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CRETACEOUS FORAMINIFERA OF THE ROCKY MOUNTAIN FOOTHILLS, ALBERTA

by

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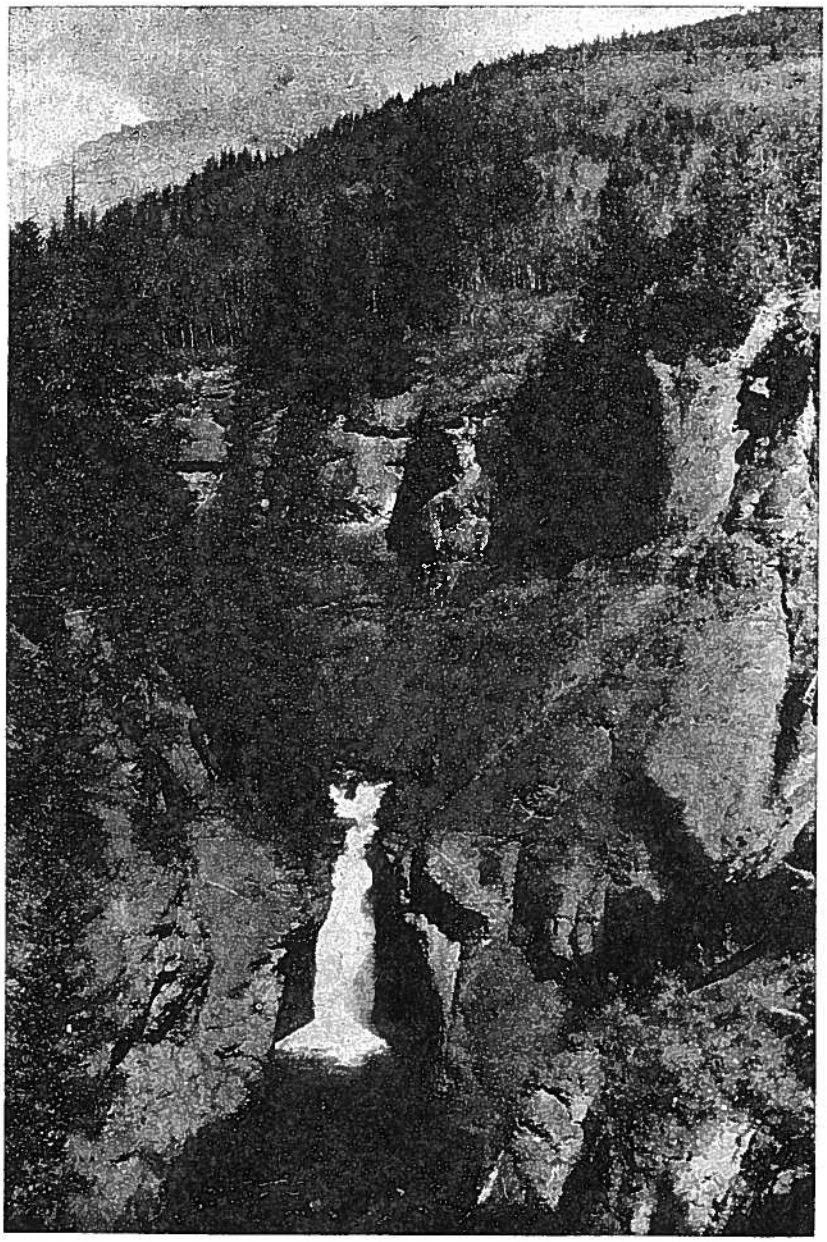

Oldfort Creek. The waterfall is formed by massive, silty, concretionary shale of the Hanson Member of the Wapiabi Formation. Sandstone ribs of the Belly River Formation are visible high on the slope above the gorge. Paleozoic rocks of the Front Range in background.

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Cretaceous Foraminifera of the Rocky Mountain Foothills, Alberta

ABSTRACT

A succession of ten microfaunas is recognized in the Alberta Group (Cretaceous) and equivalent strata in the Rocky Mountain Foothills. In ascending stratigraphic order these are: (1) *Miliammina manitobensis*, (2) *Verneuilinoides kansasensis*, (3) lower pelagic and (4) *Pseudoclavulina* sp. from the Blackstone Formation; (5) *Trochammina* sp. 1, (6) *Brachycythere-Bullopora*, (7) *Anomalinoides henbesti*, (8) upper pelagic, (9) *Trochammina ribstonensis* and (10) *Lenticulina* from the Wapiabi Formation. An unnamed sparse microfauna is present in the Cardium Formation between the Blackstone and Wapiabi Formations.

A knowledge of these assemblages may be applied toward the identification of strata in the Foothills; viz. microfaunas (4) and (5) indicate stratigraphic positions below and above the Cardium Formation, respectively. Most of the microfaunas have a distribution extending well beyond the Foothills and are of value in Foothills-Plains correlation studies, viz. microfauna (1) between the "fish-scale sand" and the Viking Formation in the Colorado Group, and microfauna (9) in the basal beds of the Montana Group of the Plains.

Correlations based on microfaunas and megafaunas are in general accord within the Blackstone Formation and basal portion of the Wapiabi Formation but differ in other parts of the latter. The Thistle Member seems to be essentially isochronous with respect to its position in the megafaunal zonation but is shown to be markedly diachronous, becoming younger from south to north, when the upper pelagic microfauna (8) associated with the first white-speckled shale "zone" is used as a datum plane. Based on their relationships with the zonal ammonites, the *Brachycythere-Bullopora* (6) and upper pelagic (8) microfaunas apparently become younger from north to south.

Two complete cycles and one partial cycle of transgression, widespread flooding and regression are revealed by the succession of microfaunas in the Alberta Group. In the first cycle, within the Blackstone Formation, the transgressive phase is indicated by microfaunas (1) and (2), the widespread flooding by microfauna (3) and the regressive phase by microfauna (4). This regressive phase is continued through the Cardium Formation, as shown by its sparse agglutinated microfauna. In the second cycle, within the Wapiabi Formation, the early and advanced stages of the transgression are indicated by microfaunas (5) and (6), the widespread flooding by microfaunas (7) and (8) and the regression by microfauna (9). A condensed third cycle is represented in the Nomad Member of the Wapiabi Formation by microfauna (10). The advancing Blackstone sea reached the southern Foothills at progressively later stages, as shown by the successive southward disappearance of microfaunas (1) and (2). The Late Cretaceous sea persisted longer in the central and northern Foothills than in the southern Foothills, as shown by the presence of microfauna (10) in the former sectors and its absence in the latter.

A total of 84 species of foraminifera are described, comprising 49 agglutinated and 35 calcareous forms. All species are either referred to previously published taxa or treated as *nomina aperta*. The agglutinated species belong to 20 genera included in 9 families; the calcareous species belong to 21 genera included in 12 families. With some exceptions among the pelagic forms and *Anomalinoides*, numbers of individuals are considerably greater in the agglutinated species.

INTRODUCTION

Area of Study

The Cretaceous strata on which this study is based outcrop in the Foothills belt of Alberta. The Foothills form a structural and topographic province, varying in width from about 10 to 30 miles, that extends in a northwesterly direction from the International Boundary in southwestern Alberta into northeastern British Columbia between latitudes 54° and 55°. The western boundary of the Foothills is drawn at the eastern margin of the Front Ranges of the Rocky Mountains, where the cliff-forming Paleozoic rocks are thrust over Mesozoic strata. The eastern edge of the Foothills is somewhat gradational with the western boundary of the Plains but is usually drawn where the surface exposures do not appear to have been involved in faulting. The approximate position of the eastern edge is shown by the dotted line on the index map (Fig. 1). Within the Foothills belt, folds and faults are common with the deformation increasing from east to west.

For purposes of discussion throughout the text, it has been found convenient to follow Stott's (1963, p. 12) general geographic division of the Foothills into three parts: the southern sector from the International Boundary to the Bow River; the central sector from the Bow River to the Athabasca River or between the Calgary-Banff (Trans-Canada) and the Edmonton-Jasper Highways; the northern sector extending north from the Athabasca River. These sectors have been further divided into areas for more specific reference. The approximate locations of all areas and localities cited herein are shown on the index map (Fig. 1), with detailed information being given in the Appendix.

Objective and Scope of Project

Studies carried out by various workers through the past two decades on the Cretaceous microfaunas of the Plains region have demonstrated their value in stratigraphic correlation. The presence of excellent exposures of the Alberta and Smoky Groups of mainly Late Cretaceous age in the Foothills belt of Alberta, with the attendant lack of published microfaunal information therefrom, prompted the author to undertake a comprehensive examination of these beds for microfossils. It was thought that if there were sufficient changes in the microfaunal succession, a basis

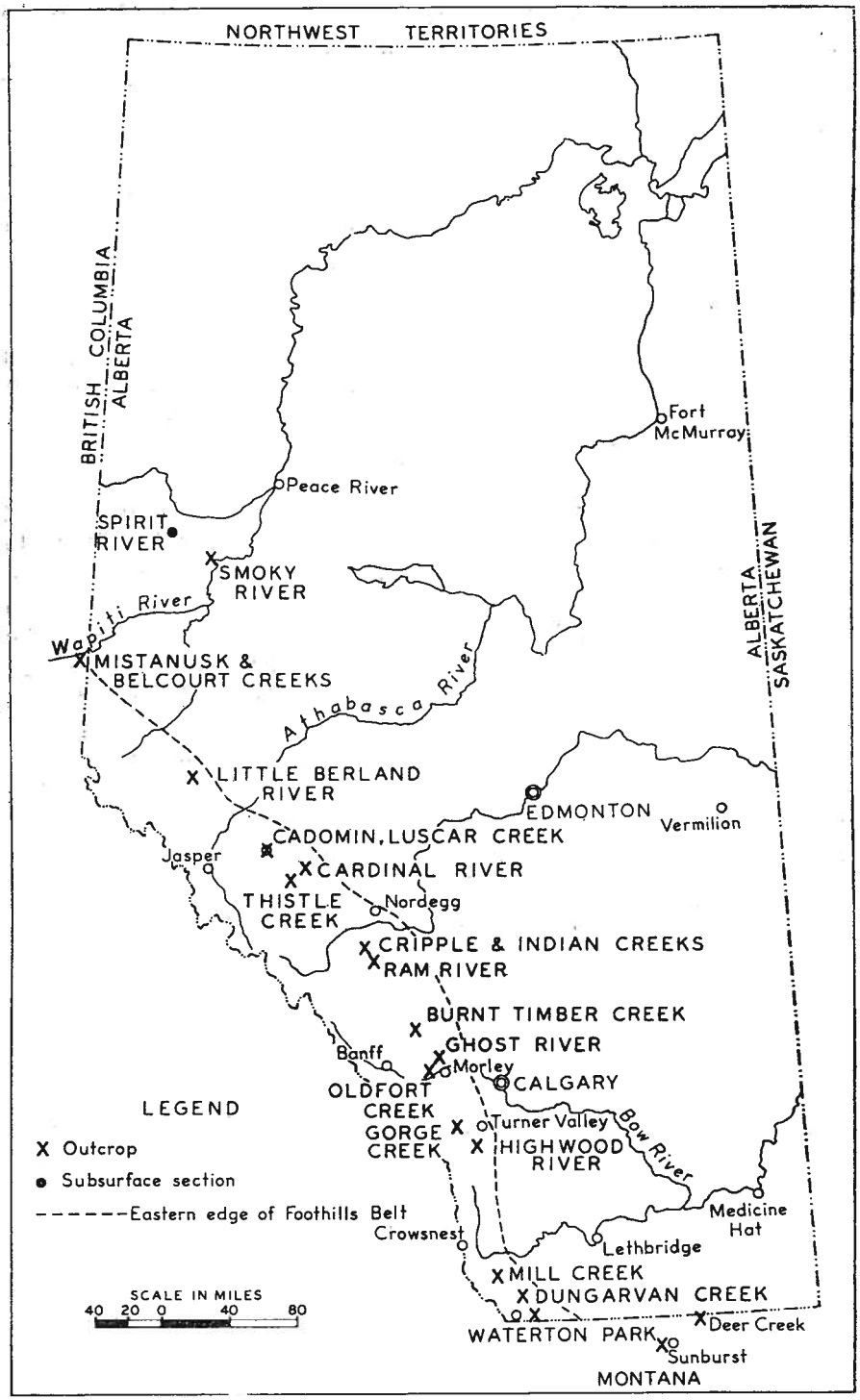


FIGURE 1. Index map of Alberta showing major collecting localities.

could be provided for exploration geologists and others to identify the stratigraphic level of well-core and outcrop samples, particularly in the absence of other criteria. The knowledge acquired also would serve to complement correlation studies between Foothills and Plains based on lithology and megafauna.

