Wall
Quadrimorphina sp.
Saracenaria trollopei Mellon and Wall

The following elements are paired for the middle Loon River shale of the Peace River area of Alberta (Wickenden, 1951) and the lower Clearwater formation of the Athabasca River area:

Middle Loon River	Clearwater
Ammobaculites sp. A.	*A. humei* Nauss
Ammodiscus sp. A	*Ammodiscus* sp.
Anomalina sp.	*Discorbis norrisi* Mellon and Wall
Gyroidina sp. A	*G.* cf. *G. nitida* (Reuss)
Haplophragmoides sp. A	*H. sluzari* Mellon and Wall
Lenticulina sp.	*L. bayrocki* Mellon and Wall
Marginulina sp. A (pars)	*Marginulinopsis collinsi* Mellon and Wall
Quadrimorphina sp.	*Q. albertensis* Mellon and Wall
Saracenaria sp. B	*S. trollopei* var.

The following forms are common to both the Wilrich member in the Bear Villa No. 1 Well and the lower Clearwater formation of the Athabasca River area:

Ammodiscus sp.
Discorbis norrisi Mellon and Wall
Globulina lacrima Reuss var. *canadensis* Mellon and Wall
Gyroidina cf. *G. nitida* (Reuss)
Haplophragmoides gigas Cushman var. *minor* Nauss
Lenticulina bayrocki Mellon and Wall
Marginulinipsis collinsi var.
Miliammina subelliptica Mellon and Wall

Patellina elliotti n. sp.
Saracenaria trollopei var.
Saracenaria sp. *A* (this report)

The continuity of the Clearwater sea with the Arctic Ocean was maintained during *Marginulinopsis collinsi* time. Megafauna referable to Clearwater flooding has been found widely. *Lemuroceras belli* McLearn has been found in the Liard River area of British Columbia; on the Peace river in Alberta; in the lower Mackenzie River area, Northwest Territories; on the Peel river in northern Yukon. Species of *Lemuroceras* and *Beudanticeras* with the pelecypod *Aucellina dowlingi* McLearn are recorded from the upper part of the Torok formation of Alaska (Imlay and Reeside, 1954).

HAPLOPHRAGMOIDES GIGAS MINOR Zone

The *Haplophragmoides gigas minor* zone extends from 110 feet above the base of the Clearwater formation in the type section area, up into the basal portion of the Grand Rapids formation. .The upper limits of this zone in the Peace River area of Alberta, may be defined as the top of the type Notikewin formation. The *H. gigas minor* zone, in contrast to the underlying *M. collinsi* zone, is marked by a sharp reduction in the number of calcareous forms, and characterized by the following microfaunal species:

Ammobaculites humei Nauss
Ammodiscus sp.
Dentalina sp. A—rare
Discorbis norrisi Mellon and Wall—rare
Eggerella sp. A (this report)
Haplophragmoides gigas Cushman var. *minor* Nauss
Haplophragmoides sluzari Mellon and Wall
Haplophragmoides cf. *H. sluzari* Mellon and Wall
Lenticulina bayrocki Mellon and Wall
Tritaxia athabascensis Mellon and Wall

Wickenden (1951) lists the additional following forms from the deeper water facies along the Peace River section:

Allomorphina sp.
Globulina sp.
Gyroidina cf. *G. nitida* Reuss
Lingulina sp.
Marginulina sp. A Wickenden
Marginulina sp. B Wickenden
Marginulina sp. C Wickenden
Marginulina sp. D Wickenden
Quinqueloculina sp.
Saracenaria trollopei var. Mellon and Wall

The loss of calcareous elements in the Athabasca River area is accompanied by an increase in the coarseness of the sediment. Along the Peace river, the upper Loon River formation becomes sandy in

a southerly direction and provides an excellent megafauna characteristic of the *H. gigas minor* zone.

The megafaunal elements of the *H. gigas minor* zone have not been differentiated from those forms listed (under the discussion of the *M. collinsi* zone) from the Clearwater flooding. However, the following forms are recorded from this zone on the Peace river by Wickenden (1951):

Beudanticeras cf. *glabrum* (Whiteaves)
Lemuroceras sp.
Nucula athabaskensis McLearn
Yoldia kissoumi McLearn
Oxytoma camselli McLearn

On the upper Peace river at the top of the *H. gigas minor* zone the following forms are present in the Gates sandstone:

Beudanticeras cf. *mcconnelli* (Whiteaves)
Entolium irenense McLearn
Protocardia alcesiana McLearn
Astarte portana McLearn
Lophidiaster cf. *silentiensis* McLearn

The *H. gigas minor* zone has a widespread development in northwestern Canada. Much of the microfauna of this zone was originally described from the Cummings member of the Mannville formation (Nauss, 1947). The Cummings member of type area has the following forms in common with the upper Clearwater formation:

Ammobaculites humei Nauss
Haplophragmoides gigas Cushman var. *minor* Nauss
Tritaxia athabascensis Mellon and Wall

The lower Mannville formation in the Edmonton area also carries *Brachidontes athabaskensis* McLearn and *Entolium irenense* McLearn in common with the Clearwater formation.

The lower part of the *H. gigas minor* zone is assumed to be in freshwater or diluted brackish phase south of Edmonton. The upper part of the zone carries coal seams and plant remains southeast of the Athabasca river. The marine connections with the Arctic were still present in upper *H. gigas minor* time as *Beudanticeras mcconnelli* is recognized from the San Sault group of the lower Mackenzie River area.

HAPLOPHRAGMOIDES MULTIPLUM Zone

The *Haplophragmoides multiplum* zone is stratigraphically coextensive with the type section of the Harmon shale of the Peace River area, Alberta. The zone is characterized by the following microfossils illustrated in this report:

Haplophragmoides cf. *H. kirki* Wickenden
Haplophragmoides multiplum n. sp.
Haplophragmoides postis n. sp.
Haplophragmoides spissum n. sp.

Haplophragmoides sp. B (this report)
Trochammina gatesensis n. sp.
Verneuilina porta n. sp.
Verneuilinoides sp.

In addition, Wickenden (1951) has illustrated the following as *nomina aperta* from this zone (Wickenden's Middle Shale member of the Peace River formation):

Ammodiscus sp.B Wickenden
Gaudryina sp.B Wickenden
Gaudryina sp.C Wickenden
Haplophragmoides sp.D Wickenden
Haplophragmoides sp.F Wickenden

In marked contrast to the 30-foot thickness of the type section of the Harmon shale, the *H. multiplum* zone extends in the upper Peace River area from the top of the Gates sandstone in type section, to about 370 feet above the Gates sand. The division between the Cadotte microfaunal zone and the *H. multiplum* zone is made at a point in the section where the bentonitic streaks, characteristic of the *H. multiplum* zone, disappear and ironstone nodules and sandy bands become common. No megafauna has been collected by the writers from the *H. multiplum* zone as outlined. However, its position between the *Lemuroceras* zone and the *Gastroplites* zone assures its Middle Albian dating and should permit recognition of the zone in the northern marine sections. It is believed to be in continental phase in the Grand Rapids and Mannville formations in the southern portions of Western Canada.

CADOTTE Microfaunal Zone

A distinctive microfauna has been illustrated from the Cadotte formation of the Peace River area by Wickenden (1951). The forms are *nomina aperta*, with the following listed by Wickenden as characteristic of this formation:

Ammobaculites sp.C Wickenden
Ammobaculites sp.D Wickenden
Ammobaculites sp.E Wickenden
Eggerella ? sp.
Glomospira sp.
Haplophragmoides sp.G Wickenden
Haplophragmoides sp.H Wickenden
Miliammina sp.A Wickenden
Miliammina sp.B Wickenden

Nikiforuk (1956) lists in addition from Bear Villa No. 1 Well:

Nodosinella sp.
Proteonina sp.

This report (Plate 4) illustrates these additional forms from the upper Peace River area:

Ammobaculites janus n. sp.
Eggerella sp. B (this report)

Haplophragmoides linki Nauss
Haplophragmoides sp. B (this report)
Haplophragmoides sp. C (this report)
Proteonina sp.

The megafauna of the Cadotte formation is well-known as the *Gastroplites* fauna, listed as follows:

Gastroplites canadensis (Whiteaves)
Gastroplites kingi McLearn
Gastroplites spiekeri McLearn
Gastroplites allani McLearn
Gastroplites stantoni McLearn
Gastroplites cf. *cantianus* Spath
Gastroplites spp. nov.
Arctica sp.
Dicranodonta dowlingi McLearn
Inoceramus altifluminis McLearn
Inoceramus cadottensis McLearn
Pecten alcesianus McLearn
Trigonia albertensis McLearn
Apporhais sp.
Comptonia ? stelcki McLearn
Lophidiaster silentiensis McLearn

Gastroplites cantianus is found in the *cristatum* zone at the top of the Middle Albian in the Gault clay of England and is found in the uppermost beds of the Cadotte sandstone, around 550 feet above the Gates sandstone in the upper Peace River area. The *Gastroplites* zone on the upper Peace river is about 180 feet thick in contrast to a thickness of about 70 feet for the type section of the Cadotte formation. Inasmuch as *G. cantianus* has not been collected in the type Cadotte formation, there is a possible stratigraphic hiatus at the top of this formation as indicated by Wickenden (1951, p. 5).

Gastroplites seems to be a locally developed fauna and rarely is found outside of the Peace River area. Species of *Gastroplites* are found in the Sans Sault group of the lower Mackenzie River area and occasionally in Alaska. The zone is probably represented by a disconformity or by continental beds in the southern part of Western Canada.

HAPLOPHRAGMOIDES GIGAS Zone

The *Haplophragmoides gigas* zone may be defined as stratigraphically coextensive with the Joli Fou shale of type section. The zone is characterized by the following Foraminifera:

Ammobaculites fragmentarius Cushman
Ammobaculites fragmentarius variety
Ammobaculites tyrrelli Nauss
Ammobaculites tyrrelli Nauss var. *jolifouensis* n. var.
Ammobaculites sp.

Ammodiscus kiowensis Leoblich and Tappan
Gaudryina hectori Nauss
Haplophragmoides cf. *H. collyra* Nauss
Haplophragmoides gigas Cushman
Haplophragmoides linki Nauss
Haplophragmoides sp. D (this report)
Hyperammina sp.
Miliammina sproulei Nauss

The zone fossil *H. gigas* is restricted in occurrence to the basal part of the zone and has not been found to date in the Peace River area. Wickenden (1951, p. 5) reports the later suites of the Joli Fou fauna as present thirty miles below Peace River town, overlying the Cadotte microfaunal zone.

Megafossils are rare within the Joli Fou formation but *Inoceramus* cf. *altifluminis* McLearn and *I.* cf. *comancheanus* Cragin are found in outcrop. It is difficult to define the actual boundary between the Upper and Middle Albian within the Joli Fou formation, as ammonites are lacking. The presence of *I.* cf. *altifluminis* would indicate continuation of the Middle Albian sequence up to the base of the Pelican sandstone. Post-Pelican faunal assemblages show early Upper Albian affinities.

The *H. gigas* microfaunal zone is perhaps the most widely known of the Middle Albian faunas in Western Canada. The Joli Fou flooding is recognized from most of Alberta east of the Foothills, and from southern Saskatchewan and southwestern Manitoba, and is probably represented by the Skull Creek equivalents within the Williston basin. The flooding probably continued across the northern part of northeastern British Columbia, and Arctic connections are highly probable. The top of the Sans Sault group of the lower Mackenzie River area shows a pronounced erosional unconformity, and over much of the northern area the *H. gigas* zone is missing through erosion.

The possibility of Gulf of Mexico connections is suggested by the presence of Kiowa shale forms such as *Inoceramus* cf. *comancheanus* and *Ammodiscus kiowensis.*

REGIONAL CORRELATIONS

The Middle Albian seaways of Western Canada were connected in early *Lemuroceras* time with the western Arctic and Pacific oceans. The *Lemuroceras* fauna may be traced through northern Yukon; through Alaska in the Kennicott and Torok formations (Imlay and Reeside, 1954); and in California in the Horsetown formation. The Albian microfauna discussed by Glaessner (1949) from the Franciscan formation of California would probably be penecontemporaneous. Such elements as *L. indicum* indicate a Tethyan connection with the Abur beds of India (Spath, 1923). Little direct correlation is shown with the European section, although the lower part of the Gault formation of Germany (Hecht, 1938) shows mor-

phologic affinities with the calcareous Forminifera of the Clearwater formation. Considering megafauna only, there seems to be no direct connection with the Gulf Coast or Texas during *Lemuroceras* time but certain microfaunal elements from the Walnut clay (Loeblich and Tappan, 1949) are suggestive of the Clearwater forms.

The later Middle Albian seaways, during *Gastroplites* time, seem more restricted. The Pacific connections are no longer evident, and the ammonite fauna is dominantly local. *Gastroplites allani, G. stantoni,* and *Inoceramus cadottensis* are known from northern and central Alaska (Imlay and Reeside, 1954; Patton and Bickel, 1955). The only other positive identification of *Gastroplites* is from the *cristatum* zone of the Gault of England. The *Gastroplites* fauna has apparently nothing in common with the late Middle Albian suites of the Gulf Coast or Texas.

It is not until latest Middle Albian that a Gulf Coast connection may be postulated. It is assumed that this is but a forerunner of the widespread inundations of Upper Albian time. The *Haplophragmoides gigas* fauna represents the transitional onlap suite. *Inoceramus comancheanus* is known from the Kiowa shale of the Mid-Continent region and Skull Creek shale of the western interior of the United States.

ECOLOGY

The inferred ecology of the Middle Albian faunas of Western Canada reveals a complex paleogeographic pattern. The transgressional inundation of the early Middle Albian sea is reflected in the shift from the arenaceous microfaunal assemblage recovered from the upper McMurray formation to the calcareous microfauna found in the basal Clearwater formation. The return of arenaceous foraminiferal suites in the upper Clearwater formation and succeeding beds indicates a shallowing or lessening salinity of the interior late Middle Albian sea.

The earliest Middle Albian faunas known in Western Canada show a cosmopolitan ammonite assemblage. The accompanying microfauna is known as yet only from along the lower Peace river (Trollope, 1951) and contains an anomalous mixture of Radiolaria and arenaceous Foraminifera. This assemblage may reflect a condition of selective preservation, but the Radiolaria do indicate an unrestricted embayment of the open ocean. Shore-line facies of this flooding may be found in the lower McMurray strata along the Athabasca river.

In the upper McMurray formation, the *Trochammina mcmurrayensis* fauna is "very similar to Recent assemblages found by Phleger in marshes adjacent to the mainland" (Mellon and Wall, 1956, p. 13).

The *Marginulinopsis collinsi* fauna is a normal neritic suite, but the succeeding *H. gigas minor* fauna with a loss of calcareous elements in the lower Athabasca River area reflects infilling of the margin of the embayment and consequent shallowing of the water. Away from the infilled margins, in the Peace River area, the *H.*

gigas minor fauna still carried normal neritic calcareous Foraminifera (Wickenden, 1951). On the other hand, the fauna of the shoreline margin in east-central Alberta retained only the brackish-tolerant forms.