The author has compiled this publication primarily with the interest of the stratigraphic micropaleontologist in mind, and the illustrations of the microfossils are arranged on a stratigraphic rather than a taxonomic basis. All foraminifera described herein are either referred to previously published species or are left as *nomina aperta,* with no new names being introduced. This bulletin is published as the micropaleontological sequel to an earlier stratigraphic contribution by Wall and Germundson (1963) on the interrelationships of the microfaunaus, megafaunas and rock-stratigraphic units of the Alberta Group.

The project was started in 1959 with the initial objective of studying the microfaunas of the Wapiabi Formation, but this was broadened to include those of the underlying Cardium and Blackstone Formations so that a complete microfaunal analysis of the entire marine succession in the Foothills between the Blairmore and Belly River Formations could be obtained. The field seasons of 1959, 1960 and 1961 were devoted to the measurement and sampling of major outcrop sections within the Alberta and Smoky Groups. Subsequent field work in the summers of 1962 and 1963 consisted of filling in minor gaps in geographic and stratigraphic coverage with the result that a fairly complete profile could be constructed for an approximately 500-mile sector of the Foothills between Waterton Park in extreme southwestern Alberta and the upper Wapiti River area of northeastern British Columbia. During the course of this study, a total of 1,400 samples was collected and processed for microfauna from 18,000 feet of strata at 20 localities.

Acknowledgments

The author wishes to acknowledge the capable assistance and companionship of Dr. R. K. Germundson in the field. Germundson (1960) also carried out an independent study of the megafaunas from part of the section involved and provided the author with some important stratigraphic data. Mrs. Nancy Weiner ably assisted in detailed examination of some of the microfaunal residues, in photographic work and in the processing of the manuscript. K. U. Kirmani and R. Feser provided efficient assistance in the laboratory and field at various times. Dr. G. B. Mellon accompanied the author to the upper Wapiti River area of northeastern British Columbia and contributed some pertinent stratigraphic information therefrom.

B. Gallant, J. E. Labrecque and G. W. Peterson of Imperial Oil Limited provided information pertaining to the accessibility and quality of some sections in the central and northern Foothills. Outfitters J. Babala of Cadomin, Alberta, and H. A. Dalgleish of Hazelmere, Alberta, supplied guides and pack-horses to reach sections inaccessible by vehicle in the central and northern Foothills, respectively. The Director of National Parks granted permission to collect samples in Waterton National Park, and the Chief and Councillors of the Stony Bands at Morley allowed entry to the Stony Indian Reserve. T. P. Chamney of the Geological Survey of Canada, Calgary, facilitated the examination of some foraminiferal types on loan from the National Museum of Canada. The author acknowledges the kindness and cooperation of these people and the organizations they represent in contributing to the success of this project.

STRATIGRAPHY

Summary of Previous Work

The stratigraphy of the rocks now included in the Alberta and Smoky Groups has been studied by many workers, beginning with Malloch's (1911) pioneer work in which the present formational names Blackstone and Wapiabi were proposed, and culminating in a series of modern detailed studies by Stott (1956, 1961, 1962 and 1963) in which a total of seventeen individual members are recognized. In the interim the most significant contribution was that of Webb and Hertlein (1934), who recognized most of the principal lithologic units and some of the megafaunal zones in present usage. Other important work includes that of Hume (1930), who introduced the term Alberta shale for this sequence of rocks, thereby discarding the old name Benton which had been improperly applied. Wall and Germundson (1963) summarized the stratigraphy of these rocks in tabular and graphic form, generally following Stott's system of nomenclature.

Table 1. Alberta Group Nomenclature, Central and Southern Foothills

Formation	Member (Stott, 1961)	Former Name Webb & Hertlein (1934) Stott (1956)		Thickness (Stott, 1961)	Description
WAPIABI	NOMAD	Transition Zone		90–130	Shale; sandstone
	CHUNGO	U. Concretionary Shale Zone	Upper Concretionary Siltstone Zone or Solomon, Highwood Ss.	135–416	Sandstone, fine grained, buff weathering; siltstone with ferruginous concretions
	HANSON	U. Concretionary Shale Zone	Upper Concretionary Shale Zone	0–232	Shale with ferruginous concretions
	THISTLE	Platy Shale Zone		384–778	Shale with interbedded siltstone; dolomite or limestone beds
	DOWLING	L. Concretionary Shale Zone	Lower Concretionary Shale Zone	101–351	Shale with ferruginous concretions
	MARSHYBANK	L. Concretionary Shale Zone	Lower Concretionary Siltstone Zone	41–104	Argillaceous siltstone grading to sandstone; ferruginous concretions
	MUSKIKI	L. Concretionary Shale Zone	Striped Zone	144–325	Shale with siltstone bands; ferruginous concretions; pebbles at base
CARDIUM	STURROCK	Upper member		15–166	Sandstone, fine grained, buff weathering
	LEYLAND	Middle member		30–175	Shale with ferruginous concretions
	CARDINAL	Middle member		0–35	Argillaceous siltstone with ferruginous concretions
	KISKA	Middle member		0–37	Shale with ferruginous concretions
	MOOSEHOUND	Middle member		0–134	Carbonaceous shale and sandstone; thin coal beds
	RAM	Lower member		24–103	Sandstone, fine grained, buff weathering
BLACKSTONE	OPABIN	Transition Zone		70–213	Shale with ferruginous concretions; siltstone and sandstone
	HAVEN	Rusty Shale Zone		35–319	Shale, rusty weathering; siltstone; limestone or dolomite concretions
	VIMY	*Inoceramus labiatus* Zone		154–605	Shale, calcareous, silver-grey weathering; limestone or dolomite beds; bentonite bed at base
	SUNKAY	Barren Zone		15–631	Shale with siltstone, sandstone and ferruginous concretions

The terms Alberta Group and Smoky Group are applied to essentially the same succession of strata in the southern and central Foothills and in the northern Foothills, respectively. Stott (1963, p. 137) has commented on the general thickening of these beds towards the west and the increase in sand content in that direction, which features indicate a western source for the sediments. In the following sections, only an outline of the stratigraphy is given, as reference may be made to Stott's (1963) comprehensive memoir for detail, but some pertinent comments on the nomenclature employed by the author in this publication are included.

Alberta Group

The term Alberta Group is applied to the predominantly shale succession in the southern and central Foothills consisting of the Blackstone and Wapiabi Formations separated near the middle by a predominantly sand unit, the Cardium Formation. The Alberta Group comprises a maximum of about 4,000 feet of strata along the western or inner edge of the central Foothills, the thickness decreasing to about 2,000 feet in the southern Foothills. In the central and southern Foothills, the Alberta Group is disconformably underlain by the nonmarine Blairmore Group, and is conformably overlain by the Belly River Formation in the southern sector and by the Brazeau Formation in the central sector.

The complete system of nomenclature for the Alberta Group proposed by Stott (1961) is presented in table 1 together with the former "zone" names, dominant lithologies and thicknesses of the units. The author has endeavored to follow these member divisions for the Blackstone and Wapiabi Formations in this publication, but because of the gradational nature of the boundaries between some of them, particularly in the Wapiabi Formation, may have assigned them thicknesses at some localities different from Stott's values.

The author has applied the name Hanson in the Crowsnest Pass and Waterton areas of the far southern Foothills to the strata above the Thistle Member and below the transition beds of the Wapiabi Formation, although with the realization that Stott did not intend the name to be used any farther south than the Turner Valley area of the southern Foothills. These beds in the far southern Foothills consist of partly calcareous shale without the ferruginous concretions and high silt-sand content, characteristic of the Hanson Member in its typical development. In Stott's view, the Hanson Member undergoes a facies change from shale to sandstone south of the Highwood River, with the equivalent strata being incorporated in the Belly River Formation at Oldman River, north of the Crowsnest Pass.

The author has used the term "transition beds" in the far southern Foothills to designate the strata in the uppermost part of the Wapiabi Formation. Although these beds occupy a stratigraphic position analogous to that of the Nomad Member farther north, they do not appear correlative with the latter, the time equivalent of which is in the Belly River Formation south of the Turner Valley area, according to Stott (1963,

p. 116 and Fig. 10). The dissimilarity of the microfaunas from the transition beds and the Nomad Member lends support to this interpretation.

Smoky Group

The term Smoky Group is used in the northern Foothills to designate essentially the same strata included in the Alberta Group of the southern and central Foothills, with the formational name Kaskapau being substituted for Blackstone. It should be mentioned, however, that the lower parts of the Kaskapau and Blackstone are only partly correlative, as the latter includes strata that are the time equivalents of the Dunvegan Formation and the upper part of the Fort St. John Group (Shaftesbury Formation). The Smoky Group comprises a maximum of about 3,000 feet of strata. It is conformably underlain by the Dunvegan Formation, and is conformably overlain by the Brazeau Formation south of the Smoky River and by the Wapiti Formation north of the Smoky.

A somewhat modified terminology is applied to strata which are the equivalent of the Wapiabi Formation in northwestern Alberta and northeastern British Columbia. There, Stott (1961, 1963) has used the formational name Puskwaskau in lieu of Wapiabi to embrace the Dowling Thistle, Hanson, Chungo and Nomad Members. The underlying Bad Heart Sandstone, which appears to be the northern equivalent of the Marshybank Member as indicated by Stott (1961), is regarded by him as having formational status in this area. The Muskiki Member underlying the Bad Heart and overlying the Cardium Formation is raised from member to formational status by Stott.