The fauna of the *Haplophragmoides multiplum* zone suggests an epicontinental sea with restricted oceanic connections. Despite the lack of calcareous foraminiferal elements, the assemblage of finely arenaceous Foraminifera indicates normal salinity and probable depth in excess of 100 feet.

Shallow water conditions are reflected in the coarsely arenaceous character of the Cadotte foraminiferal suites. The presence of fucoidal impressions in the upper Peace River area indicates depth not over 100 feet, and the presence of conglomerates and coal seams in the upper Commotion of the Pine River area at this same horizon shows proximity of the shore-line.

The transgression of the *Haplophragmoides gigas* sea within Western Canada brought a return of similar environmental conditions to those prevailing during *H. multiplum* time. Once again, salinity was normal in a shallow epicontinental sea, which environment continued into Upper Albian time.

FORMAL DESCRIPTIONS

Order *Foraminifera*

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES FRAGMENTARIUS Cushman

Plate 5, figure 18

Ammobaculites fragmentaria Cushman, 1927, Trans. Roy. Soc. Can., vol. 21, sec. IV, p. 130, pl. 1, fig. 8.

Ammobaculites fragmentarius Cushman. Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 23. pl. 3, figs. 10, 11, 13 a-b, 16 a-b (*non* 12 a-b, 14 a-b, 15 a-b).

Ammobaculites fragmentarius Cushman. Frizzell, 1954, Texas Bureau of Econ. Geol. Rept. of Investigations No. 22, p. 62, pl. 2, figs. 16, 17, 18 a-b.

Test large, slightly compressed, oval in cross-section; early portion close-coiled, involute with four chambers, later portion rectilinear, of six chambers in uniserial arrangement; sides tapering with greatest width of test made by the ultimate chamber; chambers distinct, gradually increasing in length and width as added, except for the much larger, rather pyriform terminal chamber; sutures distinct, depressed, at right angles to long axis of test; wall of very coarse, angular sand grains up to 0.156 mm. in diameter, partly embedded in a more finely arenaceous matrix; aperture terminal, central, simple, tending to appear elliptical as a result of deformation of the ultimate chamber.

Length of plesiotype: 1.53 mm.; greatest width 0.56 mm.; diameter of coiled portion 0.27 mm.

Plesiotype locality: B72 in N.E. $\frac{1}{4}$, Sec. 32, Tp. 81, Rge. 17, W. 4th Meridian, on the east bank of Athabasca river at the Rapide du Joli Fou, Alberta, Canada, from the Joli Fou shale, 53 feet above the top of the Grand Rapids formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Comparison: These north-central Alberta specimens differ from the holotype in possessing an irregular knobby exterior, a feature not present on the type since its constituent grains are flat-lying and rather neatly cemented. The holotype from the Lloydminster shale of east-central Alberta appears considerably more compressed than any of the Joli Fou forms, although this may be due to differences in fossilization.

Cushman (1946, pl. 3, figs. 10, 13, 16) assigns several forms from the Upper Cretaceous of Texas to his original species, which although similar to the holotype in wall structure, differ in being smaller and in having the sides taper toward the distal end of the test. The present authors have placed these forms in the synonymy, but seem to be of the same opinion as Frizzell (1954, p. 62), that the other specimens consisting of coiled portions only, which Cushman (1946, pl. 3, figs. 12, 14, 15) assigned to the species, should not be included with it.

Horizon: Nauss (1947) reported the occurrence of this species in the Vermilion area of east-central Alberta from the Cummings member of the Mannville formation, and from the Lloydminster shale in beds below and above the horizon of the Viking sand.

AMMOBACULITES FRAGMENTARIUS Variety

Plate 5, figure 19

Test large, not compressed, cylindrical in cross-section; early portion close-coiled, involute, with three to four chambers, later portion rectilinear, uniserial, consisting of six chambers; sides very gradually tapering with the greatest width of test made by last formed chamber; chambers poorly defined in coiled portion, better defined in straight portion, increasing slightly in size as added; sutures rather indistinct, especially in coiled portion, depressed, at right angles to long axis of test; wall of very coarse angular sand grains up to 0.211 mm. in diameter, partly embedded in a small amount of cement, giving a very rough, irregular surface; aperture terminal, central, simple but appearing elliptical when ultimate chamber is deformed.

Length of figured specimen: 1.33 mm.; greatest width 0.33 mm.; diameter of coiled portion 0.23 mm.

Locality of figured specimen: same as for the species *s.s.*

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: This varietal form is distinguished from the species *s.s.* by its sides tapering very gradually as compared to the more rapidly tapering sides of the latter form. The variant form is cylindrical in cross-section and shows no indication of being compressed, in contrast to the oval cross-section of the slightly compressed species *s.s.*

AMMOBACULITES HUMEI Nauss

Plate 2, figures 25, 26

Ammobaculites humei Nauss, 1947, Jour. Paleontology, vol. 21, p. 333, pl. 48, fig. 1.

Ammobaculites humei Nauss. Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 15, pl. 1, fig. 18.

Test elongate, compressed; early portion not tightly coiled with a tendency to become evolute, consisting of five to six chambers; later portion rectilinear with four to five chambers in uniserial arrangement, increasing slightly in length and width as added (a constriction at the ultimate suture of the plesiotype tends to give erroneous impression that test narrows at this point); sutures rather indistinct, depressed; wall arenaceous of moderately-sized subangular quartz grains with amount of cement not great; aperture terminal, elliptical.

Length of plesiotype: 0.76 mm.; diameter of coiled portion 0.24 mm.

Plesiotype locality: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type sec-

tion of the Clearwater formation, 187 feet below the top of the formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Horizon: *A. humei* was originally described by Nauss from the Cummings member of the Mannville formation of east-central Alberta. Mellon and Wall (1956) reported this species in the basal shales of the Clearwater formation in the McMurray area of northeastern Alberta. Wickenden's (1951) *Ammobaculites* sp. A from the lower Falher member of the Spirit River formation, exposed along the lower Peace river, seems identical to this form.

Comparison: The plesiotype from the type section Clearwater differs from Nauss' holotype and Mellon and Wall's plesiotype in being more finely arenaceous.

AMMOBACULITES JANUS Stelck and Wall, n. sp.

Plate 4, figures 1, 2

Test moderately compressed, oval in cross-section; early portion rather close-coiled, showing slight umbilicus, four chambers in coiled portion increasing in size as added; later portion consisting of two or three chambers in uniserial arrangement, penultimate and ultimate chambers equal in size; last chamber slightly pyriform, with decreased diameter at apertural end; sutures rather indistinct, not depressed; wall arenaceous, made of quartz grains up to 0.12 mm. in size with considerable cement covering the smaller grains and edges of the larger grains; aperture terminal, elliptical.

Length of holotype: 0.75 mm.; diameter of coiled portion 0.32 mm.; diameter of ultimate chamber 0.32 mm.

Holotype locality: S47-16 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 531 feet above the Gates sandstone.

Holotype: Stanford Univ. Pal. Type Coll.

Name: After the Latin *Janus,* an ancient Italian deity, regarded by the Romans as presiding over doors and gates, etc.

AMMOBACULITES TYRRELLI JOLIFOUENSIS Stelck and Wall, n. var.

Plate 5, figure 20

Test of medium size, not compressed, cylindrical in cross-section; early portion close-coiled, involute, consisting of three to four chambers; later portion rectilinear, of four chambers in uniserial arrangement; chambers rather well defined, those in the coiled portion gradually increasing in size, with those in the uniserial portion being of approximately equal size except ultimate one which is considerably more elongate; the dimensions of the chambers are nearly equal in the uniserial portion; sutures distinct, depressed, at right

angles to long axis of test; wall arenaceous, of quartz grains up to 0.04 mm. in diameter, with a considerable amount of cement giving a fairly smooth over-all finish; aperature terminal, elliptical, at the end of a short, but pronounced neck.

Length of holotype: 0.66 mm.; diameter of coiled portion 0.18 mm.; length of penultimate chamber 0.13 mm.; width of penultimate chamber 0.15 mm.

Holotype locality: Z1 in N.E. ¼, Sec. 31, Tp. 85, Rge. 17, W. 4th Meridian, on the north bank of Athabasca river, Alberta, Canada, from the Joli Fou shale, 22 feet above the top of the Grand Rapids formation.

Holotype: Univ. of Alberta Pal. Type Coll.

Horizon: In addition to being found in its type area on the Athabasca river, this varietal form has been recognized in the subsurface from wells in the Edmonton area of Alberta, where it occurs in close association with *A. tyrrelli* Nauss in the Lower Shale member of the Colorado group, i.e. in the *Haplophragmoides gigas* zone.

Comparison: The varietal form is differentiated mainly from the species *s.s.* by its nearly equal chamber dimensions in the rectilinear portion of the test, whereas in *A. tyrrelli* itself the width of the chambers is much greater than the length. The new variety is also a more slender and less inflated form than the rather robust species *s.s.*

Name: After the Joli Fou Rapids.

AMMOBACULITES sp.

Plate 5, figure 22

Test fairly large, slightly compressed, oval in cross-section; early portion close-coiled, involute, consisting of from three to four chambers; later portion slightly bent, of three chambers in uniserial arrangement, terminal one pyriform in outline (broken off in figured specimen); greatest width of test formed by the coiled portion; sutures in coiled portion very faint, earlier ones flush, later ones depressed; sutures in uncoiled portion indistinct, depressed, oblique; wall arenaceous, of very coarse angular grains up to 0.13 mm., with a fair amount of finely arenaceous cement; aperture terminal, elliptical.

Length of figured specimen with last formed chamber incomplete: 1.02 mm.; diameter of coiled portion 0.44 mm.

Locality of figured specimen: B72 in N.E. ¼, Sec. 32, Tp. 81, Rge. 17, W. 4th Meridian, on the east bank of Athabasca river, at the Rapide du Joli Fou, Alberta, Canada, from the Joli Fou shale, 47 feet above the top of the Grand Rapids formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: This form bears a resemblance in outline to *Ammobaculites torosus* Loeblich and Tappan from the Middle Albian Walnut formation, Fredericksburg group of Texas. The Alberta

form is less inflated, has a coarser wall structure and possesses indistinct, oblique sutures.

Genus AMMOBACULOIDES Plummer, 1932

AMMOBACULOIDES ATHABASCENSIS Stelck and Wall, n. sp.

Plate 5, figure 21

Test of fair size, only slightly compressed; early portion close-coiled, involute, four chambers visible, with a moderate umbilical development; later portion rectilinear, consisting of six to seven chambers in an alternating biserial pattern, with a suggestion of uniseriality in the ultimate chamber only; chambers indistinct, gradually increasing in size in coiled portion, those in the biserial portion of about the same size; sutures indistinct, depressed, oblique, forming a zigzag median line between the two series of chambers in the biserial portion; wall coarsely arenaceous, of large quartz grains up to 0.09 mm. in diameter, but averaging only half of this size, firmly cemented but not covered by the cement, leaving the surface rough; aperture terminal, character obscured, apparently rounded.

Length of holotype: 0.78 mm.; maximum width 0.30 mm.

Holotype locality: Z1 in N.E. ¼, Sec. 31, Tp. 85, Rge. 17, W. 4th Meridian, on the north bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 7 feet above the top of the Grand Rapids formation.

Holotype: Univ. of Alberta Pal. Type Coll.

Horizon: In addition to its occurrence in the Joli Fou shale of northeastern Alberta, this species occurs rarely in the Lower Shale member of the Colorado group, i.e., the *Haplophragmoides gigas* zone, in the central Alberta area.

Name: After the Athabasca river.

Genus AMMODISCUS Reuss, 1861

AMMODISCUS KIOWENSIS Loeblich and Tappan

Plate 5, figures 16, 17

Ammodiscus kiowensis Loeblich and Tappan, 1950, Univ. of Kansas Paleontological Contrib., Protozoa, Article 3, p. 5, pl. 1, figs. 3 a-b.

Test very small, disc-like, planispiral, composed of a proloculus and long tubular undivided second chamber, which increases gradually in diameter during its five to six coils around the proloculus; the coiling is rather irregular in many specimens, so that the tubular chamber may overlap a previous coil for a short distance; spiral suture distinct, depressed; wall finely arenaceous, smoothly finished with considerable clear cement; aperture formed by the open end of the tube.

Greatest diameter of plesiotype: 0.21 mm.; least diameter 0.2 mm.; thickness 0.05 mm.

Plesiotype locality: B 75 in S.E. ¼, Sec. 34, Tp. 82, Rge. 17, W. 4th Meridian, on the west bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 20 feet above the top of the Grand Rapids formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Horizon: This species was described originally by Loeblich and Tappan from the Kiowa shale, Lower Cretaceous of Kansas. It occurs also in the basal part of the Lower Shale member of the Colorado group, i.e., the *Haplophragmoides gigas* zone of the central Alberta area.

Comparison: The Athabasca River area specimens appear to fit very closely the figure and description of the original species. The rather irregular nature of the coiling, particularly in the early stages of this species and of *A. gaultinus* Berthelin as well, is suggestive of the genus *Glomospira.* The erratic coiling of the nucleus in certain individuals of *A. kiowensis* from the Joli Fou formation is reminiscent of the Jurassic species *Glomospira gordialis* (Jones and Parker).

AMMODISCUS sp.

Plate 2, figures 31, 32

Ammodiscus sp.A Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 34, pl. I A, fig. 2.

Test fairly small, flat, planispiral, composed of a proloculus and a long tubular undivided second chamber, which maintains approximately the same diameter during its four to five coils around the proloculus; spiral suture indistinct, made more clearly visible by wetting, somewhat thickened, not depressed; wall arenaceous composed of fine quartz grains with a large amount of cement giving a smooth finish; aperture simple, formed by the open end of the second chamber.

Greatest diameter of figured specimen: 0.37 mm.; thickness 0.03 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Horizon: Wickenden (1951) reported this form from the lower part of the Falher member of the Spirit River formation along the lower Peace river. In addition to its occurrence in type section Clearwater, this form is identical to the *Ammodiscus* sp. recorded by Mellon and Wall (1956, pp. 9-10) from the basal Clearwater and uppermost McMurray formations in the vicinity of McMurray.

Genus BATHYSIPHON M. Sars, 1872

BATHYSIPHON sp. A

Plate 1, figures 14, 15

Test elongate, a nearly straight cylindrical chamber open at both ends, preserved as a pyritized replacement; wall apparently made of finely arenaceous material with much cement; thickness of wall 0.03 mm.; wall with incipient transverse fractures or planes of weakness at 0.11 mm. to 0.14 mm. apart.

Length of figured specimen: 0.6 mm.; diameter 0.18 mm.

Locality of figured specimen: S47-22 on Hasler creek, about one-quarter mile downstream from the Goodrich mine, approximately six and one-half miles south of the junction of Hasler creek and the Pine river, British Columbia, Canada, from shales of the Moosebar formation, 150 feet above the top of the Gething formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: In size and thickness of wall this form most closely approaches *Bathysiphon alexanderi* Cushman from the Upper Cretaceous of Texas, but seems to have more arenaceous material in the wall make-up and an incipient close transverse jointing not apparent in the latter species.