Although these assignments appear quite satisfactory, the author has applied the formational name Wapiabi throughout the northern Foothills and considers the Bad Heart and Muskiki as members within the Wapiabi for the sake of uniformity in the discussion and presentation of microfaunal data. The terms "lower Chinook sandstone" and "Nomad equivalent" are used by the author in place of the Chungo and Nomad Members, respectively. The author's system of nomenclature for the Wapiabi Formation in the upper Wapiti River area of the northern Foothills is outlined in table 2.

Table 2. Wapiabi Formation Nomenclature in Upper Wapiti River Area

Rock Unit	Thickness (feet)
Chinook Sandstone	105
Nomad equivalent	85
Lower Chinook sandstone	30
Hanson Member	95
Thistle Member	330
(gradational contact)	
Dowling Member	320
Bad Heart Sandstone	85
Muskiki Member	200
Total Thickness Wapiabi	1250

A discussion of the Chinook Sandstone complex of the upper Wapiti River area is required to clarify the relationships of the rock units in the upper part of the Wapiabi Formation. On Mistanusk Creek two sands are involved: an upper sand, about 100 feet thick, separated by 85 feet of shale from a lower sand, about 30 feet thick. The upper sand underlying the Wapiti Formation is clean, well sorted and slightly glauconitic (Mellon, G. B., pers. comm. *in* Wall and Germundson, 1963, p. 345), and is apparently what stratigraphers have called the Chinook Sandstone (Gleddie, 1949, p. 523; 1954, p. 501). The lower sand is glauconitic and was called "lower Chinook" by Wall and Germundson (*op. cit.*). On nearby Belcourt Creek, a conglomeratic bed found about the same distance below the base of the main Chinook sand unit as this lower sand on Mistanusk Creek is probably equivalent to the lower sand.

The term "Nomad equivalent" is applied to the 85-foot shale interval between the two sand units of the Chinook on Mistanusk Creek and between the main sand unit and the conglomeratic bed on Belcourt Creek. This interval carries a meager microfauna, elements of which are present in the Nomad Member of the central Foothills. The faunal evidence, although not entirely conclusive, indicates that the "Nomad equivalent" is the time equivalent of the Nomad Member of the central Foothills. This further suggests that the underlying "lower Chinook sandstone" occupies the same stratigraphic position as the main sand of the Chungo Member in the central Foothills, also commonly called the "Solomon sandstone".

COLLECTION AND PREPARATION OF SAMPLES

Collecting Localities

The Alberta Group in its entirety is rarely exposed, but nearly complete to complete exposures of formations and members within the group may be conveniently studied at a number of localities, shown on figure 1. A summary discussion on a geographic pattern of the principal sections sampled follows, with details of location, access, stratigraphy, sampling and microfaunal recovery being given in the Appendix.

In the southern Foothills, Mill Creek in the Crowsnest Pass area provides easy access to a fairly complete section of the Wapiabi Formation and two exposures of the Blackstone Formation (Pl. 16, Fig. 1), all within the western fault block of a southeast-plunging anticlinal structure in the Beaver Mines map-area (Hage, 1943). The middle portion of the Wapiabi Formation was studied on the north fork of the Belly River in Waterton National Park, and the upper part of the Wapiabi Formation was sampled on Dungarvan Creek (Pl. 18, Fig. 2) between Waterton and Mill Creek. Farther north, in the Turner Valley area, a nearly complete section of the Wapiabi Formation was examined on the Highwood River, and an exposure from the lower part of the formation was sampled on Gorge Creek.

In the central Foothills, the Alberta Group is completely exposed on Burnt Timber Creek, but this section, besides being a considerable distance from a traversable road, yielded a disappointingly low number of microfossils. The Alberta Group is fairly well exposed along Cripple Creek in the Nordegg area adjacent to the Forestry Trunk Road, but there are some gaps in the Blackstone and Wapiabi Formations. The missing interval in the upper part of the Blackstone Formation there in part can be filled by the exposure on Indian Creek in the same area. Most of the Alberta Group also outcrops at or near Cadomin (Pl. 16, Fig. 2), but the Blackstone Formation there has been subjected to considerable faulting.

Some remarks concerning quality of exposures of the formations and members within the Alberta Group in the central Foothills seem pertinent. An excellent exposure of the Blackstone Formation, the one described by Webb and Hertlein (1934), is easily accessible on Ghost River. The best section of the Wapiabi Formation in the central Foothills studied for this project is in the area southeast of Cadomin, near the headwaters of Thistle Creek (Pl. 19, Fig. 1), upstream from Stott's (1961) redesignated type section of the formation. The author began sampling the former section in the belief that it was the one described by Stott (*op. cit.*), and, although the error was discovered while in the field, the latter section, which is the superior exposure, could not be sampled because of its relative inaccessibility. In the same general area, another nearly complete section of the Wapiabi Formation was sampled on Cardinal River (Pl. 17, Fig. 2). In the southern end of the central sector of the Foothills, a fairly complete

section of the Wapiabi Formation was studied on Oldfort Creek (Frontispiece; Pl. 18, Fig. 1), but difficulties in measurement and in tracing of marker-beds, together with the arenaceous nature of much of this outcrop, are factors which make this section unsatisfactory for accurate microfaunal zonation. Finally, in the central Foothills, there is an excellent exposure of about the lower half of the Wapiabi Formation on Ram River (Pl. 17, Fig. 1) in the Nordegg area, just upstream from the well-known falls adjacent to the Forestry Trunk Road.

In the northern sector of the Foothills, exposures of the Smoky Group are more sparse, less readily accessible and less productive of microfossils than equivalent strata to the south. On Little Berland River, at a considerable distance from a traversable road, the Kaskapau and Cardium Formations are well exposed, but several critical intervals within the Wapiabi Formation are covered. In the upper Wapiti River area of northeastern British Columbia adjoining the interprovincial boundary, two fairly complete sections of the Wapiabi Formation were sampled on Mistanusk (Pl. 19, Fig. 2) and Belcourt Creeks. The Kaskapau Formation in this area is shortened due to faulting and is quite sandy in character. Further, these sections are not accessible by road.

Sampling Procedure

Samples were taken from 5 to 30 feet apart, depending on lithology. If the shale seemed free from a noticeable amount of sand or silt, an attempt was made to obtain a sample at least every 10 feet. In some localities where the exposure is nearly complete and the shale appeared potentially microfossiliferous, the sample interval was reduced to 5 or 6 feet.

Generally, a select or "spot" sampling technique was used in which about a one-foot interval of shale is collected instead of the channel or continuous method in which representative pieces are obtained from the entire section. One disadavantage of "spot" sampling lies in the possibility of the microfossils being missed should they be concentrated in thin bands, which they appear to be in parts of these sections. Because of the considerable increase of time required for channel sampling, it was necessary to employ the "spot" method in which, however, the selected material may have a greater potential yield of microfossils than that obtainable from a channel sample.

In the field, attempts were made to obtain as fresh, unweathered material as possible, but these were hampered by the very hard character of the shale at most localities, which rendered deep digging impractical. The effect of weathering on microfaunal assemblages from the Foothills is difficult to assess but is not believed to be serious, as calcareous foraminifera were obtained from many samples together with the usually pre-

dominant agglutinated foraminifera. The effect of weathering may have been masked to some extent by the treatment used to prepare the samples, outlined in the next section.

Sample Preparation

The considerable induration of the Foothills shales renders normal methods of sample preparation ineffective. The most satisfactory results were obtained through multiple freezing and thawing of the shales. One hundred-gram samples were put in polyethylene beakers, sprinkled with detergent and covered with water. The beakers were placed inside an insulated cabinet filled with large blocks of dry ice, allowed to freeze completely and then were immersed in hot water to thaw rapidly. This procedure was repeated until most of the sample had been reduced to a mud-like mass, after which normal washing techniques could be applied. In a small percentage of samples, the freeze-thaw method had little or no effect, even after about twenty attempts.

Repository of Material

Microfaunal assemblage slides and the unprocessed portions of samples from all rock units at the localities discussed in this publication are filed at the Research Council of Alberta. All figured specimens are deposited in the Research Council of Alberta Mesozoic Foraminifera Type Collection, numbers MF 5042 to 5283.

BIOSTRATIGRAPHIC MICROPALEONTOLOGY

Introduction

Although the microfossils obtained from the Alberta Group in the Foothills are not consistently adequate through the entire section for accurate zonation purposes, a general succession of microfaunas has been established, knowledge of which may be applied to the study of local and regional correlation problems. Wall and Germundson (1963) listed eleven microfaunal assemblages from the Alberta Group without proposing assemblage zone or concurrent-range zone names, as defined by the American Commission on Stratigraphic Nomenclature (1961), even though it was recognized that some of these faunas were sufficiently distinctive to be so formally established. A similar informal terminology has been retained in this publication, as the stratigraphic ranges of some of the microfaunas of the Wapiabi Formation are uncertain.

Ten microfaunal assemblages numbered in ascending stratigraphic order—numbers 1 to 4 from the Blackstone Formation and numbers 6 to 10 from the Wapiabi Formation—are retained in this publication. An eleventh assemblage, the "*Anomalina* microfauna" of Wall and Germundson (1963, p. 339), has been deleted from the present work because of its poorly defined and local character. The microfauna of the Cardium Formation in the Foothills is poorly developed and has not been given a number, but the limited knowledge of it available to the author is presented in its proper order, between discussions of microfaunas (4) and (5). The order of discussion for each microfaunal assemblage follows these factors: vertical and lateral extent in the Foothills, principal component species, regional stratigraphic distribution, age and ecologic implications.

Two correlation charts have been revised from Wall and Germundson (1963) to depict the stratigraphic positions of these assemblages in the Foothills. Figure 2, with the base of the lower or second white-speckled shale "zone" and its associated pelagic microfauna taken as the datum plane, illustrates the ranges and relationships of the four microfaunal assemblages recognized within the Blackstone Formation. Figure 3, with the base of the upper or first white-speckled shale "zone" and its associated pelagic microfauna employed as the datum plane, shows the same type of information for the six assemblages established within the Wapiabi Formation. Although the relationships of the microfaunas to the megafaunal zones and rock-stratigraphic units are generally concordant within the Blackstone Formation (Fig. 2), considerable discrepancy in these relationships may be observed within the Wapiabi Formation (Fig. 3).

To facilitate the discussion of the regional stratigraphic significance of the microfaunal assemblages, the author has compiled a terminology chart (Fig. 4) showing the generally accepted correlations of the rock units involved within and beyond the Foothills, which are based principally on the standard megafaunal zones established by Cobban and

Reeside (1952) and by Jeletzky (*in* Stott, 1961, 1963). The author has superimposed on this chart the positions of the microfaunal assemblages, which, if they should in actuality represent units of time, indicate that some of the rock units are slightly to markedly diachronous.

Some explanation concerning the presentation of microfaunal data and the organization of the plates seems pertinent. In the following section, individual microfossil species are listed as components of the faunal assemblages, some of which, however, may change position with respect

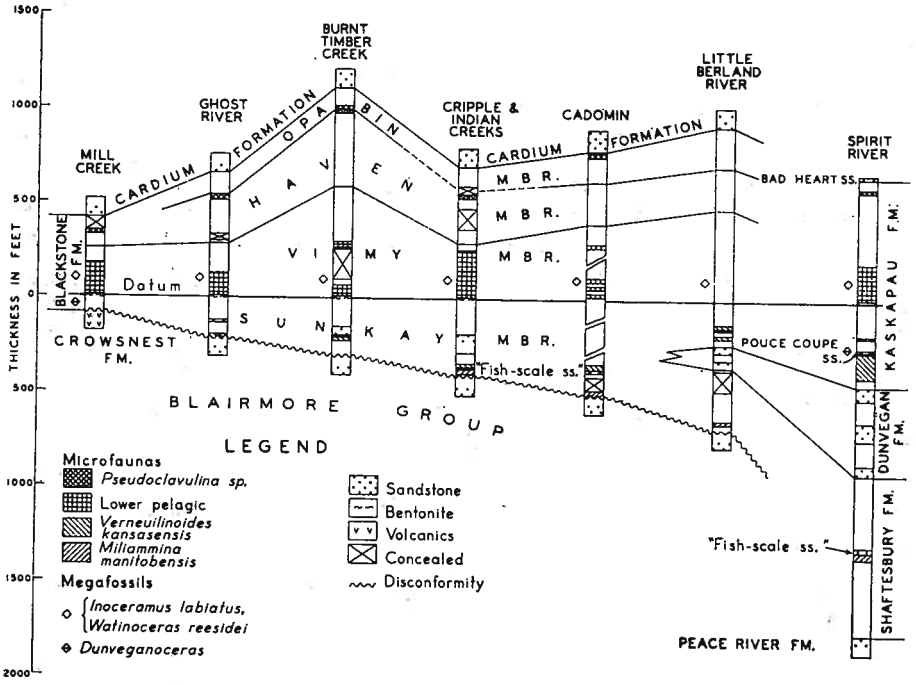


FIGURE 2. Correlation of the Blackstone Formation and equivalents from southern Foothills to northern Plains of Alberta with lower pelagic microfauna as datum plane.

to the boundaries of the rock-stratigraphic units. As it is anticipated that most workers making use of this publication will be doing so in an attempt to relate a sample from a given locality to its approximate stratigraphic position in the area, the plates have been assembled on a stratigraphic basis generally following Stott's member divisions of the Alberta Group. Representative species from the same member or members have thus been grouped for illustration on the same plate or plates, with some species appearing on several plates should they occur characteristically in more than one stratigraphic unit. Although complete faunal lists for the members are not given, this information may be obtained by reference to the range chart (Table 3, in pocket), on which the author has recorded the

presence of all species both by rock unit and locality. Some adjustment may be necessary in using the range chart for this purpose, however, as the author may have differed from others in his interpretation of the gradational boundaries of some of these rock units. The author's stratigraphic data for each locality, along with references to the works of others, may be consulted in the Appendix.

Microfaunal Assemblages

(1) Miliammina manitobensis Microfauna

This microfauna was obtained at Cripple Creek in the Nordegg area, 15 to 40 feet above the base of the Sunkay Member of the Blackstone Formation, with the basal 15 feet of the formation being concealed. The fauna has not been observed in the Foothills south of Cripple Creek, its temporal position having been cut out by the onlap of progressively younger marine beds on the Blairmore Group in a southerly direction. North of Nordegg, the fauna was collected in the railroad cut at Cadomin from the basal 25 feet of the Sunkay Member, separated by a covered interval from an overlying siltstone unit with fish scales, regarded as the equivalent of the "fish-scale sand" marker-bed in the subsurface of the Plains region. Farther north, at Little Berland River, the fauna is weakly developed in the basal 20 feet of the Fort St. John Group. Wall and Germundson had stated previously (1963, p. 335) that the assemblage was not found at this locality, probably because of lack of exposure, but a subsequent re-examination of the available material has resulted in its recognition.

This microfauna, illustrated on plate 1, includes the following species:

Ammodiscus sp. 1
Miliammina manitobensis Wickenden
Haplophragmoides sp. 1
Ammobaculites fragmentarius Cushman
Verneuilina canadensis Cushman
Uvigerinammina sp. cf. *U. athabascensis* (Mellon and Wall)
Gaudryina spiritensis Stelck and Wall.

This microfauna has a widespread distribution in the Plains region of Western Canada, being recorded in the subsurface Colorado Group from above the Viking Formation and below the "fish-scale sand" (Stelck, 1958). It has also been reported from the Peace River Plains, in the lower part of the Shaftesbury Formation, again below the "fish-scale sand" (Nielsen, 1950; Gleddie, 1954). Eicher (1960, 1965) has recorded elements of this fauna in the Shell Creek Shale of Wyoming and in the Graneros Shale of Colorado. In northern Alaska, this fauna does not appear recognizable as a unit, with *M. manitobensis* having an extended range in older strata.

The fauna is dated late Albian because of its position in the megafaunal zonations of Reeside and Cobban (1960) and of Jeletzky (*in* Stott, 1963), between the older *Gastroplites* and the younger *Neogastroplites* Zones. Although the key ammonites have not been reported from the Foothills, the presence of this microfauna directly below the "fish-scale sand" or Mowry equivalent confirms its position as pre-*Neogastroplites*, the latest Albian zone.

This entirely agglutinated fauna is suggestive of a shallow epicontinental seaway with the water somewhat turbid, probably rather cool and perhaps of subnormal salinity. The environment would appear similar to the inner sublittoral type described by Tappan (1962) in her discussion of the biofacies in the Cretaceous of Alaska.

(2) Verneuilinoides kansasensis Microfauna

This microfauna is prominent in the basal five feet of the Sunkay Member of the Blackstone Formation on Ghost River in the Morley area, at the southern end of the central Foothills. It is absent from the southern Foothills because of the onlap of progressively younger marine strata on the Blairmore Group in a southerly direction. North of the Ghost River on Burnt Timber Creek, a few specimens of the key foraminifer were obtained from about 90 feet above the base of the Sunkay Member. The fauna is more strongly developed at Cripple Creek in the Nordegg area, where it was recorded from about 55 feet above the base of the Blackstone Formation and directly above a 12-foot sandy unit, which is probably the equivalent of the "fish-scale sand" of the Plains region. At Cadomin, the fauna is present in the lower part of the Sunkay Member above the siltstone unit with fish scales mentioned in the discussion of the *Miliammina manitobensis* fauna. On Little Berland River in the northern Foothills, the characteristic fossil was collected within the 100-foot shale interval between the prominent 45-foot sandstone unit capped by an oyster coquina and an 8-foot sandy siltstone unit, regarded by Stott (1963, p. 220) as the top of the Dunvegan Formation, and from the overlying basal shales of the Sunkay Member of the Kaskapau Formation. Wall and Germundson (1963, p. 335) and the author herein (Fig. 2) have elected to draw the Dunvegan-Kaskapau contact at the top of the above-mentioned sandstone with the oyster coquina and thus consider the stratigraphic position of this faunal assemblage to be within the Sunkay.

The two principal components of this assemblage, illustrated on plate 2, are:

Trochammina rutherfordi Stelck and Wall

Verneuilinoides kansasensis Loeblich and Tappan.

Other forms present include rare specimens of *Haplophragmoides howardense* Stelck and Wall and a few nondescript representatives of *Haplophragmoides* and *Trochammina*.

This fauna is well developed in the Peace River Plains region, in the lower part of the Kaskapau Formation below the Pouce Coupe Sandstone (Stelck and Wall, 1955). The author, however, has not recognized it as a unit in the subsurface Colorado Group of the Plains region in its anticipated position above the "fish-scale sand". Eicher's (1965) work in Colorado indicates that a similar fauna is present in the upper part of the Mowry Shale and lower part of the Graneros Shale. In northern Alaska, Tappan (1962) recorded *T. rutherfordi* from the Ninuluk Formation and accorded it zonal status, which would suggest that the associated fauna is similar in stratigraphic position to this Foothills assemblage.

This assemblage probably bridges the Cenomanian *Acanthoceras athabascense* and *Dunveganoceras* megafaunal zones of Jeletzky (*op. cit.*), as reported by Wall and Germundson (1963, p. 336). The absence of the microfauna from the Crowsnest Pass area of the southern Foothills, where the *Dunveganoceras* Zone is documented, together with its presence in the Peace River Plains below the Pouce Coupe Sandstone (the type level of *Dunveganoceras*), suggest that the microfauna is pre-*Dunveganoceras* or middle Cenomanian in age.

This microfauna is entirely agglutinated and probably lived under conditions not unlike those postulated for the older *M. manitobensis* fauna.

(3) Lower Pelagic Microfauna

This microfauna is present in the lower half to two thirds of the Vimy Member of the Blackstone Formation in most of the Foothills sections studied. It is quite prominent at Mill Creek, Ghost River and Cripple Creek, and fairly well developed at Cadomin. The distribution of the fauna, however, appears erratic in the thicker sections of the Vimy Member, being weakly developed at Burnt Timber Creek and absent on the Little Berland River.

The microfauna, illustrated on plate 3, includes the following species:

Heterohelix globulosa (Ehrenberg)
H. sp. 1
Hedbergella delrioensis (Carsey)
H. loetterlei (Nauss).

This is the microfauna associated with the lower or second white-speckled shale "zone" in the Colorado Group and Alberta Shale of the Plains region. In this regard, the author did not note any "white specks" in the associated rocks of the Foothills, although the shale is calcareous. However, G. B. Mellon has informed the author that he observed the "white specks" in the Vimy Member on Mill Creek, in the exposure by the bridge in Lsd. 13, Sec. 7, Tp. 6, R. 1, W. 5th Mer.

The fauna has a wide distribution in the Western Interior region of Canada and the United States, and no attempt is made to list all of the

reported occurrences. The fauna is well developed in the central part of the Kaskapau Formation at Spirit River in the Peace River Plains (Stelck and Wall, 1954). Nauss (1945, 1947) documented the presence of the fauna in the central part of the Lloydminster (=Colorado) Shale in the Vermilion area of east-central Alberta. The author has collected the fauna from the Cone Calcareous Member of the Marias River Formation on Summit Creek, just outside the southeast boundary of Glacier National Park, Montana (see Cobban, 1956). In southern Montana, Young (1951) reported a similar fauna from the "*Vascoceras* beds" of the central portion of the Frontier Formation. In Manitoba, the Favel Formation has yielded a similar fauna (Wickenden, 1945, p. 33). In northern Alaska, Tappan (1962) recorded this fauna in the lower part of the Seabee Formation, within the *Pseudoclavulina hastata-Arenobulimina torula* Zone.

This fauna is readily dated early Turonian by its association with the well-known index megafossils *Watinoceras reesidei* and *Inoceramus labiatus*, the ranges of which constitute a subzone in Jeletzky's (*op. cit.*) zonation for the Canadian Western Interior.

The presence of pelagic foraminifera to the virtual exclusion of calcareous benthonic and agglutinated forms is considered indicative of open-sea conditions or of a trend toward them. The scarcity of pelagic foraminifera in some of the Foothills sections might be explained by more rapid sedimentation creating greater turbidity, which has been assumed by various workers to be harmful to this group of foraminifera, or by the action of offshore currents preventing the influx of these forms, or possibly by a combination of such factors.