BATHYSIPHON sp. B

Plate 2, figures 33, 34

Test elongate, a straight cylindrical chamber, with the sides tapering slightly, open at both ends; wall finely arenaceous, smoothly finished; wall thin, collapsed in most specimens, with faintly indicated, incipient transverse fractures spaced about 0.06 mm. apart; color white.

Length of figured specimen: 0.78 mm.; maximum diameter 0.15 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Genus CONORBINA Brotzen, 1936

CONORBINA sp. A

Plate 1, figures 22, 23, 24

Test small, subquadrangular in outline, dorsal side strongly convex, parabolic in vertical section, ventral side concave; test rotaloid, of about four convolutions, chambers increasing gradually in size, five chambers in ultimate whorl; spiral suture fairly distinct, transverse sutures indistinct, oblique on the dorsal side, slightly curved,

nearly radial on the ventral side; wall calcareous, finely perforate; aperture ventral, a rounded notch on the inner umbilical margin of the ultimate chamber.

Diameter of figured specimen: 0.3 mm.; height 0.23 mm.

Locality of figured specimen: S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: This form bears a general relationship to *C. conica* Lozo from the Lower Cretaceous Comanchean series of Texas. The British Columbia specimen seems to have a somewhat higher spire with at least another whorl of chambers and the chambers are not inflated as they appear to be in the Texas species. The transverse sutures on the present authors' specimen are inclined forward on the dorsal side, and are not curved backward as in the Texas form.

CONORBINA ? sp. B

Plate 1, figures 18, 19, 20

Test rather small, subelliptical in outline, dorsal side convex, ventral side flattened, periphery subacute; test trochoid of two and one-half convolutions, four chambers in outermost whorl, five in penultimate whorl; chambers distinct, rather rapidly increasing in size, all visible dorsally, only those of final whorl visible ventrally where ultimate chamber constitutes nearly one-half of the test; center of ventral side infilled with extra calcite material obscuring the inner points of the chambers of the ultimate whorl; sutures distinct, flush, strongly arcuate on dorsal side, much less so on ventral side; wall calcareous, hyaline, finely perforate; aperture ventral, a rounded notch on the inner umbilical margin of the ultimate chamber with a narrow opening running out toward the periphery.

Maximum diameter of figured specimen: 0.23 mm.; minimum diameter 0.20 mm.; height 0.17 mm.

Locality of figured specimen: S47-22 on Hasler creek, about one-quarter mile downstream from the Goodrich mine, approximately six and one-half miles south of the junction of Hasler creek and the Pine river, British Columbia, Canada, from shales of the Moosebar formation, 146 feet above the top of the Gething formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: This species is probably identical to *Conorbina* sp. of Wickenden (1951, p. 41, pl. I A, figs. 33 a-c) from the lower part of the Falher member of the Spirit River formation.

The generic assignment of this form is in question. It lacks the elevated spiral development and the typical aperture of *Conorbina*. The position of the aperture in the current authors' form is suggestive of the genus *Conorboides* Hofker.

Genus DENTALINA d'Orbigny, 1826

DENTALINA sp. A

Plate 2, figures 13, 14

Test rather short, nearly straight, sides gradually tapering, widest part across the ultimate chamber; test consists of a large proloculus and three very gradually enlarging, non-inflated subsequent chambers; sixteen rather fine longitudinal costae run from the initial end of the test uninterruptedly across the sutures to the aperture; sutures indistinct, thickened, slightly depressed; wall calcareous, finely perforate; aperture terminal, radiate, near the margin on a slight projection.

Length of figured specimen: 0.62 mm.; maximum width 0.2 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 161 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: This form seems more closely related to *D. pertinens* Cushman from the Upper Cretaceous of Texas than to any other described species. The size, ornamentation, and character of the aperture are similar in the two forms but the later chambers of the Alberta form are not inflated.

DENTALINA sp. B

Plate 3, figures 3, 4

Test elongate, cylindrical, slightly curved; test consists of six chambers, first five of approximately the same size, with nearly equal dimensions, final one more elongate; sutures distinct, depressed; wall calcareous, smooth, finely perforate; aperture on a terminal eccentric beak-like projection, radiate with five prominent slits.

Length of figured specimen: 0.9 mm.; greatest width 0.16 mm.; length of ultimate chamber with apertural projection 0.29 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from the shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: This form bears some similarity to *Dentalina cylindroides* Reuss as figured by Tappan (1940) from the Lower Cretaceous Grayson formation of Texas. Our Clearwater specimen, however, has a distinctive apertural projection, which is absent in *D. cylindroides*.

Genus DISCORBIS Lamarck, 1804

DISCORBIS NORRISI Mellon and Wall

Plate 2, figures 4, 5, 6

Discorbis norrisi Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 15, pl. 2, figs. 9, 10, 11.

Maximum diameter of holotype: 0.31 mm.; minimum diameter 0.28 mm.; thickness 0.11 mm.

Holotype locality: Bear Villa No. 1 Well in Lsd. 7, Sec. 8, Tp. 74, Rge. 14, W. 5th Meridian, Alberta, Canada, between depths of 2539 and 2545 feet, in the shale of the Wilrich member of the Spirit River formation.

Holotype: Univ. of Alberta Pal. Type Coll.

Horizon: In addition to its common occurrence in the Wilrich member of the Spirit River formation in the Bear Villa No. 1 Well, this species is present in the central part of the Clearwater formation in type section. Mellon and Wall (*op. cit.*) described the species and figured a paratype from the basal shales of the Clearwater formation in the McMurray area. It occurs also in the upper part of the Loon River formation, exposed along the lower Peace river (Trollope, 1951) and is probably identical to *Anomalina* sp. of Wickenden (1951, pl. I A, figs. 34, 35) from the lower Falher member of the Spirit River formation.

DISCORBIS cf. D. TURBO (d'Orbigny)

Plate 2, figures 1, 2, 3

Discorbis turbo Noth (*non* d'Orbigny), 1951, Wien, Jahrbuch der Geologischen Bundesanstalt Sonderband 3, p. 69, pl. 3, figs. 16 a-c.

Test rather small, trochoid, dorsal side convex, ventral side flat to concave with a fairly prominent umbilicus developed, periphery rounded; test of three whorls, seven chambers in ultimate whorl; chambers distinct, gradually enlarging in size, all visible on dorsal side, only those of last whorl visible ventrally; sutures distinct, flush except for final two which are depressed, strongly oblique dorsally, radial ventrally, where the inner ends of the first four are somewhat thickened, tending to give the umbilical area a star-shaped appearance; wall calcareous, hyaline, medium perforate; aperture a slit extending from the umbilicus part way toward the periphery.

Maximum diameter of figured specimen: 0.32 mm.; greatest thickness 0.1 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: Our sole specimen seems fairly close to a form referred to *D. turbo* by Noth from the Albian of Austria, but the

latter is apparently much larger. From Noth's figure it appears that the Austrian species may have an umbilical plug, but no mention of such a character is made in the description. Noth placed in synonymy a form of Chapman's from the Gault of Folkestone, England.

Genus EGGERELLA Cushman, 1933

EGGERELLA sp. A

Plate 2, figures 17, 18, 19, 20

Test rather short, somewhat compressed, tapering; four earliest whorls of five chambers apiece followed by one to two whorls of four chambers each, with last two to three whorls being triserial; chambers, early ones very small increasing gradually in size as added, triserial ones much larger and increasing rapidly in size; sutures rather indistinct, slightly depressed; wall finely arenaceous with a considerable amount of cement; aperture a low arched opening at the base of the inner margin of the last chamber; color brownish-white.

Length of specimen (figs. 17, 18): 0.42 mm.; greatest width 0.18 mm.

Length of specimen (figs. 19, 20): 0.42 mm.; greatest width 0.22 mm.

Locality of figured specimens: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimens: Univ. of Alberta Pal. Type Coll.

Horizon: Although not included among the species figured by Mellon and Wall (1956) from the basal Clearwater shales of the McMurray area, this form does occur commonly at that level and locality, as well as in the type section Clearwater.

EGGERELLA sp. B

Plate 4, figure 7

Test rather small, tapering; first four whorls of four to five chambers apiece, last one or two whorls triserial; early chambers very small, those in triserial portion much enlarged and sub-globose in outline; sutures distinct, depressed; wall arenaceous, grains to 0.018 mm., much cement leaving a smooth glaze over the outer surface obscuring sand grains; aperture a low notch at base of last chamber.

Length of figured specimen: 0.35 mm.; maximum width 0.24 mm.

Locality of figured specimen: S47-16 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 429 feet above the Gates sandstone.

Figured specimen: Stanford Univ. Pal. Type Coll.

Remarks: This species seems similar in chamber arrangement to *Eggerella* sp. A but the later chambers of the former appear more globose. Such a feature may not be too reliable, however, for purpose of comparison as compression on fossilization could have accounted for the flattened state of the chambers in *Eggerella* sp. A. The wall of *Eggerella* sp. A lacks the smooth glazed outer surface of *Eggerella* sp. B, which has more distinct sutures.

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA HECTORI Nauss

Plate 5, figures 14, 15

Gaudryina canadensis Cushman (*pars*) 1943, Contr. Cushman Found. Foram. Research, vol. 19, p. 27, pl. 6, figs. 7,8 (*non Bigenerina angulata* Cushman, 1927).

Gaudryina hectori Nauss, 1947, Jour. Paleontology, vol. 21, p. 335, pl. 48, figs. 6 a-b.

Test elongate, early portion triserial of about four whorls, later portion biserial and twisted of four to five whorls; chambers distinct, rather gradually increasing in size as added, somewhat inflated in biserial part; sutures distinct, depressed, nearly at right angles to long axis of test, forming a zigzag line between the two series of chambers in the biserial portion; wall arenaceous, grains up to 0.025 mm., with considerable cement; aperture large, a high arched opening at the base of the interface of the last formed chamber.

Length of plesiotype: 0.48 mm.; greatest width 0.17 mm.

Plesiotype locality: Z1 in N.E. $\frac{1}{4}$, Sec. 31, Tp. 85, Rge. 17, W. 4th Meridian, on the north bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 22 feet above the top of the Grand Rapids formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Horizon: In the areas of central and east-central Alberta, *G. hectori* seems to be confined to the Lower Shale member of the Colorado group, i.e., the *Haplophragmoides gigas* zone.

Comparison: Nauss has already noted the similarity of this species to *G. filiformis* Berthelin from the Albian of France.

Genus GLOBULINA d'Orbigny, 1839

GLOBULINA LACRIMA CANADENSIS Mellon and Wall

Plate 1, figure 21; Plate 3, figures 13, 14

Globulina sp. Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 40, pl. IA, fig. 27.

Globulina lacrima canadensis Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 16, pl. 2. fig. 6.

Length of specimen (Plate 1, fig. 21): 0.31 mm.; width 0.2 mm.

Length of specimen (Plate 3, figs. 13, 14): 0.25 mm.; width 0.16 mm.

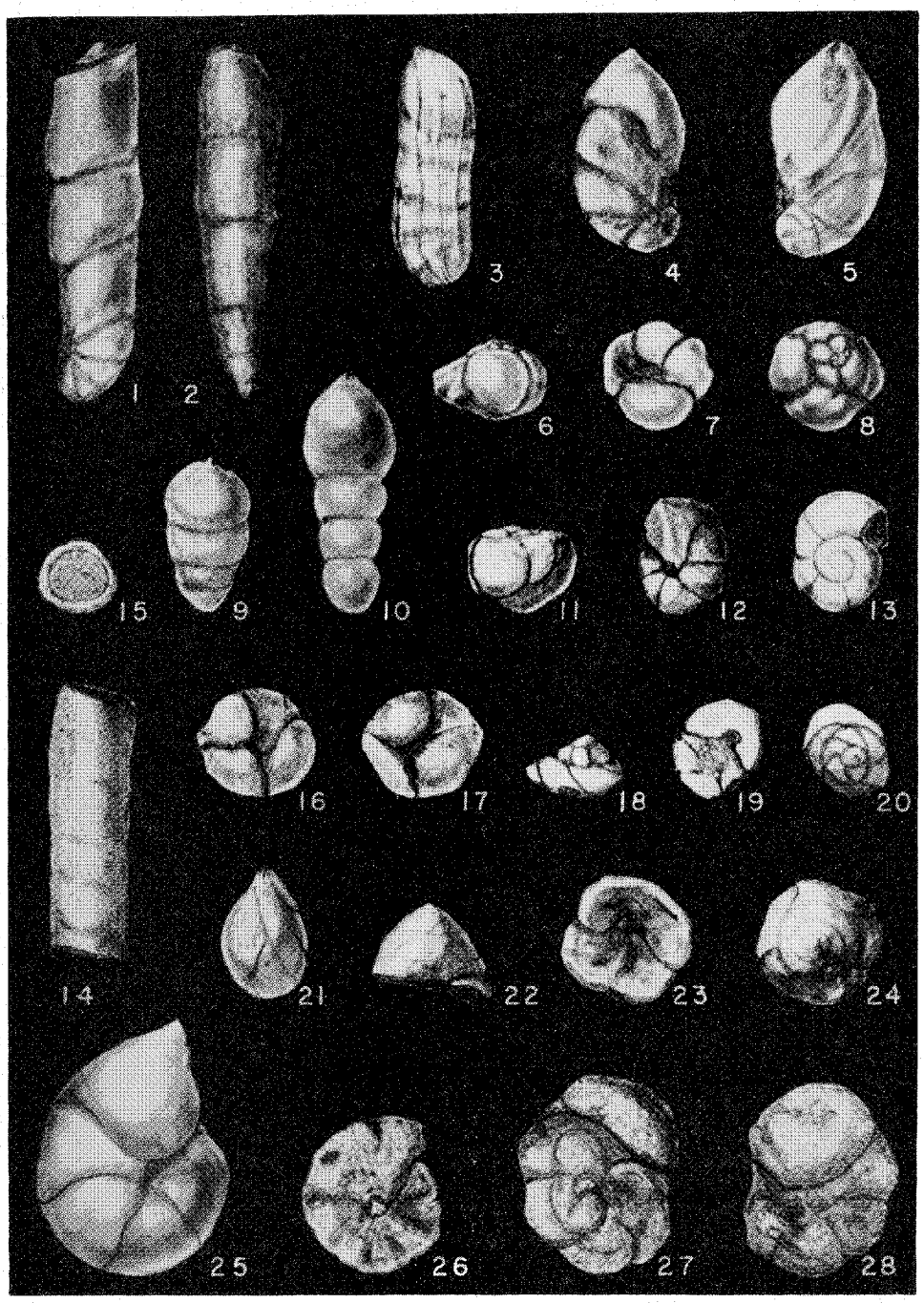


Plate 1—Moosebar Foraminifera.

EXPLANATION OF PLATE 1

Moosebar Formation

Upper Pine River Area, British Columbia

Magnification x60

Figs. 1, 2: *Marginulina* sp. from Crassier creek; 1—side view, 2—dorsal view ..... (p. 43)

Fig 3: *Marginulinopsis collinsi* Mellon and Wall variety from Hasler creek ..... (p. 44)

Figs. 4, 5: *Saracenaria trollopei* Mellon and Wall from Crassier creek; views of opposite sides ..... (p. 50)

Figs. 6-8: *Quadrimorphina albertensis* Mellon and Wall from Crassier creek; 6—peripheral view, 7—ventral view, 8—dorsal view ..... (p. 48)

Figs. 9, 10: *Pseudonodosaria clearwaterensis* Mellon and Wall; 9—from Crassier creek, 10—from Hasler creek ..... (p. 47)

Figs. 11-13: *Gyroidina* cf. *nitida* (Reuss) from Crassier creek; 11—peripheral view, 12—ventral view, 13—dorsal view. (p. 33)

Figs. 14, 15: *Bathysiphon* sp.A from Hasler creek; 14—side view, 15—end view ..... (p. 27)

Figs. 16, 17: *Quadrimorphina* sp. from Crassier creek; views of opposite sides ..... (p. 49)

Figs. 18-20: *Conorbina* ? sp.B from Hasler creek; 18—peripheral view, 19—ventral view, 20—dorsal view ..... (p. 28)

Fig. 21: *Globulina lacrima canadensis* Mellon and Wall from Crassier creek ..... (p. 32)

Figs. 22-24: *Conorbina* sp.A from Crassier creek; 22—peripheral view, 23—ventral view, 24—dorsal view ..... (p. 27)

Fig. 25: *Lenticulina* sp. from Crassier creek ..... (p. 43)

Fig. 26: *Haplophragmoides* sp.A from Crassier creek ..... (p. 40)

Figs. 27, 28: *Trochammina* sp. from Crassier creek; 27—dorsal view, 28—ventral view ..... (p. 54)

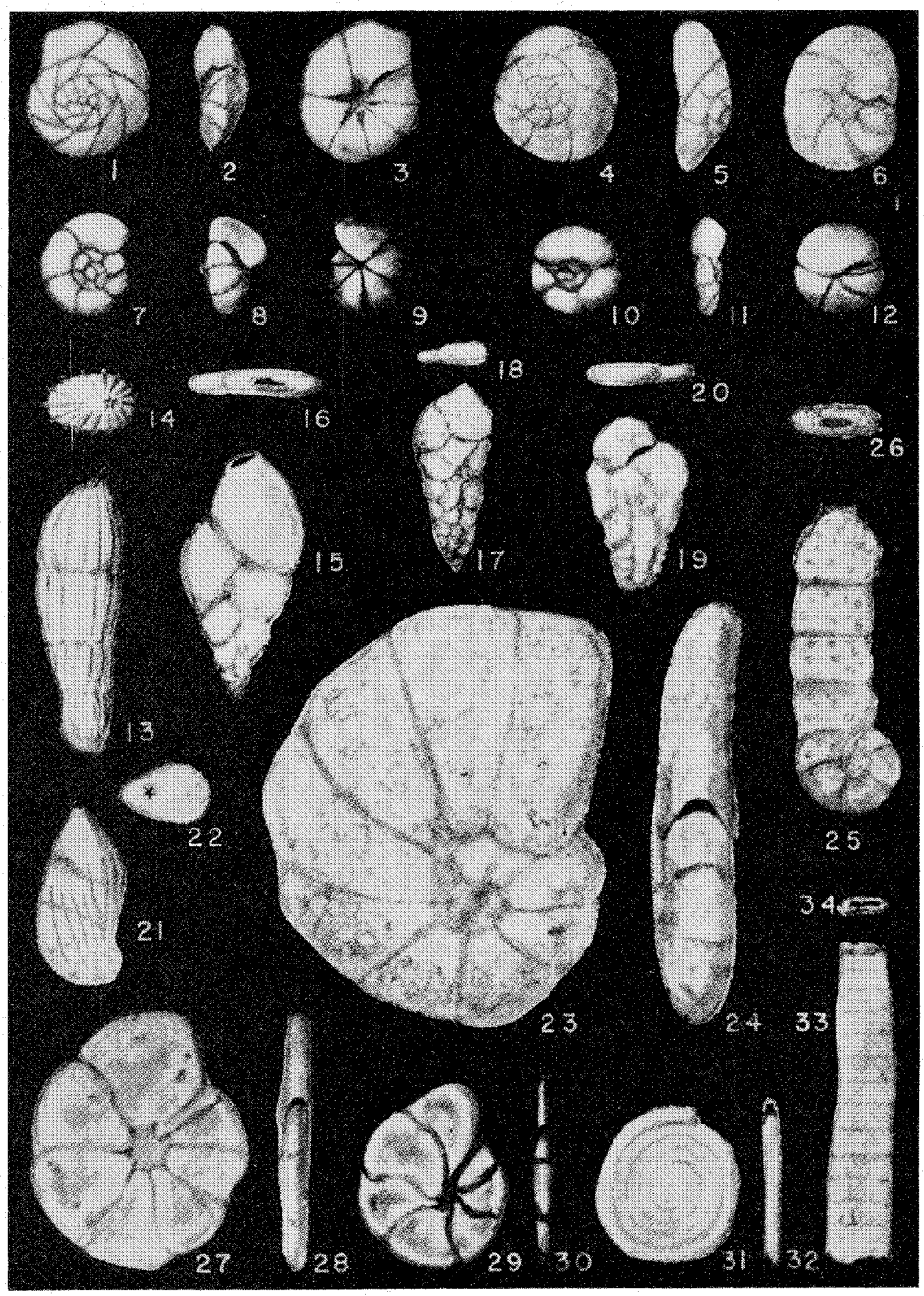


Plate 2—Clearwater Foraminifera.

EXPLANATION OF PLATE 2

Clearwater Formation

Athabasca River, Alberta

Magnification x60

Figs. 1-3: *Discorbis* cf. *turbo* (d'Orbigny); 1—dorsal view, 2—peripheral view, 3—ventral view ..... (p. 30)

Figs. 4-6: *Discorbis norrisi* Mellon and Wall, holotype from Bear Villa No. 1 Well; 4—dorsal view, 5—peripheral view, 6—ventral view ..... (p. 30)

Figs. 7-9: *Gyroidina* cf. *nitida* (Reuss); 7—dorsal view, 8—peripheral view, 9—ventral view ..... (p. 33)

Figs. 10-12: *Quadrimorphina* sp.; 10—dorsal view, 11—peripheral view, 12—ventral view ..... (p. 49)

Figs. 13, 14: *Dentalina* sp. A; 13—side view, 14—apertural view. (p. 29)

Figs. 15,16: *Tritaxia athabascensis* Mellon and Wall; 15—side view, 16—apertural view ..... (p. 53)

Figs. 17-20 *Eggerella* sp. A.; side and apertural views of two specimens ..... (p. 31)

Figs. 21, 22: *Marginulinopsis collinsi* Mellon and Wall variety; 21—side view, 22—apertural view ..... (p. 44)

Figs. 23, 24: *Haplophragmoides sluzari* Mellon and Wall; 23—side view, 24—apertural view ..... (p. 38)

Figs. 25, 26: *Ammobaculites humei* Nauss; 25— side view, 26—apertural view ..... (p. 22)

Figs. 27,28: *Haplophragmoides* cf. *sluzari* Mellon and Wall; 27—side view, 28—apertural view ..... (p. 39)

Figs. 29, 30: *Haplophragmoides gigas minor* Nauss; 29— side view, 30—peripheral view. ..... (p. 35)

Figs. 31, 32: *Ammodiscus* sp.; 31—side view, 32—peripheral view. ..... (p. 26)

Figs. 33, 34: *Bathysiphon* sp. B; 33—side view, 34—end view (p. 27)

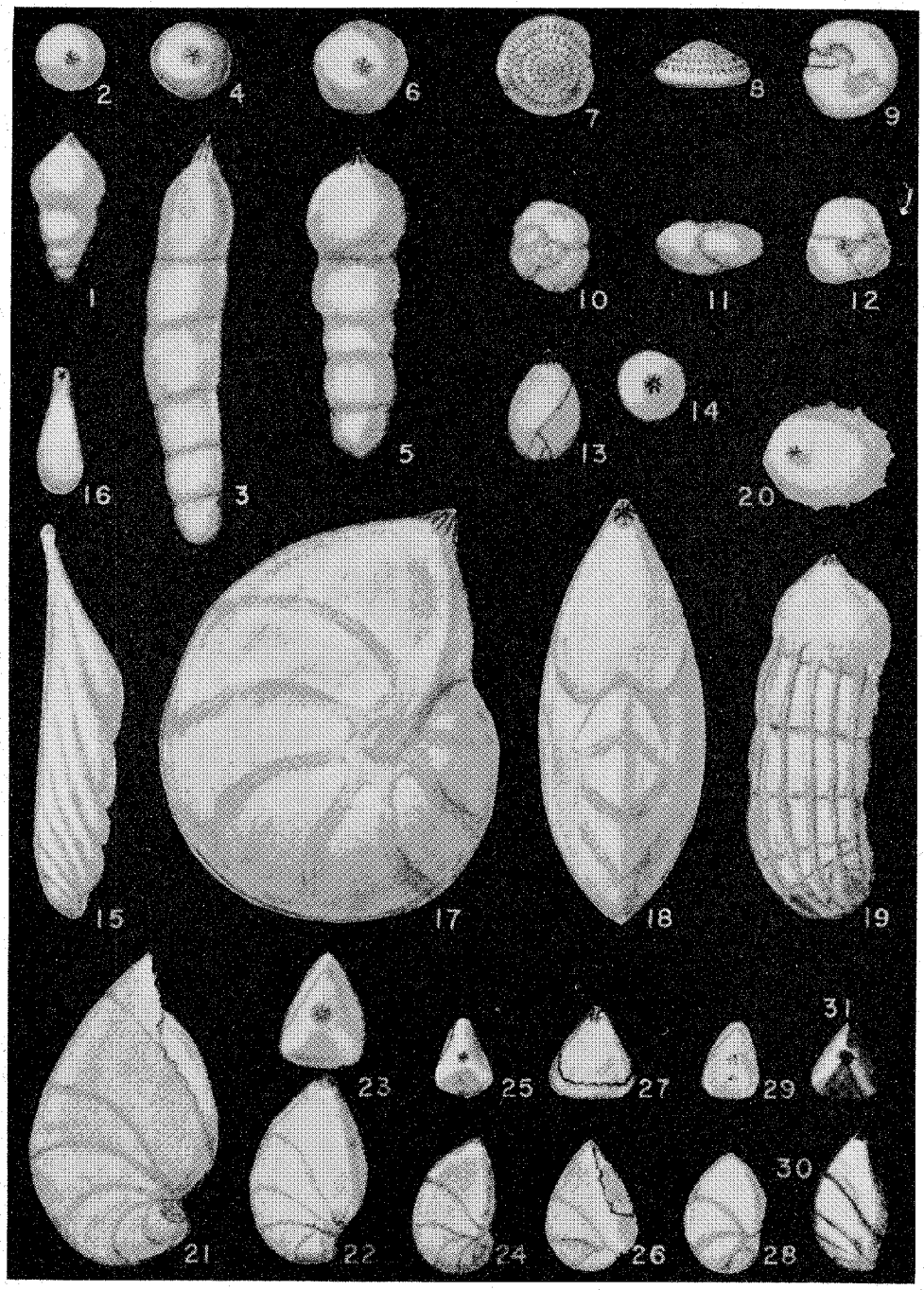


Plate 3—Clearwater Foraminifera.

EXPLANATION OF PLATE 3

Clearwater Formation

Athabasca River, Alberta

Magnification x60

Figs. 1, 2, 5, 6: *Pseudonodosaria clearwaterensis* Mellon and Wall; side and apertural views of two specimens ..... (p. 47)

Figs. 3, 4: *Dentalina* sp. B; 3—side view, 4—apertural view (p. 29)

Figs. 7-9: *Patellina elliotti* Stelck and Wall, n. sp., holotype; 7—dorsal view, 8—peripheral view, 9—ventral view (p. 46)

Figs. 10-12: *Quadrimorphina albertensis* Mellon and Wall; 10—dorsal view, 11—peripheral view, 12—ventral view ... (p. 48)

Figs. 13, 14: *Globulina lacrima canadensis* Mellon and Wall; 13—side view, 14—apertural view ..... (p. 32)

Figs. 15, 16: *Vaginulina* sp.; 15—side view, 16—apertural view (p. 55)

Figs. 17, 18: *Lenticulina bayrocki* Mellon and Wall; 17—side view, 18—peripheral view ..... (p. 42)

Figs. 19, 20: *Marginulinopsis collinsi* Mellon and Wall; 19—side view, 20—apertural view ..... (p. 44)

Fig. 21: *Saracenaria trollopei* Mellon and Wall ..... (p. 50)

Figs. 22-25: *Saracenaria projectura* Stelck and Wall, n. sp.; 22, 23—side and apertural views of paratype; 24, 25—side and apertural views of immature specimen ..... (p. 50)

Figs. 26, 27: *Saracenaria* sp. A; 26—side view, 27—apertural view ..... (p. 51)

Figs. 28, 29: *Saracenaria* sp. B; 28—side view, 29—apertural view ..... (p. 52)

Figs. 30, 31: *Saracenaria* sp. C; 30—side view, 31—apertural view ..... (p. 52)

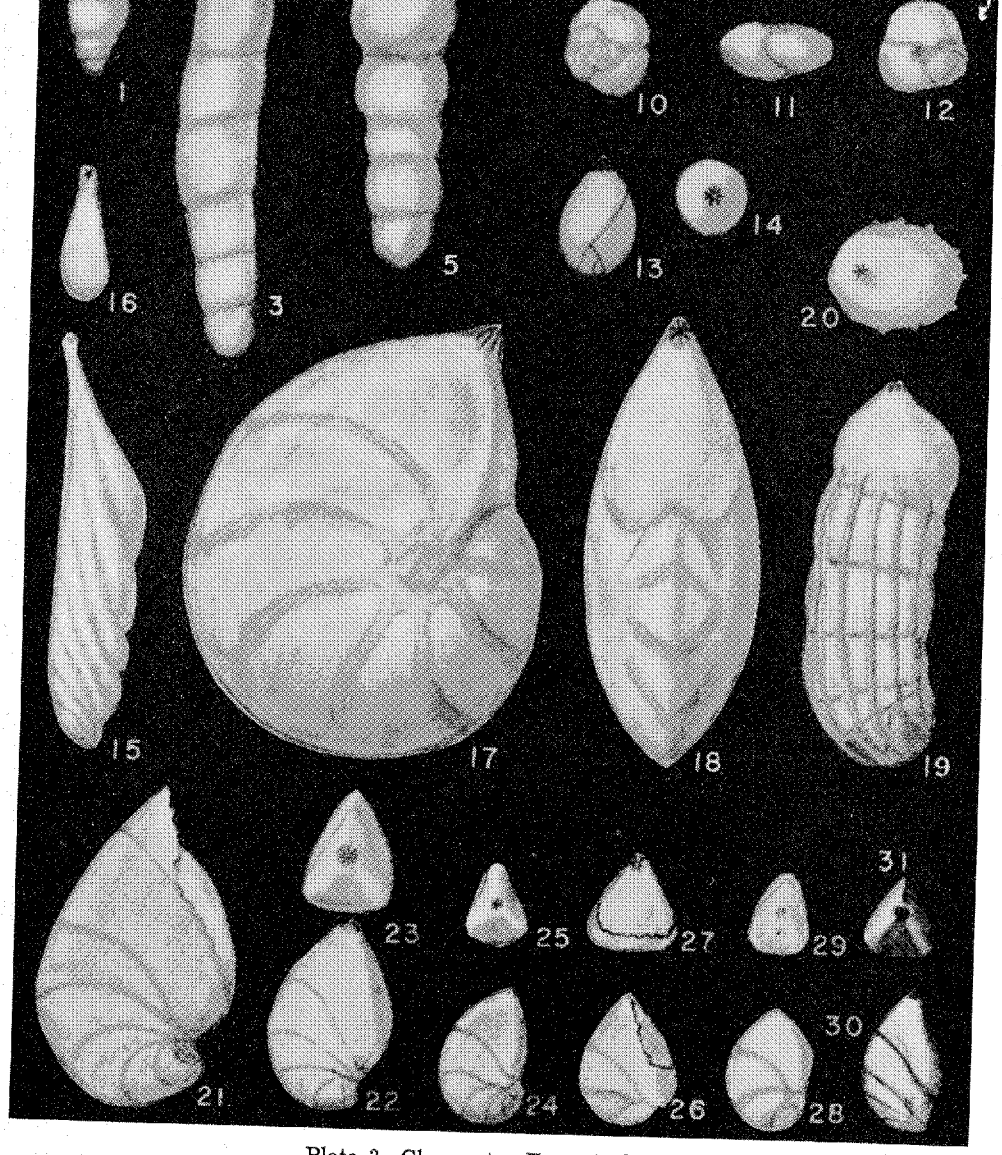


Plate 3—Clearwater Foraminifera.