(4) Pseudoclavulina sp. Microfauna

This microfauna is best developed in the southern part of the central Foothills, where it is present in about 40 feet of strata straddling the contact between the Haven and Opabin Members of the Blackstone Formation at Ghost River and Burnt Timber Creek. At Indian Creek in the Nordegg area, the fauna was observed 150 feet below the base of the Cardium Formation, just below a covered interval in which, it is believed, the Haven-Opabin contact may be drawn. Farther north, at Luscar Creek near Cadomin, this assemblage appears somewhat higher stratigraphically, being collected from the Opabin Member within 50 feet of the base of the Cardium Formation. The fauna is recognizable at Mill Creek in the southern Foothills, where it was collected from the upper part of the Blackstone Formation in beds arbitarily designated as Opabin Member on the range chart (Table 3, in pocket), although the Haven Member may also be present, the two members not being differentiated in the area. At Mistanusk Creek in the northern Foothills, there is a trace of the fauna in the upper part of the Kaskapau Formation, about 200 feet below the base of the Cardium Formation.

The fauna, illustrated on plate 4 with other forms from the upper Blackstone not belonging to it, includes the following species:

Haplophragmoides bonanzaense Stelck and Wall
H. howardense Stelck and Wall
H. howardense manifestum Stelck and Wall
Dorothia sp. 1
Pseudoclavulina sp.

Of the above group, *Pseudoclavulina* sp. is the key species and seems restricted to a vertical range of approximately 40 feet. *Dorothia* sp. 1 and *H. howardense* are both prominent in this assemblage but are not restricted to it, although *D.* sp. 1 is typically and most commonly associated with this fauna.

East of the Foothills in the Peace River Plains, this fauna is present in the upper part of the Kaskapau Formation. It was stated by Wall and Germundson (1963, p. 337) that the species of *Pseudoclavulina* recorded on the Smoky River, about 50 feet below the Bad Heart Sandstone and a similar distance above a thin band of chert and quartzite pebbles, was probably not identical to *Pseudoclavulina* sp. of this fauna, but a further examination of additional material from this area indicates that the two forms are conspecific. As this pebble band may well be the same as the one at the base of the Wapiabi Formation in the Foothills, it seems quite possible that the stratigraphic position of *Pseudoclavulina* sp. in the Plains is above the Cardium Formation, but this hypothesis needs confirmation from subsurface sources. In northern Alaska, the equivalent of this fauna probably lies within the upper 100 feet of the Ayiyak Member of the Seabee Formation, in the upper part of the *Pseudoclavulina hastata-Arenobulimina torula* Zone, as the form which Tappan (1962) assigned to *P. hastata* (Cushman) appears identical to *Pseudoclavulina* sp. of the Foothills fauna.

This microfauna falls within the megafaunal zone of *Prionocyclus* (*Collignoniceras*) *woolgari,* which is coextensive with the Haven and Opabin Members according to Stott (1961, 1963), and which is dated as early late Turonian by Jeletzky.

The exclusively agglutinated character of this fauna, together with its position between the offshore, open-sea type of deposition linked with the Vimy Member and the shore-line or beach type of deposition associated with the Cardium Formation, are suggestive of a general regression and a return to the near-shore, shallow-water, somewhat turbid environment prevailing before the onset of the widespread early Turonian flooding with its pelagic foraminferal fauna.

Microfauna of the Cardium Formation

The Cardium Formation in the Foothills in general has yielded a sparse microfauna consisting mainly of agglutinated foraminifera with minor

elements of marine and nonmarine ostracodes. Nearly all of the microfossils have been obtained from that part of the formation which was formerly known as the middle shale member. In the central Foothills, this shale is now included in the Leyland and Kiska Members, whereas in the northern Foothills, it is designated as the Moosehound Member (Stott, 1961, 1963).

The author sampled the Cardium Formation on Bow River at the mouth of Oldfort Creek, on Burnt Timber and Cripple Creeks in the central Foothills, and on the Little Berland River in the northern Foothills. Microfaunal recovery was poor with the exception of the last locality.

The Leyland Member on Bow River and Burnt Timber Creek yielded only *Haplophragmoides* spp. in quantity, rare specimens of *Dorothia* sp. 1 or *D.* sp. cf. *D.* sp. 1, and two specimens belonging to different unidentified genera of marine ostracodes. The Leyland or Kiska Member on Cripple Creek produced *Haplophragmoides* spp., *Dorothia* sp. cf. *D.* sp. 1 and one poorly preserved specimen of *Quinqueloculina sphaera* Nauss.

The most varied microfauna from the Cardium Formation was collected from the Moosehound Member on Little Berland River, with the following foraminiferal species being present:

Reophax sp. 1
Haplophragmoides crickmayi Stelck and Wall—uncommon
H. howardense Stelck and Wall
Ammobaculites sp. cf. *A. fragmentarius* Cushman—uncommon
Spiroplectammina semicomplanata (Carsey)
Trochammina sp.
Verneuilinoides bearpawensis (Wickenden)
Dorothia smokyensis Wall—uncommon.

About 20 specimens of the ostracode *Cypridea* also were collected from the basal 4 feet of shale of the Moosehound Member (G.S.C. locality 27074).

The above-listed foraminiferal fauna contains species which are generally found in the lower part of the Wapiabi Formation elsewhere, although most of them also have been recorded from the Blackstone Formation. One principal exception, however, is *Spiroplectammina semicomplanata*, which was not collected lower than the basal Wapiabi at any other locality.

The age of the Cardium Formation in the Foothills of Alberta is regarded as late Turonian to early Coniacian according to Stott (1963,

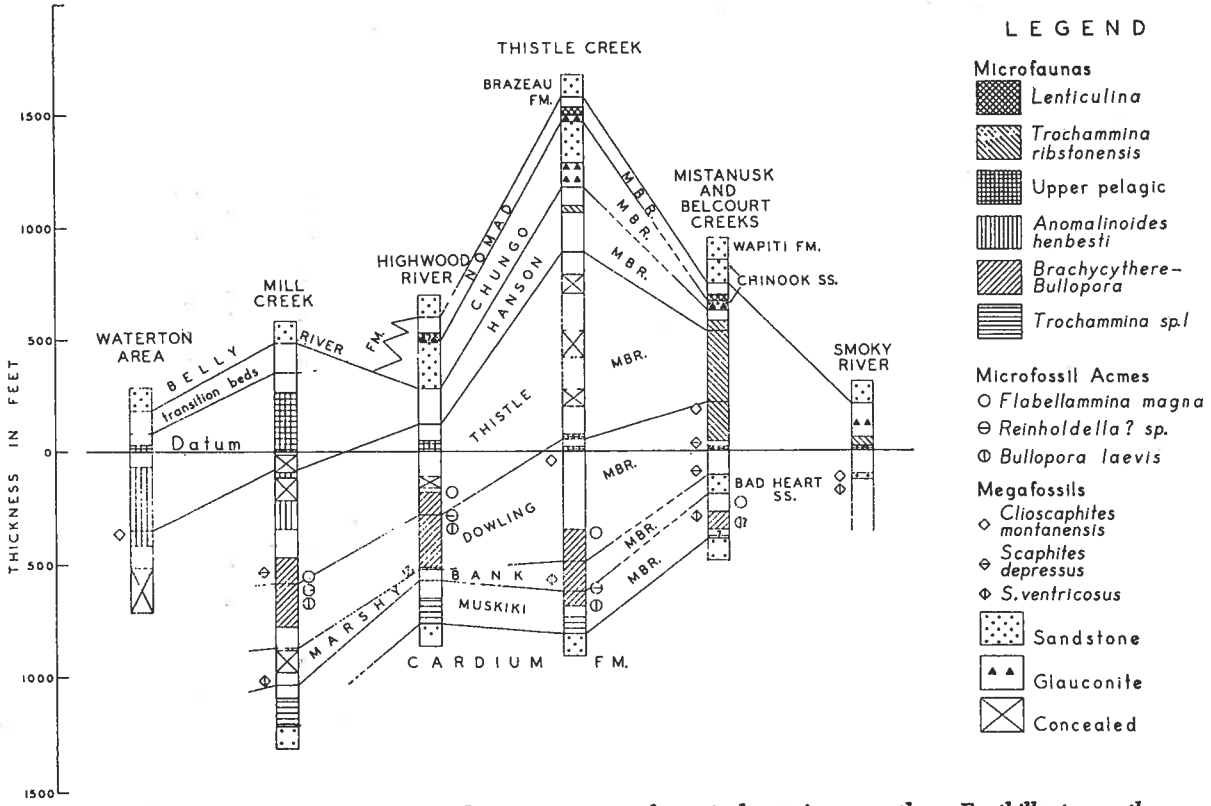


FIGURE 3. Correlation of the Wapiabi Formation and equivalents from southern Foothills to northern Plains of Alberta with upper pelagic microfauna as datum plane.

p. 62). Stelck (1955) considered the formation in the Foothills of northeastern British Columbia to be mainly late Turonian in age. As the microfossils are present in the Moosehound Member or equivalent beds, they may be dated as late Turonian.

The character of the Cardium foraminiferal fauna suggests a brackish, probably lagoonal type of environment of deposition for the middle shale unit. At the beginning of deposition of the basal shale of the Moosehound Member in the Little Berland River area, the water may have been nearly fresh as shown by the presence of the nonmarine ostracode *Cypridea*. The associated megafauna of *Corbula* and *Corbicula*, along with the presence of coal, also indicates a fresh- or brackish-water environment, according to Stott (1963, p. 71 and 139). The author's limited observations concerning the ecology of the Cardium microfaunas lend general support to Stott's interpretation of the depositional environment.

(5) Trochammina sp. 1 Microfauna

This microfauna is developed in the Muskiki Member of the Wapiabi Formation with its upper limit being recorded at about 125 feet above the base. It has a wide distribution in the Foothills. The fauna was recognized at the following localities, listed from south to north, with approximate vertical ranges in feet given in parentheses: Mill Creek (125), Highwood River (115), Oldfort Creek (65+), Burnt Timber Creek (85), Ram River (70), Thistle Creek (110) and Cardinal River (65). The key fossil also has been questionably identified at Mistanusk Creek in the northern Foothills, directly above the Cardium Formation.

The fauna, the important members of which are illustrated on plates 5 and 6, includes the following species:

Reophax sp. 1
Haplophragmoides howardense Stelck and Wall
H. howardense manifestum Stelck and Wall
Ammobaculites sp. 1
Spiroplectammina semicomplanata (Carsey)
Pseudobolivina rollaensis (Stelck and Wall)
Trochammina sp. 1
Dorothia smokyensis Wall
D. sp. 1
Quinqueloculina sphaera Nauss
Guembelitria sp.

Elements of this fauna, including the name fossil, have been collected by the author in the Kevin-Sunburst oil field of northern Montana, from below the MacGowan concretionary bed in the lower part of the middle unit of the Kevin Shale Member of the Marias River Formation.

The range of this microfauna appears to coincide mainly with the upper part of the *Scaphites preventricosus-Inoceramus deformis* Zone but may extend into the lower part of the *Scaphites ventricosus s.s.-Inoceramus involutus* Zone as well. As the former zone is considered latest Turonian or earliest Coniacian by Jeletzky (*in* Stott, 1963, p. 93), the age of the associated microfauna is thus established.