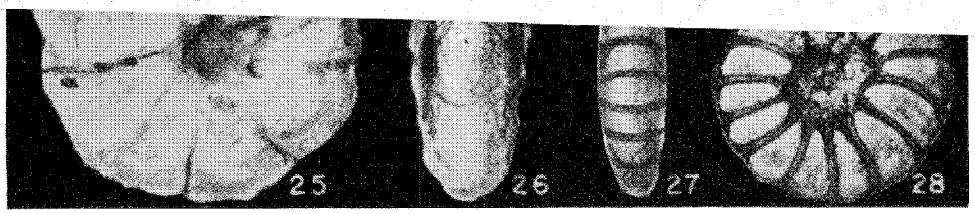


Plate 4—Foraminifera from middle Commotion formation.

EXPLANATION OF PLATE 4

Fort St. John Group, Commotion Formation Correlative
"Gates" of the Peace River, British Columbia

Magnification x60

Figs. 1, 2: *Ammobaculites janus* Stelck and Wall n. sp., holotype; 1—side view, 2—apertural view ..... (p. 23)

Figs. 3, 4: *Verneuilina porta* Stelck and Wall, n. sp., holotype; views of opposite sides ..... (p. 55)

Figs. 5, 6: *Verneuilinoides* sp.; 5—side view, 6—apertural view ..... (p. 56)

Fig. 7: *Eggerella* sp. B ..... (p. 31)

Fig. 8: *Proteonina* sp. ..... (p. 47)

Figs. 9-11: *Trochammina gatesensis* Stelck and Wall, n. sp., holotype; 9—dorsal view, 10—peripheral view, 11—ventral view ..... (p. 53)

Figs. 12, 13: *Haplophragmoides* cf. *H. kirki* Wickenden; 12—side view, 13—peripheral view ..... (p. 36)

Figs. 14-16: *Haplophragmoides multiplum* Stelck and Wall, n. sp., holotype; 14, 16—views of opposite sides; 15—peripheral view ..... (p. 37)

Figs. 17, 18: *Haplophragmoides linki* Nauss; 17—peripheral view, 18—side view ..... (p. 36)

Figs. 19-22: *Haplophragmoides* sp. B.; 19,20—side and peripheral views of a specimen; 21, 22—views of opposite sides of another specimen ..... (p. 40)

Figs. 23, 24—*Haplophragmoides postis* Stelck and Wall, n. sp., holotype; 23—peripheral view, 24—side view. ..... (p. 38)

Figs. 25,26: *Haplophragmoides* sp. C; 25—side view, 26—peripheral view ..... (p. 41)

Figs. 27, 28: *Haplophragmoides spissum* Stelck and Wall, n. sp., holotype; 27—peripheral view, 28—side view ..... (p. 39)

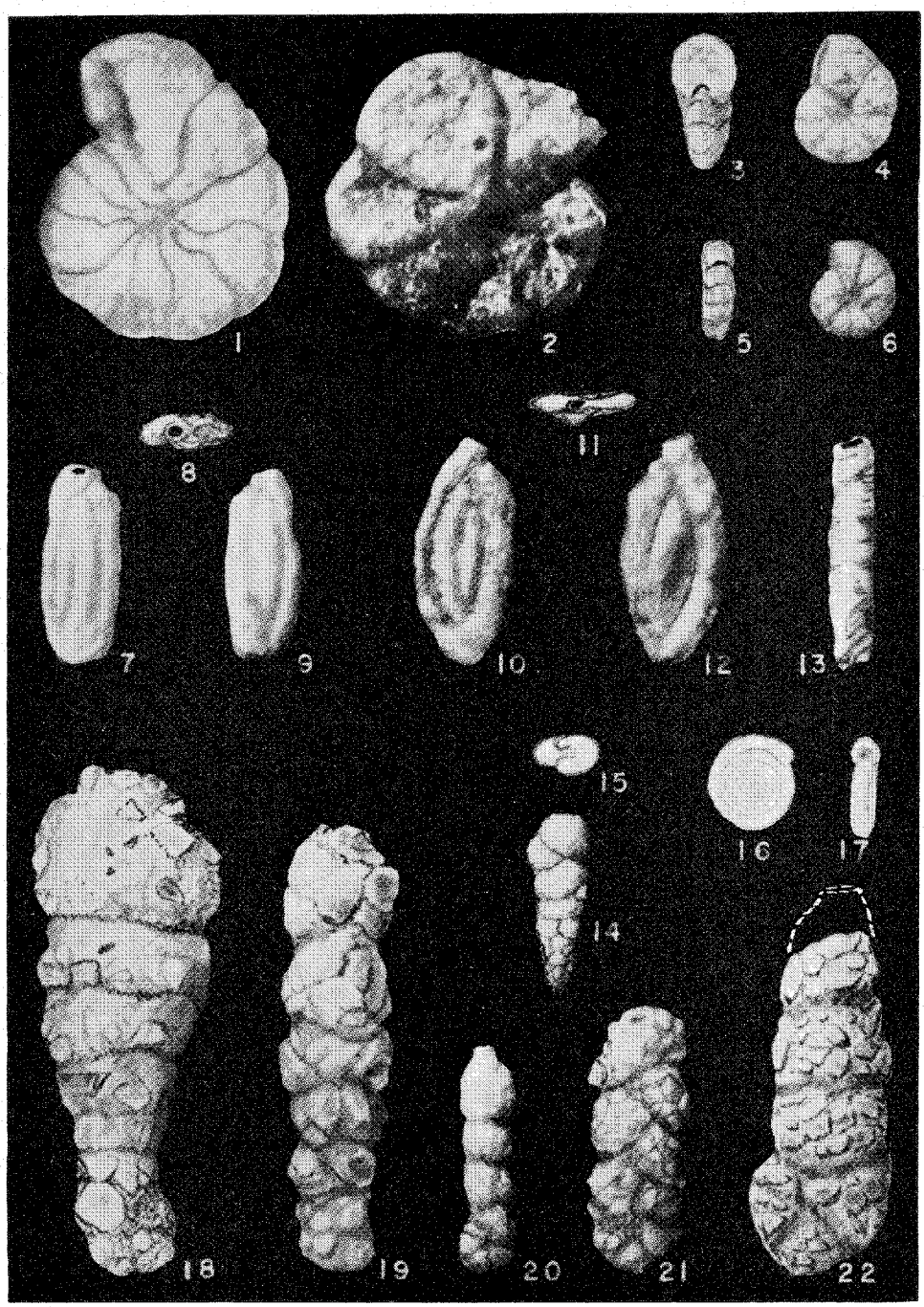


Plate 5—Foraminifera from Joli Fou and Grand Rapids formations.

EXPLANATION OF PLATE 5

Joli Fou and Grand Rapids Formations

Athabasca River, Alberta

Magnification x45 except for figs. 16, 17, which are x60

Fig. 1: *Haplophragmoides gigas* Cushman from Joli Fou formation (p. 35)

Fig. 2: *Haplophragmoides* sp. D from Joli Fou formation (p. 41)

Figs. 3, 4: *Haplophragmoides* cf. *H. collyra* Nauss from Joli Fou formation; 3—peripheral view, 4—side view (p. 34)

Figs. 5, 6: *Haplophragmoides linki* Nauss from Joli Fou formation; 5—peripheral view, 6—side view (p. 36)

Figs. 7-12: *Miliammina sproulei* Nauss; 7, 8, 9—views of opposite sides and aperture of specimen from the top of the Grand Rapids formation; 10, 11, 12—views of opposite sides and aperture of specimen from the Joli Fou formation (p. 45)

Fig. 13: *Hyperammina* sp. from Joli Fou formation (p. 42)

Figs. 14, 15: *Gaudryina hectori* Nauss from Joli Fou formation; 14—side view, 15—apertural view (p. 32)

Figs. 16,17: *Ammodiscus kiowensis* Loeblich and Tappan from Joli Fou formation; 16—side view, 17—peripheral view (p. 25)

Fig. 18: *Ammobaculites fragmentarius* Cushman from Joli Fou formation (p. 21)

Fig. 19: *Ammobaculites fragmentarius* Cushman variety, from Joli Fou formation (p. 22)

Fig. 20: *Ammobaculites tyrrelli* Nauss var. *jolifouensis* Stelck and Wall, n. var., variety holotype, from Joli Fou formation (p. 23)

Fig. 21: *Ammobaculoides athabascensis* Stelck and Wall, n. sp., holotype, from Joli Fou formation (p. 25)

Fig. 22: *Ammobaculites* sp. from Joli Fou formation (p. 24)

Locality of specimen (Plate 1, fig. 21): S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Locality of specimen (Plate 3, figs. 13, 14): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Specimen (Plate 1, fig. 21): Stanford Univ. Pal. Type Coll.

Specimen (Plate 3, figs. 13, 14): Univ. of Alberta Pal. Type Coll.

Horizon: Mellon and Wall (1956) described and assigned a name to this form recovered from the basal Clearwater shales in the McMurray area, while Wickenden (1951) had reported it from the middle part of the Falher member of the Spirit River formation. The two occurrences reported in this paper, i.e., the type section Clearwater on the Athabasca river of northeastern Alberta and the lower part of the Moosebar formation of northeastern British Columbia, serve to show the rather widespread distribution of this form in Middle Albian strata.

Remarks: Due to the unsatisfactory state of preservation of the Moosebar specimen, it is difficult to determine the chamber arrangement, position of the sutures, etc.

Genus GYROIDINA d'Orbigny, 1826

GYROIDINA cf. G. NITIDA (Reuss)

Plate 1, figures 11, 12, 13; Plate 2, figures 7, 8, 9

Rotalina nitida Reuss, 1844, Geognostiche Skizzen Böhmen, vol. 2, pt .1, p. 214; Verstein. böhm. Kreideformation, 1845, pt. 1, p. 35, pl. 8, figs. 52 a-b; pl. 12, figs. 8 a-c, 20 a-b.

Gyroidina nitida (Reuss) Morrow. Cushman, 1946, U. S. Geol. Surv. Prof. Paper 206, p. 140, pl. 58, figs. 5 a-c (synonymy).

Gyroidina sp. A. Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 41, pl. I A, figs. 30 a-c.

Test small, nearly plano-convex, with dorsal side only very slightly convex and ventral side strongly convex with a small umbilicus; periphery narrowly rounded; test consists of a spherical proloculus and two whorls of six chambers apiece; chambers distinct,gradually increasing in size as added, somewhat inflated in ultimate whorl, all visible dorsally, only those of final whorl visible ventrally; sutures distinct, slightly curved, flush except for the last two or three which are depressed; the spiral suture is slightly depressed; wall calcareous, hyaline, thin, fragile, finely perforate; aperture a slit at the base of the face of the last formed chamber between the periphery and the umbilicus and connecting with the latter.

Maximum diameter of figured specimen (Plate 1, figs. 11, 12, 13): 0.28 mm., minimum diameter 0.2 mm.; height 0.2 mm.

Maximum diameter of figured specimen (Plate 2, figs. 7, 8, 9): 0.25 mm.; minimum diameter 0.2.; height 0.15 mm.

Locality of figured specimen (Plate 1, figs. 11, 12, 13): S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Locality of figured specimen (Plate 2, figs. 7, 8, 9): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen (Plate 1, figs. 11, 12, 13): Stanford Univ, Pal. Type Coll.

Figured specimen (Plate 2, figs. 7, 8, 9): Univ. of Alberta Pal. Type Coll.

Horizon: Wickenden (1951) reported this species from the lower and middle parts of the Falher member of the Spirit River formation, while Trollope (1951) also reported it in the upper part of the Loon River formation on the lower Peace river, further downstream from Wickenden's locality. These occurrences together with those of the specimens figured in this paper from the Clearwater and Moosebar formations indicate that this form is a good index of Middle Albian age in northwestern Canada.

Comparison: This form seems very closely related to Reuss' original species from the Cretaceous of Bohemia, but differs from the latter in having distinct earlier chambers and sutures. This feature may be only a phenomenon of preservation, in which event the two forms could be regarded as identical. In this connection, the specimen from the Moosebar formation is poorly preserved and it is very difficult to observe the earlier chambers.

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES cf. H. COLLYRA Nauss

Plate 5, figures 3, 4

Haplophragmoides collyra Nauss, 1947, Jour. Paleontology, vol. 21, p. 337, pl. 49, figs. 2 a-b, 5.

Test planispiral, partly evolute with portions of all chambers visible, periphery rounded, moderate umbilicus developed; chambers seven in ultimate whorl, of nearly equal size, final two inflated; sutures distinct, straight, radial, earlier ones slightly depressed, later ones more deeply impressed; wall arenaceous, of grains averaging between .01 and .02 mm. in size, with considerable cement giving a smooth finish; aperture an arch at the base of the terminal face, not readily visible.

Greatest diameter of figured specimen: 0.35 mm.; least diameter 0.26 mm; thickness 0.11 mm.

Locality of figured specimen: Z1 in N.E. $\frac{1}{4}$, Sec. 31, Tp. 85, Rge. 17, W. 4th Meridian, on the north bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 22 feet above the top of the Grand Rapids formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: This form is similar to *H. collyra* Nauss, originally described from the Lloydminster shale of east-central Alberta, in that both have approximately the same number of chambers, radial sutures, and the same type of wall structure. The Joli Fou specimens, however, tend to be less globose in appearance, lacking the strongly inflated chambers of the species *s.s.*, and again the Joli Fou material shows a tendency to become considerably more evolute.

HAPLOPHRAGMOIDES GIGAS Cushman

Plate 5, figure 1

Haplophragmoides gigas Cushman, 1927, Trans. Roy. Soc. Can., vol. 21, sec. IV, p. 129, pl. 1, fig. 5.

Haplophragmoides gigas Cushman. Cushman, 1946, U. S. Geol. Surv. Prof. Paper 206, p. 21, pl. 3, fig. 2.

Haplophragmoides gigas Cushman. Nauss, 1947, Jour. Paleontology, vol. 21, p. 338, pl. 49, figs. 8 a-b.

Test large, planispiral, compressed, involute becoming evolute in later stages; periphery narrowly rounded; chambers about ten in last whorl, with their inner ends tending to form a lobe around the umbilicus; sutures distinct, slightly thickened, depressed, somewhat sigmoidal (a feature more noticeable in crushed specimens); wall rather finely arenaceous with a large amount of cement giving a smooth finish; aperture a slit at the base of the apertural face, with a lip, which is visible only in thin-walled, badly flattened specimens.

Greatest diameter of plesiotype: 0.98 mm.; least diameter 0.78 mm.; thickness 0.23 mm.

Locality of plesiotype: Z1 in N.E. $\frac{1}{4}$, Sec. 31, Tp. 85, Rge. 17, W. 4th Meridian, on the north bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 22 feet above the top of the Grand Rapids formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Horizon: This species provides an excellent index for latest Middle Albian (pre-Viking) strata in Alberta, Saskatchewan, and Manitoba.

Remarks: The Joli Fou specimens usually show a prominent concave depression on the terminal face, which is set somewhat oblique to the plane of coiling. These features can probably be regarded as phenomena of fossilization.

HAPLOPHRAGMOIDES GIGAS MINOR Nauss

Plate 2, figures 29, 30

Haplophragmoides gigas minor Nauss, 1947, Jour. Paleontology, vol. 21, p. 338, pl. 49, figs. 10 a-b.

Haplophragmoides gigas minor Nauss. Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 17, pl. 1, fig. 10.

Test compressed, planispiral, involute, with some umbilical development; periphery angular, chambers gradually increasing in

size, seven visible in ultimate whorl, with their inner ends tending to form a lobe around the umbilicus; sutures fairly distinct, thickened, slightly depressed, sigmoidal; wall finely arenaceous with much cement giving a smooth exterior surface; aperture an arched slit at the base of the terminal face.

Maximum diameter of plesiotype: 0.4 mm.; minimum diameter 0.34 mm.; thickness 0.12 mm.

Plesiotype locality: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Horizon: This form was described originally by Nauss from the Cummings member of the Mannville formation in east-central Alberta. It is present in the middle and upper part of the Clearwater formation in type section and is common in the basal shales of the Clearwater in the McMurray area.

HAPLOPHRAGMOIDES cf. H. KIRKI Wickenden

Plate 4, figures 12, 13

Haplophragmoides kirki Wickenden, 1932, Trans. Roy. Soc. Can., vol. 26, sec. IV, p. 85, pl. 1, figs. 1 a-c.

Haplophragmoides kirki Wickenden. Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 21, pl. 2, figs. 23 a-c.

Test small, planispiral, close-coiled, involute, periphery broadly rounded; chambers somewhat inflated, four in ultimate whorl, last three of nearly equal size; sutures distinct, depressed, straight; wall finely arenaceous with much cement giving a smooth external surface; aperture a low slit at the base of the terminal face.

Diameter of figured specimen: 0.24 mm.; thickness 0.1 mm.

Locality of figured specimen: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, about 40 feet above the Gates sandstone.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: This form seems to differ from *H. kirki* Wickenden only in being less robust and in having less inflated chambers.

HAPLOPHRAGMOIDES LINKI Nauss

Plate 4, figures 17, 18; Plate 5, figures 5, 6

Haplophragmoides rugosa Cushman, 1927 (*non* Cushman and Waters, 1927), Trans. Roy. Soc. Can., vol. 21, sec. IV, p. 128, pl. 1, fig. 2.

Haplophragmoides linki Nauss, 1947, Jour. Paleontology, vol. 21, p. 339, pl. 49, figs. 7 a-b.

Test rather small, planispiral, involute, umbilicate, periphery rounded; chambers distinct, eight in ultimate whorl, of nearly equal size; sutures distinct, somewhat thickened, slightly depressed, radial;

wall finely arenaceous, with a few moderately-sized grains, considerable cement giving a smooth outer finish; aperture a low arched slit at the base of the terminal face.

Maximum diameter of plesiotype (Plate 5, figs. 5, 6): 0.27 mm.; thickness 0.12 mm.

Diameter of specimen (Plate 4, figs. 17, 18): 0.36 mm.; thickness 0.2 mm.

Plesiotype locality: Z1 in N.E. ¼, Sec. 31, Tp. 85, Rge. 17, W. 4th Meridian, on the north bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 22 feet above the top of the Grand Rapids formation.

Locality of figured specimen: S47-16 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 531 feet above the Gates sandstone.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Figured specimen: Stanford Univ. Pal. Type Coll.

Horizon: *H. linki* was described originally by Nauss from the basalmost portion of the Lloydminster shale of east-central Alberta. In the subsurface of the Edmonton (central Alberta) area, it occurs commonly in the Lower Shale member of the Colorado group, i.e., the *Haplophragmoides gigas* zone. Its occurrences here recorded in the Joli Fou formation of northeastern Alberta and in the St. John shales of northeastern British Columbia, would indicate that the species has a rather widespread distribution in rocks of late Middle Albian age.

Remarks: The current authors' description is based on the plesiotype from the Joli Fou shale. The figured specimen from the St. John shales of British Columbia is more robust than average representatives of the species, but specimens have been recovered at this latter locality which approach the normal thickness of topotype material.

HAPLOPHRAGMOIDES MULTIPLUM Stelck and Wall, n. sp.

Plate 4, figures 14, 15, 16

Haplophragmoides sp.E Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 43, pl, IB, fig. 2.

Test small, compressed, planispiral, completely evolute with proloculus and three and one-half whorls of chambers visible; periphery narrowly rounded; chambers distinct, twelve in ultimate whorl, increasing slightly in size added; sutures distinct, slightly depressed, radial, with small but prominent forward-bending lobes, particularly noticeable in the ultimate whorl; wall finely arenaceous with much cement giving a smooth finish; aperture a low arch at the base of the terminal face.

Maximum diameter of holotype: 0.27 mm.; minimum diameter 0.22 mm.; thickness 0.08 mm.

Holotype locality: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 195 feet above the Gates sandstone.

Holotype: Stanford Univ. Pal. Type Coll.

Horizon: In addition to the occurrence in the St. John shales of the western Peace River area of British Columbia, this species is present in the Middle Shale member (Harmon) of the Peace River formation (Wickenden, 1951).

Comparison: This highly evolute species is related to *H. howardense manifestum* Stelck and Wall from the central part of the Kaskapau formation, but may be distinguished from the latter by its smaller size and distinctly lobed sutures.

HAPLOPHRAGMOIDES POSTIS Stelck and Wall, n. sp.

Plate 4, figures 23, 24

Test of medium size, planispiral, close-coiled becoming evolute in final whorl, periphery broadly rounded, umbilicus shallow and inconspicuous, usually covered with extraneous material; chambers distinct, about ten visible in ultimate whorl, of approximately the same size; sutures distinct, slightly depressed, nearly straight but occasionally with a slight sigmoidal tendency, irregularly thickened, especially toward the umbilicus; wall arenaceous with grains to 0.03 mm., forming a close mosaic on the inside and plastered with cement on outside, leaving a smooth dull finish to the exterior; aperture a low broad arch at the base of the terminal face.

Diameter of holotype: 0.4 mm.; thickness 0.19 mm.

Holotype locality: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John Shales, 205 feet above the Gates.

Holotype: Stanford Univ. Pal. Type Coll.

Comparison: This species bears some similarity to *H. linki* Nauss, but differs from the latter in possessing additional chambers and tending to become evolute.

The new species seems to have a similar chamber arrangement and sutures to *H. carlilensis* Fox from the Upper Cretaceous of South Dakota and Wyoming, but the latter species is considerably larger and deeply umbilicate.

Name: After the Latin *postis* meaning gateway.

HAPLOPHRAGMOIDES SLUZARI Mellon and Wall

Plate 2, figures 23, 24

Haplophragmoides sluzari Mellon and Wall, 1956 Research Council of Alberta Report No. 72, p. 17, pl. 1, fig. 15.

Test large, compressed, planispiral, partly evolute with the shallow umbilicus revealing a portion of the penultimate whorl; peri-

phery narrowly rounded; chambers gradually increasing in size, nine in ultimate whorl; sutures indistinct, flush to slightly depressed, straight, somewhat thickened; wall arenaceous, composed of fine, clear quartz grains set in a considerable amount of brownish cement, giving an even exterior finish; aperture a low arch at the base of the terminal face.

Maximum diameter of plesiotype: 1.0 mm., minimum diameter 0.84 mm.; thickness 0.25 mm.

Plesiotype locality: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below top of the formation.

Plesiotype: Univ. of Alberta Pal. Type Coll.

Horizon: This species is present throughout the Clearwater formation, being found in its central and upper parts in type section, and in its basal beds in the McMurray area (Mellon and Wall, 1956). This form is fairly close to one reported by Wickenden (1951, p. 34, pl. IA, fig. 3) from the lower and middle parts of the Falher member of the Spirit River formation along the lower Peace river.

Remarks: The plesiotype shown in this paper seems to have been somewhat obliquely deformed in fossilization, resulting in the later chambers appearing more elongate that their probable original shape.

HAPLOPHRAGMOIDES cf. H. SLUZARI

Plate 2, figures 27, 28

Haplophragmoides cf. *sluzari* Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 18, pl. 1, figs. 11, 12.

Maximum diameter of figured specimen: 0.57 mm.; approximate thickness 0.1 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 95 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Remarks. The specimen here figured from the upper part of the Clearwater formation is very close to *H.* cf *sluzari* from the top of the McMurray formation, as both forms have the same chamber arrangement, similar sutures and an identical wall structure. The McMurray specimen is, however, considerably thicker through the umbilicus.

HAPLOPHRAGMOIDES SPISSUM Stelck and Wall, n. sp.

Plate 4, figures 27, 28

Test of medium size, compressed, planispiral, partly evolute but earlier whorls concealed by siliceous deposit in the wide shallow umbilicus; periphery narrowly rounded; chambers distinct, fourteen in ultimate whorl, of nearly equal size; sutures distinct, flush, slight-

ly curved, nearly radial, much thickened; wall finely arenaceous, overlain by a thick smooth coating of cement that covers the umbilical area with an irregularly pustulate deposit; aperture a high arched hooded opening at the base of the terminal face.

Maximum diameter of holotype: 0.64 mm.; minimum diameter 0.55 mm.; thickness 0.17 mm.; diameter of umbilicus 0.2 mm.; thickness of sutures 0.02 mm.

Holotype locality: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 195 feet above the Gates sandstone.

Holotype: Stanford Univ. Pal. Type Coll.

HAPLOPHRAGMOIDES sp. A

Plate 1, figure 26

Test small, compressed, planispiral, close-coiled with small umbilicus; chambers indistinct, eight in ultimate whorl, their inner ends tending to form a lobe around the umbilicus; sutures indistinct, straight, their positions emphasized to a certain extent as a result of a crushing action, reflecting the strength of the intercameral walls; wall arenaceous with grain size to 0.01 mm., with considerable cement in the wall making an outer surface of a very finely irregularly papillate nature; aperture a low arch at the base of the terminal face.

Diameter of figured specimen: 0.33 mm., thickness 0.15 mm.

Locality of figured specimen: S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Remarks: This species bears a vague similarity to *H. gigas minor* Nauss, but lacks the distinct, sigmoidal sutures of the latter. The authors have figured this rather nondescript form since an identical species of *Haplophragmoides* is known to occur in the Bear Villa No. 1 Well, between depths of 2539 and 2545 feet in shale of the Wilrich member of the Spirit River formation.

HAPLOPHRAGMOIDES sp. B

Plate 4, figures 19, 20, 21, 22

Test fairly small, compressed, planispiral, close-coiled but slightly evolute; periphery sharply rounded; chambers, seven visible in ultimate whorl, of approximately the same size; sutures fairly distinct, flush or nearly so, straight, somewhat thickened; wall arenaceous, sand grains of various sizes up to 0.02 mm., cement covering exterior leaving a smooth finish; aperture obscured, apparently a low arch at the base of the terminal face.

Diameter of figured specimen (figs. 19, 20): 0.27 mm.; thickness 0.10 mm.

Diameter of figured specimen (figs. 21,22): 0.26 mm.; thickness 0.11 mm.

Locality of figured specimen (figs. 19, 20): S47-16 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half miles east of the "Gates", British Columbia, Canada, from St. John shales, 429 feet above the Gates sandstone.

Locality of figured specimen (figs. 21, 22): S47-17, geographically identical with the above, from St. John shales, 355 feet above the Gates sandstone.

Figured specimens: Stanford Univ. Pal. Type Coll.

Comparison: This form bears some similarity to *H. linki* Nauss but differs in being partly evolute and considerably compressed with an angular periphery.

HAPLOPHRAGMOIDES sp. C.

Plate 4, figures 25, 26

Test large, slightly compressed, planispiral, involute with a small, rather shallow umbilicus; periphery rounded; chambers indistinct, between eight and nine visible in ultimate whorl; sutures obscured in part, slightly depressed, radial; wall arenaceous, of rounded grains to 0.03 mm. with much cement obscuring the outlines of the sand grains and giving exterior a dull smooth finish; aperture a narrow arched opening at the base of the terminal face.

Diameter of figured specimen: 0.75 mm.; diameter of umbilicus 0.12 mm.; thickness 0.27 mm.

Locality of figured specimen: S47-16 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 531 feet above the Gates sandstone.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: *Haplophragmoides* sp. C shows a general resemblance to *Haplophragmoides dickinsoni* Crespin from the Lower Cretaceous of the Great Artesian Basin, Australia, but the latter is smaller and has fewer chambers.

HAPLOPHRAGMOIDES sp. D

Plate 5, figure 2

Test rather large, planispiral, compressed, nearly involute; periphery narrowly rounded; seven chambers visible in ultimate whorl, their inner ends tending to form a lobe around the umbilicus; sutures fairly distinct, slightly depressed, slightly sigmoidal; wall arenaceous of moderate size grains with considerable cement giving a fairly smooth finish; aperture a slit at the base of the apertural

face with a lip, which is visible only in thin-walled, badly flattened specimens.

Greatest diameter of figured specimen: 0.89 mm.; least diameter 0.78 mm.; thickness 0.19 mm.

Locality of figured specimen: B75 in S.E. ¼, Sec. 34, Tp. 82, Rge. 17, W. 4th Meridian, on the west bank of the Athabasca river, Alberta, Canada, from the Joli Fou shale, 13 feet above the top of the Grand Rapids formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Horizon: In addition to its occurrence in the Joli Fou formation of north-central Alberta, this form has been observed in the Lower Shale member of the Colorado group from wells in the central Alberta area.

Comparison: This form bears a general similarity to *H. gigas* Cushman, but is more involute and has only seven chambers in the final whorl, as opposed to ten in the latter species.

Genus HYPERAMMINA H. B. Brady, 1878

HYPERAMMINA sp.