The almost exclusively agglutinated character of this fauna suggests that the transgressing sea, which followed the regression associated with the deposition of the Cardium Formation, was shallow, somewhat turbid, rather cool and perhaps brackish.

(6) Brachycythere-Bullopora Microfauna

This microfauna is the most diverse in the Alberta Group and is readily recognizable at most Foothills localities from the Crowsnest Pass area of the southern Foothills to the upper Wapiti River area of the northern Foothills. Its compound name is based on prominent components from the ostracodal and foraminiferal elements of the fauna.

In the southern Foothills and southern extremity of the central Foothills, the fauna is separated from the older *Trochammina* sp. 1 microfauna by an interval of 300 to 150 feet (the amount reducing in a northerly direction) carrying a sparse assemblage, the "*Anomalina* microfauna" of Wall and Germundson (1963, p. 339). In the central and northern Foothills, this interval is reduced further as a result of near coalescence of the underlying and overlying assemblages, and the "*Anomalina* microfauna" loses its identity. For this reason, and because most of its components are present in either the underlying or overlying assemblages in the southern Foothills, the "*Anomalina* microfauna" has not been retained in this publication. In this regard, the name "*Anomalina*" was an unfortunate choice for that fauna, as subsequent critical examination disclosed that the species involved was not distinguishable from *Anomalinoides talaria* (Nauss), which is a prominent component of the *Lenticulina* fauna of the Nomad Member of the Wapiabi Formation.

The *Brachycythere-Bullopora* microfauna has a consistent vertical range of from 320 to 360 feet in the southern and central Foothills. The fauna is best developed at Mill Creek, from 445 to 765 feet above the base of the Wapiabi Formation, thus spanning the upper part of the Dowling Member and the lower part of the Thistle Member. It is not as prominent northward from here. On the Highwood River, it was observed from 260 to 595 feet above the base of the Wapiabi, where it falls largely within the Dowling Member, extending less than 100 feet into the Thistle. On Burnt Timber Creek, the fauna is erratically developed from 225 to 585 feet above the base of the Wapiabi, in strata below the Thistle Member. On Ram River and Thistle Creek, the fauna was collected from about 125 to 465 feet above the base of the Wapiabi, again in beds underlying

the Thistle Member. On Mistanusk Creek in the northern Foothills, the fauna occupies a reduced interval, from 40 to 120 feet above the Cardium Formation, within the Muskiki Member of the Wapiabi Formation or the Muskiki Formation.

This microfaunal unit in the Foothills appears to embrace the total vertical ranges of several ostracode and foraminiferal species and probably constitutes a concurrent-range zone as defined by the American Commission on Stratigraphic Nomenclature (1961). Within these limits, or with slight overlap of the upper boundary in part, the acmes of development or "peak zones" of three benthonic foraminiferal species have been observed in the same relative position at most localities between Mill Creek and Thistle Creek. In ascending order, these guide fossils are *Bullopora laevis, Reinholdella*? sp. and *Flabellammina magna.*

The following foraminiferal species, many of which are illustrated on plates 6 to 10, comprise this fauna:

Bathysiphon vitta Nauss
Saccammina sp. cf. *S. alexanderi* (Loeblich and Tappan)
Ammodiscus sp. 2
Reophax sp. 1
R. sp. 2
R. sp. 3—uncommon
Haplophragmoides crickmayi Stelck and Wall
H. howardense Stelck and Wall
Ammobaculites sp. cf. *A. fragmentarius* Cushman
A. sp. 2
Flabellammina magna Alexander and Smith
Coscinophragma? *codyensis* (Fox)
Spiroplectammina semicomplanata (Carsey)
Dorothia smokyensis Wall
Marssonella oxycona (Reuss)
Dentalina summitensis Peterson—uncommon
D. sp. 1—uncommon
Bullopora laevis (Sollas)
Bolivina elkensis Nauss
B. sp. 1—uncommon
Valvulineria sp. cf. *V. umbilicata* (d'Orbigny)
V. sp. 1—uncommon
Guembelitria sp.
Praeglobotruncana sp. 1
Pullenia? sp.

?*Anomalinoides henbesti* (Plummer)
A. talaria (Nauss)
A.? sp. 1—uncommon
Reinholdella? sp.

The following ostracode species are present in this assemblage:

Brachycythere sphenoides (Reuss)
Cytherella parallela (Reuss)
Cytheridea perforata (F. A. Roemer)
Paracypris sp.

Part of the foraminiferal element of this fauna has a widespread distribution in the Western Interior region. Wickenden (1932) described some of its components from the subsurface of the southern Alberta Plains and noted the stratigraphic range of the fauna as about 300 to 500 feet below the "top of the Alberta shale", which was then, as now, drawn at the first or upper white-speckled shale "zone". This range is quite compatible with the position of the fauna in the Foothills, if allowance is made for a general thickening of the strata to the west. The author has collected some of the foraminifera of this fauna from an exposure of the middle unit of the Kevin Shale Member of the Marias River Formation in the Kevin-Sunburst oil field of northern Montana. Here, the fauna is prominent below the MacGowan concretionary bed, but extends above this marker-bed, probably into the lower part of the upper unit of the Kevin Shale. Fox (1954) described or listed part of this foraminiferal fauna from the basal 388 feet of the Cody Shale near Greybull, Wyoming, and commented on the similarity of his assemblages 3 and 4 to Wickenden's fauna from the Alberta Shale. Three prominent species in common among all of these areas are *Coscinophragma*? *codyensis* (Fox) of this publication (=*Polyphragma codyensis* Fox, *Clavulina*? sp. of Wickenden), *Marssonella oxycona* and *Bullopora laevis*.

The ostracodes of this Foothills microfauna are identical to species illustrated by Loetterle (1937) from the Niobrara Formation and lower part of the Pierre Shale in Nebraska and adjoining central Plains states.

Relative to its position in the megafaunal succession, the age of this microfauna appears to become younger from north to south in the Foothills. In the northern foothills, the position of the microfauna falls within the Coniacian *Scaphites ventricosus s.s.-Inoceramus involutus* Zone of Jeletzky. In the central Foothills, its range also extends through the overlying *Scaphites depressus* Zone, dated latest Coniacian or earliest Santonian by Jeletzky. In the southern Foothills, the range of the microfauna seems to include, in ascending order, the upper part of the *Scaphites depressus* Zone, the *Clioscaphites vermiformis* Zone and the lower part of the *Clioscaphites montanensis* Zone, with an over-all age span from early to middle Santonian. The indicated age differential is not so great, however,

as to detract from the considerable value of this microfauna in the recognition of strata locally and in their general correlation through the region.

The presence of such a varied assemblage of agglutinated (dominant) and calcareous foraminifera and ostracodes suggests a further deepening of the water following the occurrence of the *Trochammina* sp. 1 microfauna and the "*Anomalina* microfauna" in the early transgressive phase of the Wapiabi sea. It is believed that this fauna lived in about the middle of the neritic zone, with the water being moderately but not excessively turbid, cool to temperate, and of near-normal salinity. The position of this microfauna seems to fall in between the inner and outer sublittoral categories which Tappan (1962) recognized in her study of the Cretaceous biofacies of Alaska, with similarity to the latter being more evident.

(7) Anomalinoides henbesti Microfauna

This microfauna, called the "*Planulina* microfauna" by Wall and Germundson (1963, p. 341), has been observed only in the Waterton and Crowsnest Pass areas of the southern Foothills. It is not possible to define accurately the stratigraphic range of the fauna because of covered intervals in the outcrop sections. The fauna is strongly developed on the north fork of the Belly River in Waterton National Park, where it was found in beds referred to the Hanson Member and upper part of the underlying Thistle Member by Wall and Germundson. It is recognizable but less varied at Mill Creek in the Crowsnest Pass area, where it is present in the upper part of the Thistle Member and probably extends into the concealed overlying basal part of the Hanson Member. Wall and Germundson indicated that the fauna may be represented by a depauperate, agglutinated foraminiferal assemblage in the Dowling Member of the Wapiabi Formation in the central and northern Foothills. This hypothesis was based largely on the assumption that the position of the overlying upper pelagic microfauna represented a widespread time plane, which is open to question in view of the conflicting evidence supplied by the zonal ammonites. It was also stated by these authors that the boundary between the "*Planulina* microfauna" and the upper pelagic microfauna was somewhat gradational in Waterton National Park, and it must be admitted that pelagic foraminifera are fairly prominent there in some of the beds within the over-all range of *A. henbesti*.

This fauna, the most characteristic components of which are illustrated on plates 11 and 12, includes the following species:

Saccammina sp. cf. *S. alexanderi* (Loeblich and Tappan)
Reophax pepperensis Loeblich—uncommon
R. sp. 4—common
Haplophragmoides sp. 2—abundant

Pseudobolivina rollaensis (Stelck and Wall)
P. sp. 1—common
Trochammina sp. 2—abundant
Uvigerinammina? sp. 1
Dorothia glabrata—common
Nodosaria sp. 1—uncommon
N. sp. 2—uncommon
Frondicularia sp. cf. *F. greybullensis* Fox—uncommon
Neobulimina sp.—common
Bolivina sp. cf. *B. elkensis* Nauss
B. sp. 1
Heterohelix globulosa (Ehrenberg)
H. sp. cf. *H. reussi* (Cushman)
H. sp. 1
Hedbergella delrioensis (Carsey)
Praeglobotruncana sp. 1
Anomalinoides henbesti (Plummer)—abundant
?*Reinholdella*? sp.

The author has collected the key species from the middle of the upper unit of the Kevin Shale Member near Sunburst, Montana, in which there is some overlap with the range of the succeeding upper pelagic microfauna. Loetterle (1937) reported the name fossil of this assemblage as *Planulina complanata* (Reuss) from the Niobrara Formation of Nebraska and adjoining central Plains states.

On the basis of its distribution in the southern Foothills and in northern Montana, this microfauna coincides mainly in stratigraphic position with that of the *Clioscaphites choteauensis* megafauna (Cobban, 1951, p. 2195; Cobban and others, 1959, Fig. 3), which is middle Santonian in age. However, the lower range of the microfauna includes the upper part of the underlying *Clioscaphites montanensis-Clioscaphites vermiformis* Zone in Waterton National Park, as these ammonites were obtained here by Wall and Germundson (1963, p. 334) in the uppermost beds of what is considered to be the Thistle Member.

The presence of this mixed agglutinated and calcareous benthonic assemblage, with some intrusions of pelagic foraminifera, suggests a further deepening of the water in which the previous fauna lived and increasing similarity of ecologic conditions to those prevailing in the Niobrara seaway to the south, if not an actual connection with this flooding. The water was probably of moderate depth in the middle to outer part of the neritic zone, of normal salinity, temperate and relatively free of excessive turbidity.

(8) Upper Pelagic Microfauna

The vertical range of this microfauna embraces those strata in the Wapiabi Formation yielding a preponderance of pelagic foraminifera. The upper limit of the fauna is taken at the level where the pelagic foraminifera disappear and are replaced by a dominantly agglutinated assemblage, either the *Trochammina ribstonensis* microfauna in the central and northern Foothills or an unnamed arenaceous microfauna in the southern Foothills. The lower boundary is drawn at the earliest appearance of the pelagic foraminifera in strength, which is difficult to define in the extreme southern Foothills, where there is some intermingling of this fauna with the preceding *Anomalinoides henbesti* microfauna.

The thickness of the beds carrying this fauna varies from about 200 feet at Mill Creek in the southern Foothills to 20 feet at Belcourt Creek in the northern Foothills, with values of 50 to 60 feet recorded at Highwood River and Thistle Creek in the intervening area. At Thistle Creek in the inner or western Foothills, the fauna is only erratically developed through 60 feet of section, but at the other localities it appears to be nearly continuous through the intervals in which it is present.

The position of this microfauna in the Foothills varies markedly with respect to the rock-stratigraphic units of the Wapiabi Formation, occurring at progressively lower levels from south to north. In the Waterton and Crowsnest Pass areas of the southern Foothills, the fauna is present above the Thistle Member. Farther north, on the Highwood River, it was observed in the upper part of the Thistle Member. On Thistle Creek in the central Foothills, the fauna is weakly developed near the contact of the Thistle and underlying Dowling Member. On Belcourt Creek in the northern Foothills, the assemblage is found in the Dowling Member, about 100 feet above the Bad Heart Sandstone.

This microfauna, the characteristic members of which are illustrated on plate 13, includes the following species:

Reophax sp. 4
Haplophragmoides sp. 2
Trochammina sp. 2
Neobulimina sp.
Bolivina sp. cf. *B. elkensis* Nauss
B. sp. 1
Heterohelix globulosa (Ehrenberg)
H. sp. cf. *H. reussi* (Cushman)
H. sp. 1
Hedbergella delrioensis (Carsey)
Praeglobotruncana sp. cf. *P. coarctata* Bolli
P. sp. 1.

This is the microfauna associated with the first or upper white-speckled shale "zone" at the top of the Colorado Group or Alberta Shale in the Plains region of Western Canada. The "white specks" have been observed in the shale carrying the fauna at several localities in the outer or eastern part of the Foothills. Wall and Germundson (1961) reported on the presence of this "zone" at Dungarvan Creek in the Waterton area and later (1963) discussed its presence at Highwood River and Belcourt Creek. They also commented on the absence of the "white specks" from Mill Creek, Oldfort Creek, Burnt Timber Creek and Thistle Creek—localities in the inner or western part of the Foothills—but noted that the associated microfauna was present at Mill and Thistle Creeks.

On the basis of its association with the first or upper white-speckled shale "zone" in the Foothills, this microfauna undoubtedly has a wide distribution in the Western Interior region of Canada and the United States, but the author has not studied it in the subsurface of the Plains. In the Smoky River outcrop section of the Peace River Plains, the author (1960) has established the presence of the fauna in the Puskwaskau Formation, about 100 feet above the Bad Heart Sandstone, the same position it occupies to the west in the upper Wapiti River area of the northern Foothills. The author has also collected the fauna in outcrop from the upper part of the upper unit of the Kevin Shale Member of the Marias River Formation near Sunburst, Montana. It is believed that the pelagic element of the microfauna from the Niobrara Formation of the Western Interior is in part similar to this Foothills fauna, although the author has not made any detailed comparison.

In any assessment of the value of this microfauna for dating or correlation purposes, the question may well be raised if it is, in reality, distinguishable from the lower pelagic microfauna of the Vimy Member of the Blackstone Formation. The general aspect of these faunas is similar, but some significant differences have been observed in the Foothills:

(1) the upper pelagic fauna has associated with it a fairly prominent agglutinated element, whereas the lower fauna is composed exclusively of pelagic forms;

(2) total populations of pelagic forms in the upper fauna are markedly less than those in the lower fauna;

(3) the upper fauna is dominated by *Heterohelix*, whereas *Hedbergella* shares prominence with *Heterohelix* in the lower fauna;

(4) certain species are present in one assemblage to the complete exclusion of the other—*Bolivina* sp. cf. *B. elkensis*, *Heterohelix* sp. cf. *H. reussi*, *Praeglobotruncana* sp. cf. *P. coarctata* and *Praeglobotruncana* sp. 1 have been observed in only the upper fauna, whereas *Hedbergella loetterlei* seems restricted to the lower fauna.

The age of this microfauna appears to vary considerably if its position with respect to the megafaunal zones is considered. In the southern Foothills and in northern Montana, the microfauna seems to correspond with the lower part of the *Desmoscaphites* spp. Zone of Jeletzky, which is late Santonian in age. In the upper Wapiti River area of the northern Foothills, however, the microfauna occurs in association with *Scaphites depressus,* which is regarded as early Santonian in age. At Thistle Creek, between these extremities of the Foothills, the position of the microfauna seems to coincide with the intermediate *Clioscaphites montanensis* Zone of Jeletzky, dated middle to early late Santonian by him (Stott, 1963, p. 103). Thus, on the basis of its relationships with the ammonite zones, the upper pelagic microfauna becomes progressively younger from north to south. If, on the other hand, this microfauna is considered a more reliable indicator of time than ammonites, then the Thistle Member of the Wapiabi Formation is a diachronous unit, becoming progressively younger from south to north. (Fig. 3).

The general ecologic implications of pelagic foraminiferal assemblages have already been discussed, but there is evidence to indicate that the environments of the lower and upper pelagic microfaunas of the Foothills were somewhat dissimilar. The common presence of agglutinated foraminifera in the upper fauna and its smaller pelagic populations, compared with both the stratigraphically equivalent Niobrara fauna and the lower fauna, suggest that the upper fauna lived farther from the open sea and perhaps fairly close to land, with onshore currents being largely responsible for the distribution of the pelagic elements.

(9) Trochammina ribstonensis Microfauna

This agglutinated microfauna is developed in the Wapiabi Formation on Mistanusk and Belcourt Creeks in the upper Wapiti River area of the northern Foothills. Here, it is present erratically through an interval of 500 to 600 feet, including the upper part of the Dowling Member, the Thistle Member and the lower part of the Hanson Member. The fauna is not readily recognizable as a unit elsewhere in the Foothills. In the central Foothills, the name fossil is quite rare and widely scattered in the Hanson and Dowling Members at Thistle Creek and is present but not common in the upper part of the Dowling Member at Ram River. These occurrences in the Dowling Member of the central Foothills suggest that the range of the key fossil overlaps that of the upper pelagic microfauna. *T. ribstonensis* was not recorded in the southern Foothills, and the agglutinated assemblage overlying the upper pelagic microfauna in that area has very little in common with this fauna. Further mention of the southern assemblage is made at the conclusion of the discussion of this fauna.

The *T. ribstonensis* microfauna, the principal components of which are illustrated on plates 7, 8, 10 and 11, includes the following species:

Ammodiscus sp. 2—uncommon
Reophax pepperensis Loeblich
R. sp. 4
Haplophragmoides howardense Stelk and Wall
H. howardense manifestum Stelck and Wall
Spiroplectammina semicomplanata (Carsey)
S. sp. 2—uncommon
Pseudobolivina rollaensis (Stelck and Wall)—abundant
P. sp. 1
Trochammina ribstonensis Wickenden
T. sp. cf. *T. ribstonensis*
T. wetteri Stelck and Wall—common
T. sp. 2
Verneuilinoides bearpawensis (Wickenden)
Dorothia smokyensis Wall.

T. ribstonensis is a valuable guide fossil for the strata directly above the first or upper white-speckled shale "zone" at the top of the Colorado Group in the Plains region. Nauss (1947) observed its consistent presence in the basal 40 feet of the Lea Park Formation of east-central Alberta, and the author (1960) recorded it in the Puskwaskau Formation on the Smoky River in the Peace River Plains region. Tappan (1962) reported *T. ribstonensis* and other species from the lower part of the Lea Park Formation in the upper part of the Seabee Formation and lower part of the Schrader Bluff Formation of northern Alaska. In view of the broad species concept applied to *T. ribstonensis* by Tappan, however, the range of this form in Alaska is shown to be more extensive than in Alberta.

Based on its ammonite associations and stratigraphic position in the northern Foothills, this microfauna appears to extend from the upper part of the *Clioscaphites vermiformis* Zone into the lower part of the *Scaphites hippocrepis* Zone and thus ranges in age from middle Santonian to early Campanian. In the Plains, the microfauna appears to be restricted to the lower part of the *Scaphites hippocrepis* Zone and would be dated as early Campanian, as Jeletzky found the zonal index near the base of the Lea Park Formation in the lower Athabasca River area (Wall and Germundson, 1963, p. 335).

The presence of this almost entirely agglutinated fauna in the northern Foothills, following the period of dominance of pelagic foraminifera in the underlying strata, suggests a gradual regression of the sea, accompanied by increased turbidity in the shallowing waters, and a return to ecologic conditions like those assumed to have prevailed during the early transgression of the Wapiabi sea. Wall and Germundson (1963, Fig. 4) suggested that this Foothills microfauna was probably the near-

shore biofacies equivalent of the comparatively rich offshore microfauna of the *Trochammina ribstonensis* Zone and overlying *Epistomina fax* Zone of the lower part of the Lea Park Formation in east-central Alberta. The rate of sedimentation was postulated to have been much higher in the Foothills, which would account for the greater thickness of strata and the extended local range of *T. ribstonensis,* and which might also explain, through the accompaniment of highly turbid conditions, the absence of calcareous foraminifera.

The presence of an agglutinated assemblage in the southern Foothills overlying the upper pelagic microfauna, but differing in composition from the *T. ribstonensis* microfauna, already has been mentioned. This southern assemblage is developed in the upper part of what has been called the Hanson Member in this study and in the transition beds of the Wapiabi Formation in the Crowsnest Pass and Waterton areas. This microfauna is probably correlative with the *T. ribstonensis* fauna but may be somewhat older. Its composition indicates that the sea began a regression after the period of dominance of the pelagic microfauna and became brackish and progressively shallower, this phase terminating with the onset of deposition of nonmarine sediments of the Belly River Formation.

This southern assemblage, the members of which are illustrated on plates 11 and 14, includes the following species:

Saccammina sp. cf. *S. alexanderi* (Loeblich and Tappan)
S. sp. 1
Reophax sp. 4
Haplophragmoides sp. cf. *H. rota* Nauss
H. sp. 2—common
Ammobaculites? sp. 3
Spiroplectammina sp. 2
Pseudobolivina sp. 1
Trochammina sp. 2—abundant
Uvigerinammina? sp. 1
Praebulimina sp. 1.