Plate 5, figure 13

Test elongate, tubular, slightly constricted at irregular intervals throughout its length; primary chamber broken off in figured specimen but another specimen shows a compressed proloculus at an angle to the second chamber; wall thick composed of fine arenaceous material with considerable white cement giving a fairly smooth surface; aperture terminal, the open end of tube.

Length of figured specimen: 0.71 mm.; greatest width 0.15 mm.; diameter of aperture 0.07 mm.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Locality of figured specimen: B74 in S.E. ¼, Sec. 27, Tp. 82, Rge. 17, W. 4th Meridian, on the east bank of the Athabasca river, Alberta, Canada, from the Joli Fou Shale, 65 feet above the top of the Grand Rapids formation.

Genus LENTICULINA Lamarck, 1804

LENTICULINA BAYROCKI Mellon and Wall

Plate 3, figures 17, 18

Lenticulina sp. Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 37, pl. IA, figs. 12, 13.

Lenticulina bayrocki Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 19, pl. 2, figs. 7, 8.

Maximum diameter of figured specimen: 1.0 mm.; minimum diameter 0.85 mm.; thickness 0.4 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of

the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Horizon: In addition to its occurrence in the central and upper parts of the Clearwater formation in type section, this species is present in the basal Clearwater shales of the McMurray area, where it was named and described by Mellon and Wall (1956). Wickenden (1951) had previously recorded this form from the lower Falher member of the Spirit River formation exposed along the lower Peace river.

Comparison: The specimen figured here fits very closely the original description of Mellon and Wall's holotype. The former is more robust and has an orange coloration as compared to the whitish color of the holotype. Mellon and Wall (*op. cit.*) have already noted a similarity between this species and *Cristellaria gaultina* Berthelin from the Albian of France.

LENTICULINA sp.

Plate 1, figure 25

Test close-coiled, longer than broad, inflated, periphery broadly rounded; five and one-half chambers visible, last four of nearly equal size, with the ultimate one inflated and drawn to a blunt point at the peripheral angle; umbilical area slightly depressed; sutures rather indistinct, nearly straight to slightly sigmoidal, slightly depressed, last suture strongly depressed; wall calcareous, recrystallized with character obscured; aperture at the peripheral angle, somewhat protruding, radiate.

Maximum diameter of figured specimen: 0.6 mm.; minimum diameter 0.45 mm.; thickness 0.2 mm.

Locality of figured specimen: S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Genus MARGINULINA d'Orbigny, 1826

MARGINULINA sp.

Plate 1, figures 1, 2

Test elongate, early coiled portion considerably compressed, adult uncoiled portion slightly compressed and ovoid in cross-section; dorsal margin convex, ventral margin almost straight; chambers, four visible in the coiled portion, four to five in the straight portion; sutures rather indistinct, somewhat thickened; sutures in coiled portion flush and radial, in the straight portion depressed and oblique; wall calcareous, perforate; aperture radiate, at the outer margin of the last formed chamber.

Length of figured specimen: 0.85 mm.; greatest width 0.22 mm.; thickness 0.19 mm. The figured specimen is lacking the ultimate chamber — total length of species is estimated to be about 1.1 mm.

Locality of figured specimen: S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: This form shows some similarity to *Cristellaria* (*Cristellaria*) *schlönbachi* Reuss from the Lower Gault of Germany but the latter has a more extensive coiled portion.

Genus MARGINULINOPSIS Silvestri, 1904

MARGINULINOPSIS COLLINSI Mellon and Wall

Plate 3, figures 19, 20

Marginulina sp.A Wickenden (*pars*), 1951, Geol. Surv. Canada Paper 51-16, p. 37, pl. IA, figs. 14, 16 (*non* 15).

Marginulinopsis collinsi Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 20, pl. 2, figs. 1,2.

Length of figured specimen: 0.81 mm.; diameter of coiled portion 0.24 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Horizon: This species was named and described by Mellon and Wall (1956) from the basal Clearwater shales in the McMurray area. It was stated by them that the species occurred in the lower part of the Moosebar formation, but it has been since established that the varietal form and not the species *s.s.* is present in the Moosebar. Wickenden (1951) reports the species from the Falher member of the Spirit River formation.

Comparison: The specimen here figured is not quite as robust as Mellon and Wall's holotype, but is otherwise identical. There are, however, additional unfigured specimens from the type section Clearwater as robust as the species holotype.

MARGINULINOPSIS COLLINSI Variety

Plate 1, figure 3; Plate 2, figures 21, 22

Marginulinopsis collinsi variety Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 21, pl. 2, figs. 3, 4.

Length of specimen (Plate 1, fig. 3): 0.55 mm.; diameter of coiled portion 0.17 mm.

Length of specimen (Plate 2, figs. 21, 22): 0.44 mm.; diameter of coiled portion 0.16 mm.

Locality of specimen (Plate 1, fig. 3): S47-22 on Hasler creek, about one-quarter mile downstream from the Goodrich mine, approximately six and one-half miles south of the junction of Hasler creek and the Pine river, British Columbia, Canada, from shales of the Moosebar formation, 146 feet above the top of the Gething formation.

Locality of specimen (Plate 2, figs. 21, 22): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 181 feet below the top of the formation.

Specimen (Plate 1, fig. 3): Stanford Univ. Pal. Type Coll.

Specimen (Plate 2, figs. 21, 22): Univ. of Alberta Pal. Type Coll.

Horizon: Same as for the species *s.s.* with the additional occurrence in the lower part of the Moosebar formation.

Comparison: The Moosebar specimen is poorly preserved, but it seems to be referable to this varietal unit. The Clearwater specimen is apparently an immature individual, but it too would appear correctly assigned taxonomically.

Genus MILIAMMINA Heron-Allen and Earland, 1930

MILIAMMINA SPROULEI Nauss

Plate 5, figures 7, 8, 9, 10, 11, 12

Miliammina sproulei Nauss, 1947, Jour. Paleontology, vol. 21, p. 339, pl. 48, figs. 13 a-b.

Test elliptical, compressed; chambers distinct, tubular, in quinqueloculine arrangement, four visible on one side of test, three on the other; sutures distinct, depressed; wall finely arenaceous with much cement giving a smooth finish; aperture round, terminal on a neck-like extension of the last formed chamber.

Length of specimen (figs. 7, 8, 9): 0.62 mm.; width 0.24 mm.

Length of specimen (figs. 10, 11, 12): 0.7 mm.; width 0.31 mm.

Locality of specimen (figs. 7, 8, 9): B76 in the S.W. $\frac{1}{4}$, Sec. 35, Tp. 82, Rge. 17, W. 4th Meridian, on the east bank of the Athabasca river, Alberta, Canada, in the Grand Rapids formation, 23 feet below the top.

Locality of specimen (figs. 10, 11, 12): B74 in the S.E. $\frac{1}{4}$, Sec. 27, Tp. 82, Rge. 17, W. 4th Meridian, on the east bank of the Athabasca river, Alberta, Canada, near the top of the Joli Fou shale, 75 feet above the top of the Grand Rapids formation.

Figured specimens: Univ. of Alberta Pal. Type Coll.

Horizon: This species occurs characteristically in the Cummings member of the Mannville formation of east-central Alberta but it is known to range somewhat higher stratigraphically, being found as well in younger beds in the lower part of the Colorado group.

Comparison: The specimen figured (figs. 7, 8, 9) from the Grand Rapids formation lacks the black coloration characteristic of material

from the type area in east-central Alberta. It also does not show the neck-like projection of the final chamber, a prominent feature of type locality paratypes, but other specimens from the Grand Rapids do possess this neck development.

The specimen figured (figs. 10, 11, 12) from the Joli Fou shale possesses the black coloration of the species holotype, but seems to be larger than the average size of type locality specimens, and perhaps should be regarded as an intermediate form between the species *s.s.* and *Miliammina sproulei gigantea* Mellon and Wall from the upper part of the McMurray formation.

Genus PATELLINA Williamson, 1858

PATELLINA ELLIOTTI Stelck and Wall, n. sp.

Plate 3, figures 7, 8, 9

Test unequally biconvex, dorsal side a low trochoid spire, ventral side less convex, bevelled, periphery narrowly rounded; test consists of a spherical proloculus, a second chamber occupying a whorl and one-half, followed by five to six whorls of two chambers each; later chambers narrow and elongate, added very regularly; two chambers visible on ventral side, trilobate, with a prominent depression on each chamber; dorsal sutures distinct, flush; internal ornamentation consisting of small radial partial septa, regularly spaced, visible on the dorsal wall; wall calcareous, hyaline, finely perforate, thin; aperture ventral, a small arched opening on the inner margin of the last chamber.

Diameter of holotype: 0.24 mm.; height of spire 0.1 mm.

Holotype locality: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Holotype: Univ. of Alberta Pal. Type Coll.

Horizon: In addition to its occurrence in the type section Clearwater, this species is present in the Wilrich member of the Spirit River formation as encountered in the Bear Villa No. 1 Well.

Comparison: This new species seems closely related to *P. subcretacea* Cushman and Alexander from the Lower Cretaceous Upper Goodland formation of Texas, but *P. elliotti* differs in having its later chambers added more uniformly, giving the effect of a nearly continuous spiral suture. The periphery of the new species is not as acute as in the Texas form.

Name: After Robert H. G. Elliott, geologist, Imperial Oil Limited, Edmonton.

Genus PROTEONINA Williamson, 1858

PROTEONINA sp.

Plate 4, figure 8

Test a single flask-shaped chamber with a prominent, tapering tubular neck; maximum diameter of test at two-thirds of the length back from the aperture; wall fairly thick, of coarse sand grains up to about 0.1 mm. in size covering the main chamber, grains fairly well fitted with finely arenaceous cement; neck smooth with much cement on the exterior obscuring outline of sand grains in that portion of the wall; aperture terminal, simple.

Length of figured specimen: 0.46 mm.; maximum diameter 0.27 mm.

Locality of figured specimen: S47-16 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 429 feet above the Gates sandstone.

Figured specimen: Stanford Univ. Pal. Type Coll.

Genus PSEUDONODOSARIA Boomgaart, 1949

PSEUDONODOSARIA CLEARWATERENSIS Mellon and Wall

Plate 1, figures 9, 10; Plate 3, figures 1, 2, 5, 6

Pseudonodosaria clearwaterensis Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 23, pl. 2, figs. 15, 16, 17.

Length of specimen (Plate 1, fig. 9): 0.38 mm.; maximum width 0.2 mm.

Length of specimen (Plate 1, fig. 10): 0.57 mm.; maximum width 0.22 mm.

Length of specimen (Plate 3, figs. 1, 2): 0.36 mm.; maximum width 0.16 mm.

Length of specimen (Plate 3, figs. 5, 6): 0.71 mm.; maximum width 0.23 mm.

Locality of specimen (Plate 1, fig. 9): S47-22 on Hasler creek, about one-quarter mile downstream from the Goodrich mine, approximately six and one-half miles south of the junction of Hasler creek and the Pine river, British Columbia, Canada, from shales of the Moosebar formation, 109 feet above the top of the Gething formation.

Locality of specimen (Plate 1, fig. 10): S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Locality of specimens (Plate 3, figs. 1, 2, 5, 6): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Specimens (Plate 1, figs. 9, 10): Stanford Univ. Pal. Type Coll.

Specimens (Plate 3, figs. 1, 2, 5, 6): Univ. of Alta. Pal. Type Coll.

Horizon: In addition to its occurrences here recorded in the lower part of the Moosebar formation and central part of the Clearwater in type section, this form is present in the upper part of the Wilrich member of the Spirit River formation, exposed along the lower Peace river (Wickenden, pers. comm.). Mellon and Wall (1956) erected the species on specimens recovered from the basal shales of the Clearwater formation in the McMurray area.

Remarks: As in the original material from the McMurray area, dimorphism would appear to be demonstrated by the specimens figured in this report. One form exemplified by the specimens (Plate 1, fig. 10 and Plate 3, figs. 5, 6) tapers only slightly and its chambers embrace gradually. This first form corresponds to the species holotype and paratype (Mellon and Wall, 1956, pl. 2, figs. 17 and 16 respectively). The other form exemplified by the specimens (Plate 1, fig. 9 and Plate 3, figs. 1, 2) tapers considerably backwards and its later chambers are more embracing. This latter form is illustrated in the original reference by the paratype (Mellon and Wall, 1956, pl. 2, fig. 15). It is of interest to note that this dimorphism occurs in the Clearwater formation at McMurray and in the type area, as well as in the Moosebar formation of northeastern British Columbia.

Genus QUADRIMORPHINA Finlay, 1939

QUADRIMORPHINA ALBERTENSIS Mellon and Wall

Plate 1, figures 6, 7, 8; Plate 3, figures 10, 11, 12

Quadrimorphina sp. Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 42, pl. IA, figs. 36 a-c.

Quadrimorphina albertensis Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 24, pl. 2, figs. 12, 13, 14.

Maximum diameter of specimen (Plate 1, figs. 6, 7, 8): 0.27 mm.; thickness 0.19 mm.

Maximum diameter of specimen (Plate 3, figs. 10, 11, 12): 0.21 mm.; thickness 0.12 mm.

Locality of specimen (Plate 1, figs. 6, 7, 8): S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Locality of specimen (Plate 3, figs. 10, 11, 12): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Specimen (Plate 1, figs. 6, 7, 8): Stanford Univ. Pal. Type Coll.

Specimen (Plate 3, figs. 10, 11, 12): Univ. of Alta. Pal. Type Coll.

Horizon: In addition to the occurrences here recorded in the lower part of the Moosebar formation and in the central part of the

Clearwater formation in type section, Wickenden (1951) has reported the form in the lower Falher member of the Spirit River formation. The type locality of the species is in the vicinity of McMurray, Alberta, where Mellon and Wall (1956) named it from the basal shales of the Clearwater formation.

Remarks: The specimen shown here from the type section Clearwater is apparently a juvenile form and probably aberrant, as it has closer to three rather than the usual four chambers to the whorl. The characters of the Moosebar specimen, however, correspond very well with those of the species holotype.

QUADRIMORPHINA sp.

Plate 1, figures 16, 17; Plate 2, figures 10, 11, 12

Test small, unequally biconvex, dorsal surface flat to slightly convex, ventral side moderately convex, periphery rounded; test with a low depressed spire consisting of a spherical proloculus and about two and one-half whorls with four chambers per whorl; chambers tiny in early whorls, much enlarged in final whorl, where they are considerably inflated, more so ventrally; chambers, only last whorl visible on ventral side, all usually visible dorsally but earlier ones may be occasionally embraced in part on this side as well; sutures fairly distinct, curved and flush in early whorls, nearly straight and depressed in last whorl; wall calcareous, hyaline, medium perforate; aperture a low slit between the umbilicus and periphery, with a slight lip; color yellow.

Maximum diameter of specimen (Plate 1, figs. 16, 17): 0.27 mm.; thickness 0.1 mm.

Maximum diameter of specimen (Plate 2, figs. 10, 11, 12): 0.2 mm.; thickness 0.08 mm.

Locality of specimen (Plate 1, figs. 16, 17): S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Locality of specimen (Plate 2, figs. 10, 11, 12): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Specimen (Plate 1, figs. 16, 17): Stanford Univ. Pal. Type Coll.

Specimen (Plate 2, figs. 10, 11, 12): Univ. of Alta. Pal. Type Coll.

Remarks: The description of this form is based on the figured specimen from the Clearwater formation. The Moosebar specimen is reddish-brown in color, and poorly preserved with the chamber pattern obscured.

This form may be referable to *Q. albertensis* but has its spire depressed well below the level of the chambers in the ultimate whorl. We have included the form because of its occurrence in

stratigraphically equivalent Middle Albian beds in the Athabasca and Pine River drainage areas.

Genus SARACENARIA Defrance, 1824

SARACENARIA PROJECTURA Stelck and Wall, n. sp.

Plate 3, figures 22, 23, 24, 25

Saracenaria sp. Mellon and Wall, (*pars*), 1956, Research Council of Alberta Report No. 72, p. 26, pl. 2, figs. 18, 19 (*non* 20 to 25).

Test of medium size, close-coiled, involute, later portion becoming somewhat inflated and triangular in cross-section; apertural face elongate and rather narrow; periphery sharply rounded, without a keel; chambers wedge-shaped, gradually increasing in length and breadth as added, six to seven and one-half visible; sutures distinct, arcuate, flush except for final two which are depressed; wall calcareous, hyaline, very finely perforate; aperture a terminal circular opening rimmed by sixteen radii of equal length situated on a small projecting cone at the peripheral angle.

Holotype: Here designated as Mellon and Wall's specimen, pl. 2, figs. 18, 19 (*op. cit.*).

Length of holotype: 0.47 mm.; width of apertural face 0.2 mm.

Length of paratype (Plate 3, figs. 22, 23): 0.45 mm.; width of apertural face 0.18 mm.

Length of immature form (Plate 3, figs. 24, 25): 0.31 mm.; width of apertural face 0.13 mm.

Holotype locality: Socony-Vacuum Oil Sands Well No. 27, in Sec. 27, Tp. 91, Rge. 10, W. 4th Meridian, Alberta, Canada, between depths of 73 and 92 feet, 9 to 28 feet above the base of the Clearwater formation.

Locality of paratype and immature form: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Holotype, paratype and immature form: Univ. of Alberta Pal. Type Coll.

Comparison: This species bears some similarity to *Lenticulina navicula* (d'Orbigny) Cushman and Jarvis from the Cretaceous of Trinidad but lacks the sharp keel of the latter.

The name refers to the little conical projection in which the aperture is located.

SARACENARIA TROLLOPEI Mellon and Wall

Plate 1, figures 4, 5; Plate 3, figure 21

Saracenaria trollopei Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 25, pl. 2, figs. 26, 27.

Length of specimen (Plate 1, figs. 4, 5): 0.5 mm.; diameter of coiled portion 0.22 mm.

Estimated length of specimen with ultimate chamber broken off (Plate 3, fig. 21): 0.75 mm.; diameter of coiled portion 0.35 mm.

Locality of specimen (Plate 1, figs. 4, 5): S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Locality of specimen (Plate 3, fig. 21): Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Specimen (Plate 1, figs. 4, 5): Stanford Univ. Pal. Type Coll.

Specimen (Plate 3, fig. 21): Univ. of Alberta Pal. Type Coll.

Horizon: Besides its occurrences here reported from the lower part of the Moosebar and central part of the Clearwater formations, this species was named and described by Mellon and Wall (1956) from the basal Clearwater shales in the McMurray area.

Remarks: The Moosebar specimen is very poorly preserved and has a deformed ultimate chamber. Due to recrystallization of the wall, it is most difficult to follow the suture pattern on this specimen, and it is possible that its sutures are not as arcuate as in the species holotype. The dorsal margin of this specimen seems less strongly curved than in the holotype.

The yellow-colored Clearwater specimen has a more robust penultimate chamber than the holotype, but otherwise it seems to exhibit no aberrant characters.

SARACENARIA sp. A

Plate 3, figures 26, 27

Saracenaria sp. Mellon and Wall, (*pars*), 1956, Research Council of Alberta Report No. 72, p. 26, pl. 2, figs. 20, 21, possibly 24, 25 (*non* 18, 19, 22, 23).

Test rather small, close-coiled, later portion becoming inflated and triangular in cross-section; apertural face rather wide, spade-shaped; periphery broadly rounded, not keeled; chambers wedge-shaped, expanding rapidly in size as added, four visible; sutures distinct, arcuate, flush, except ultimate one which is depressed; wall calcareous, hyaline, finely perforate; aperture at the peripheral angle, finely radiate with multiple slits.

Length of figured specimen: 0.29 mm.; width of apertural face 0.21 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Remarks: The specimen shown as figures 24 and 25 on Plate 2 of Mellon and Wall (1956) probably belongs with this group. It is

larger and has two additional chambers, but seems closely related as it has the some broad apertural face and arcuate sutures. It would appear that this form may well represent the mature development stage of *Saracenaria* sp. A.

SARACENARIA sp. B

Plate 3, figures 28, 29

Saracenaria sp. Mellon and Wall, (*pars*), 1956, Research Council of Alberta Report No. 72, p. 26, pl. 2, figs. 22, 23 (*non* 18 - 21, 24, 25).

Test small to medium sized, close-coiled, involute, later portion becoming somewhat inflated and triangular in cross-section, apertural face rather elongate and not particularly wide, resembling an attenuated spade in outline; periphery rather narrowly rounded, not keeled; chambers expanding fairly rapidly in size as added, five to five and one-half visible; sutures distinct, arcuate, flush except ultimate one which is depressed; wall calcareous, hyaline, finely perforate; aperture at the peripheral angle, radiate with six slits.

Length of figured specimen: 0.28 mm.; width of apertural face 0.14 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Comparison: This form differs from *Saracenaria* sp. A in being less inflated, and consequently shows a more elongate apertural face. *Saracenaria* sp. B has an additional one to two chambers visible and has far fewer slits in its aperture, as opposed to the numerous fine radii in the aperture of *Saracenaria* sp. A.

Saracenaria sp. B is closely related to *Saracenaria projectura* Stelck and Wall, n. sp., both forms being inflated to about the same degree with similarly-shaped apertural faces. *Saracenaria* sp. B differs, however, in having about two less chambers than *S. projectura* and lacks the apertural conical projection of the latter species.

SARACENARIA sp. C

Plate 3, figures 30, 31

Test uncoiling, later portion becoming somewhat inflated and triangular in cross-section; apertural face elongate and narrow; periphery rather acute; six chambers visible, first three wedge-shaped, small, gradually increasing in size, last three trapezoidal-shaped, expanding much more rapidly; sutures distinct, oblique becoming slightly arcuate near the outer peripheral margin, flush except ultimate one which is depressed; wall calcareous, hyaline, finely perforate; aperture finely radiate on a small projecting cone at the peripheral angle.

Length of figured specimen: 0.32 mm.; width of apertural face 0.15 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 189 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Remarks: The specimen figured here is probably a juvenile, as other specimens from the same locality attain lengths of between 0.5 and 0.6 mm. Due to the poorer preservation of these larger specimens, a young individual was selected for illustration.

With its slender apertural face and produced, finely radiate aperture, *Saracenaria* sp. C shows some relationship to *Saracenaria projectura* Stelck and Wall, n. sp. and may represent an uncoiled variant form of the latter species.

Genus TRITAXIA Reuss, 1860

TRITAXIA ATHABASCENSIS Mellon and Wall

Plate 2, figures 15, 16

Tritaxia athabascensis Mellon and Wall, 1956, Research Council of Alberta Report No. 72, p. 27, pl. 1, figs. 16, 17.

Length of figured specimen: 0.61 mm.; maximum width 0.3 mm.

Locality of figured specimen: Sec. 12, Tp. 87, Rge. 16, W. 4th Meridian, on the Athabasca river, about two miles downstream from Brulé Rapids, Alberta, Canada, from shales of the type section of the Clearwater formation, 95 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Horizon: The species seems to range through most of the Clearwater formation, having been described originally from the basal Clearwater shales in the McMurray area.

Remarks: The specimens from the type section Clearwater exhibit the same flattened character of the original material from the McMurray area, both suites having a similar biserial appearance.

Genus TROCHAMMINA Parker and Jones, 1859

TROCHAMMINA GATESENSIS Stelck and Wall, n. sp.

Plate 4, figures 9, 10, 11

Test small, periphery rounded; test trochoid, with a low spire, of three whorls with six chambers in ultimate whorl, seven chambers in penultimate whorl, and six or seven chambers in primary whorl; chambers distinct, increasing regularly in size as added, those in the final whorl somewhat inflated with the ultimate chamber expanding slightly into the umbilical area; all chambers visible from dorsal side, only those of last whorl visible ventrally; sutures dis-

tinct, slightly depressed, slightly curved on dorsal side, radial on ventral side; wall finely arenaceous of uniform grain size to 0.01 mm., with much cement forming smooth finish on exterior; aperture a small notch on the ventral side at the base of the terminal chamber.

Maximum diameter of holotype: 0.2 mm.; minimum diameter 0.15 mm.; thickness (estimated) 0.08 mm.

Holotype locality: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian, on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada, from St. John shales, 355 feet above the Gates sandstone.

Holotype: Stanford Univ. Pal. Type Coll.

Comparison: This new species is similar in several respects to *Trochammina rutherfordi* Stelck and Wall from the late Cenomanian portion of the Kaskapau formation. *T. gatesensis* differs from *T. rutherfordi* s.s. in being smaller, having a more finely arenaceous wall of uniform grain size, and in lacking the somewhat thickened sutures of *T. rutherfordi.*

Again, *T. gatesensis* may be confused with *T. rutherfordi* variety 1, but the new species has fewer chambers in its ultimate whorl and thin, as opposed to the thickened sutures of the latter form.

Name: After the "Gates" of the Peace river, British Columbia, Canada.

TROCHAMMINA sp.

Plate 1, figures 27, 28

Test of medium size, compressed, periphery broadly rounded, somewhat lobulate; test trochoid with five inflated chambers in ultimate whorl; six or seven chambers make up the spire in two earlier indistinct whorls, visible on dorsal side only; chambers in final whorl much larger than those in earlier whorls; sutures indistinct in earlier whorls, distinct and depressed in later whorls, slightly curved on dorsal side, radial on ventral side; umbilicus rather wide and shallow; wall arenaceous of uniform grain size to 0.02 mm. with cement forming smooth dull surface and obscuring earlier chambers and sutures and apparently infilling the umbilicus; aperture ventral, a low opening at the base of the ultimate chamber between the periphery and umbilical area.

Maximum diameter of figured specimen: 0.46 mm.; minimum diameter 0.34 mm.; thickness (estimated) 0.15 mm.

Locality of figured specimen: S47-20 on Crassier creek, one mile upstream from its junction with the Pine river, British Columbia, Canada, from shales in the lower part of the Moosebar formation.

Figured specimen: Stanford Univ. Pal. Type Coll.

Remarks: The figured specimen is crushed and probably more globigerinoid than indicated by the drawing.

This species bears a general resemblance to *Trochammina lattai* Loeblich and Tappan from the Lower Cretaceous Kiowa shale of

Kansas, but has more rapidly expanding chambers in the ultimate whorl and lacks the distinct umbilicus of the Kansas species.

Genus VAGINULINA d'Orbigny, 1826

VAGINULINA sp.

Plate 3, figures 15, 16

Test compressed, elongate, early portion coiled, small, later portion uncoiled with parallel sides; dorsal margin straight, extended distally as a prominent beak-like projection, ventral margin slightly indented by sutures; chambers low, increasing gradually in width in early portion, of nearly the same width in later portion; sutures distinct, flush, first two arcuate, later ones oblique, not bent; five costae traverse the last five chambers diagonally, running at an angle of 45 degrees to the sutures; wall calcareous, hyaline, finely perforate; aperture terminal radiate, at the end of the beak-like projection; color yellow.

Length of figured specimen: 0.9 mm.; maximum width 0.17 mm.

Locality of figured specimen: Sec. 19, Tp. 87, Rge. 14, W. 4th Meridian, on the Athabasca river, Alberta, Canada, from shales of the type section of the Clearwater formation, 187 feet below the top of the formation.

Figured specimen: Univ. of Alberta Pal. Type Coll.

Remarks: An examination of the literature has failed to reveal any species bearing much similarity to this Clearwater form, which is rendered distinct by its sharp, terminal projection. Due to the scarcity of material presently available, the authors have decided not to assign a name to this species.

Genus VERNEUILINA d'Orbigny, 1840

VERNEUILINA PORTA Stelck and Wall, n. sp.

Plate 4, figures 3, 4

Verneuilina sp.A Wickenden, 1951, Geol. Surv. Canada Paper 51-16, p. 35, pl. IA, figs. 8 a-b.

Test of medium size, somewhat compressed, triangular in cross-section, sides tapering gradually; test triserial throughout, composed of about seven convolutions of three chambers each, twisting slightly in the upper half of the test, maximum width at ultimate convolution; chambers gradually enlarging; sutures not very distinct, depressed; wall finely arenaceous with grains seldom exceeding 0.02 mm., considerable amount of dark carbonaceous (?) material adhering to surface, siliceous cement covering exterior camouflaging the granular nature of the test; aperture a low arched opening at the base of the ultimate chamber.

Length of holotype: 0.53 mm.; maximum width 0.25 mm.

Holotype locality: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian on the north bank of the Peace river, one half mile east of the "Gates",

British Columbia, Canada, from St. John shales, 181 feet above the Gates sandstone.

Holotype: Stanford Univ. Pal. Type Coll.

Horizon: This species is known to occur commonly in the Falher member of the Spirit River formation exposed along the lower Peace river (Wickenden, 1951). It has also been recorded by Trollope (1951) from the upper part of the Loon River formation, downstream from Wickenden's locality.

Comparison: This species shows some similarity to *Verneuilina chapmani* ten Dam from the Middle Neocomian of the Netherlands. *V. porta*, however, seems stubbier, has less distinct sutures, and its wall is covered with siliceous cement.

Name: After the Latin *porta* meaning gate.

Genus VERNEUILINOIDES Loeblich and Tappan, 1949

VERNEUILINOIDES sp.

Plate 4, figures 5, 6

Test small, tapering, rounded lobate in cross-section; test composed of five convolutions of three chambers each, arranged in a *Buliminella*-like pattern; maximum width near apertural end of test; chambers increasing regularly in size throughout, roughly equidimensional, slightly inflated; sutures distinct, depressed; wall finely arenaceous, grain size to 0.01 mm., with considerable cement giving a smooth finish to exterior; aperture a notched opening at the base of the last-formed chamber.

Length of figured specimen: 0.29 mm.; maximum width 0.17 mm.

Locality of figured specimen: S47-17 in Tp. 82, Rge. 25, W. 6th Meridian on the north bank of the Peace river, one-half mile east of the "Gates", British Columbia, Canada from St. John shale, 355 feet above the Gates sandstone.

Figured specimen: Stanford Univ. Pal. Type Coll.

Comparison: This form seems rather closely related to *Verneuilinoides cummingensis* (Nauss) from the Cummings member of the Mannville formation of east-central Alberta, but is not as elongate as the latter species, to which however it might bear varietal relationship.

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