(10) Lenticulina Microfauna

This microfauna is associated with the Nomad Member of the Wapiabi Formation. It is most prominent in the central sector of the Foothills but is present in a modified form in the northern part of the southern Foothills and in the northern Foothills. The fauna is typically developed on Thistle Creek, where calcareous benthonic foraminifera are dominant, and it is also readily recognizable on Burnt Timber Creek and on the McLeod River near Cadomin. It undergoes a change in composition in the southern and northern sectors of the Foothills, where agglutinated foraminifera overshadow the calcareous forms. In the southern sector, on the Highwood

River near Longview, a trace of the calcareous element of the fauna was found in the Nomad Member above the type Highwood Sandstone (Chungo Member of Stott). In the northern sector, on Mistanusk and Belcourt Creeks, a similar trace was recorded in beds considered by the author to be the equivalent of the Nomad Member, between the "lower Chinook Sandstone" or conglomerate bed and the base of the main Chinook Sandstone. This microfauna has not been observed in the Crowsnest Pass area of the southern Foothills, where it is assumed that its time equivalent lies in nonmarine strata of the Belly River Formation.

This microfauna, the characteristic elements of which are illustrated on plates 14 and 15, includes the following species:

Haplophragmoides sp. cf. *H. rota* Nauss
Verneuilinoides bearpawensis (Wickenden)
Lenticulina sp. 1
L. sp. 2
L. spp.
Vaginulina sp.
Neobulimina sp.
Praebulimina venusae (Nauss)
Eoeponidella sp. cf. *E. linki* Wickenden
Cibicides? sp.
Anomalinoides talaria (Nauss)
A.? sp. 2.

This fauna is considered correlative with one described by Nauss (1947) from the upper beds of the Lea Park Formation and marine tongues of the overlying Belly River Formation in the east-central Alberta area of the Plains. The assemblage is also similar to one reported by Tappan (1960, 1962) from the upper part of the *Trochammina ribstonensis-Neobulimina canadensis* Zone in the Sentinel Hill Member of the Schrader Bluff Formation in northern Alaska.

The megafauna of the Nomad Member ranges in age from Santonian to early Campanian (Stott, 1963, p. 118). Jeletzky (*in* Stott, *op. cit.*) suggested a late Santonian age for the fauna, whereas Stott favored a Campanian age for the member, considering it to be the equivalent of the Pakowki Formation of the Plains. The author, on the basis of the correlation of the associated microfauna with that of the upper part of the Lea Park Formation and lower part of the Belly River Formation, believes Stott's age assignment to be correct.

The presence of this dominantly calcareous benthonic foraminiferal fauna in the central Foothills documents a readvance of the Wapiabi sea after the shoaling that had resulted in the deposition of the sandstones included by Stott in the Chungo Member. The assemblage probably lived

in about the middle of the neritic zone, with the water being relatively quiet and of normal salinity. The southern and northern sectors of the Foothills were apparently marginal to this flooding with the water being shallower and brackish, as suggested by the replacement of most of the calcareous elements of the fauna by agglutinated forms.

Summary

The stratigraphic, ecologic and paleogeographic significance of the ten numbered and named microfaunal assemblages recognized in the Alberta Group of the Foothills is summarized below. The microfaunas are numbered in ascending stratigraphic order with four from the Blackstone and six from the Wapiabi Formation. The unnumbered microfauna of the intervening Cardium Formation is also included.

Blackstone Formation

(1) Miliammina manitobensis Microfauna

This entirely agglutinated microfauna is present in the Sunkay Member and has a wide distribution in the Plains region below the "fish-scale sand" and above the Viking Formation. Its absence from the southern Foothills reveals the time-transgressive nature of the base of the Blackstone Formation which becomes progressively younger to the south. Its composition suggests that the transgressing sea in the Foothills, which followed the period of nonmarine deposition represented by the Blairmore Group, was shallow, cool, somewhat turbid and perhaps of subnormal salinity.

(2) Verneuilinoides kansasensis Microfauna

This entirely agglutinated microfauna is present in the Sunkay Member. Its distribution is not as wide as that of the preceding *M. manitobensis* microfauna, but it is recognized in the lower part of the Kaskapau Formation of the Peace River area, and elements of the fauna also have been reported from Colorado and Alaska. Its disappearance from the Sunkay Member at a point farther south in the Foothills than that of the preceding fauna is further evidence of the time-transgressive nature of the base of the Blackstone Formation.

(3) Lower Pelagic Microfauna

This exclusively pelagic microfauna is present in the Vimy Member of the Blackstone Formation and has a wide distribution in the Western Interior region of Canada and the United States. This is the microfauna associated with the lower or second white-speckled shale "zone" of the Colorado Group in the Plains. Its presence indicates that, at this time, offshore marine conditions prevailed, and open-sea connections were more firmly established than at any other stage during the deposition of the Alberta Group.

(4) Pseudoclavulina sp. Microfauna

This exclusively agglutinated microfauna is present in the upper beds of the Haven Member and lower beds of the Opabin Member in the southern part of the central Foothills. Its stratigraphic position appears to be higher in the north, however, as it is found in the upper part of the Opabin Member in the Cadomin area. Its distribution seems fairly wide, as it has been recorded from the upper part of the Kaskapau Formation of the Peace River area and probably is present in the Ayiyak Member of the Seabee Formation of Alaska. The character of the microfauna suggests a pronounced regression following the widespread flooding associated with the preceding pelagic microfauna.

Cardium Formation

The microfauna of the Cardium is sparse, consisting mainly of agglutinated foraminifera obtained from the middle shaly portion of the formation. A brackish, lagoonal environment is indicated, with possibly nearly fresh-water conditions prevailing for a time in the northern Foothills, as shown by the presence of the nonmarine ostracode *Cypridea.*

Wapiabi Formation

(5) Trochammina sp. 1 Microfauna

This dominantly agglutinated microfauna is present in the lower part of the Muskiki Member in the southern and central Foothills, with the name species also being collected from the middle unit of the Kevin Shale Member of the Marias River Formation in northern Montana. The composition of the microfauna suggests that ecologic conditions in the early Wapiabi sea differed little from those in the initial Blackstone transgression, with the water being shallow, cool, somewhat turbid and perhaps brackish.

(6) Brachycythere-Bullopora Microfauna

This microfauna is the most varied in the Alberta Group and is recognizable over much of the Foothills. Its position varies with respect to the boundaries of the rock-stratigraphic units and megafaunal zones involved. In the southern sector, its range includes the upper part of the Dowling Member and the lower part of the overlying Thistle Member, whereas in the northern sector, it lies within the stratigraphically lower Muskiki Member. Similarly, its relationship with the zonal ammonites changes, with the microfauna apparently becoming younger from north to south. The foraminiferal portion of the microfauna has a wide distribution in the Western Interior region, being present in the Alberta Shale of the southern Alberta Plains, the middle unit of the Kevin Shale Member of the Marias River Formation in northern Montana, and the basal part of the Cody Shale of Wyoming. The ostracodes are present in the Niobrara Formation of Nebraska and adjoining central Plains states. The mixed

character of the microfauna indicates a gradual change from the shallow, somewhat turbid, brackish environment assumed to have existed during the initial phase of the Wapiabi transgression, to one of increasing depth, less turbidity and near-normal salinity.

(7) Anomalinoides henbesti Microfauna

This microfauna is present in the far southern part of the Foothills, where it is developed in beds referred to the Hanson Member and the upper part of the underlying Thistle Member in this publication. Its boundary is somewhat gradational with that of the succeeding upper pelagic microfauna. The nature of this assemblage with its strong calcareous benthonic element suggests a further deepening of the water and a general trend toward normal marine conditions associated with the Niobrara seaway to the south.

(8) Upper Pelagic Microfauna

This dominantly pelagic microfauna changes position along the Foothills with respect to the boundaries of the rock-stratigraphic units and megafaunal zones involved. From south to north, the microfauna is observed at progressively lower stratigraphic levels, being present in the Hanson Member in the southern sector and in the Dowling Member in the northern sector. Its relationship with the megafaunal zones changes in a similar manner, as the microfauna is associated with progressively younger zonal ammonites from north to south. If, however, the microfauna is considered a more reliable indicator of time than the megafauna, then the Thistle Member must be regarded as a markedly diachronous unit, becoming progressively younger from south to north. This microfauna is the one associated with the first or upper white-speckled shale "zone" at the top of the Colorado Group in the Plains region. Because of the relatively small populations of pelagic species and the presence of agglutinated foraminifera in the assemblages, it is considered probable that this microfauna in the Foothills did not live under open marine conditions, such as postulated for the lower pelagic microfauna, but that it may well have lived fairly close to land, with onshore currents being largely responsible for its distribution.

(9) Trochammina ribstonensis Microfauna

This agglutinated microfauna is present in the upper Wapiti River area of the northern Foothills, where it is developed, in ascending order, in the upper part of the Dowling Member, the Thistle Member and lower part of the Hanson Member. It is not recognizable as a unit elsewhere in the Foothills, although the name fossil is uncommon through part of the same interval in the central Foothills. In the far southern sector, another agglutinated microfauna—the "southern assemblage"— is developed in the upper part of the Hanson Member and overlying transition beds, and although its components are essentially different from those of

the *T. ribstonensis* microfauna, it may be correlative based on its stratigraphic position. The character of the *T. ribstonensis* microfauna indicates a regression of the sea and a return to environmental conditions like those assumed to have existed during the early phase of the Wapiabi transgression. The microfaunas of the *Trochammina ribstonensis* and overlying *Epistomina fax* Zones in the lower part of the Lea Park Formation in the Plains region probably represent an offshore biofacies equivalent of this Foothills microfauna.

(10) Lenticulina Microfauna

This mixed calcareous benthonic and agglutinated foraminiferal fauna is present in the Nomad Member. It documents a readvance of the Wapiabi sea in the central Foothills after the withdrawal associated with the deposition of the sandstones of the Chungo Member. The northern Foothills and northern part of the southern Foothills were probably marginal to this flooding, as the calcareous element of the fauna is greatly reduced in the Nomad Member or its equivalent in these areas. Its absence from the far southern Foothills indicates that nonmarine sedimentation, represented by the strata of the Belly River Formation, had already become firmly established in this area. This microfauna is correlative with that of the upper part of the Lea Park Formation and marine tongues of the overlying Belly River Formation in the Plains region.

FORMAL DESCRIPTIONS

Phylum PROTOZOA

Subphylum SARCODINA Schmarda, 1871

Class RETICULAREA Lankester, 1885

Subclass GRANULORETICULOSIA de Saedeleer, 1934

Order FORAMINIFERIDA Eichwald, 1830

Suborder TEXTULARIINA Delage and Hérouard, 1896

Superfamily AMMODISCACEA Reuss, 1862

Family ASTRORHIZIDAE Brady, 1881

Genus BATHYSIPHON M. Sars, 1872

BATHYSIPHON VITTA Nauss

Plate 7, figures 4-7

Bathysiphon vitta Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 334, pl. 48, fig. 4—Trujillo, 1960, Jour. Paleont., vol. 34, no. 2, p. 302-303, pl. 43, figs. 2a-b—Takayanagi, 1960, Tohoku Univ. Sci. Rept., 2nd ser., vol. 32, no. 1, p. 64-65, pl. 1, figs. 5a-b—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 128-129, pl. 29, figs. 6-8—Graham and Church, 1963, Stanford Univ. Pubs. Geol. Sci., vol. 8, no. 1, p. 17-18, pl. 1, figs. 1-2—North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 10-11, pl. 1, fig. 1.

Description: Test tubular, variously compressed appearing oval to nearly circular in cross section, with numerous weak transverse growth constrictions visible in some specimens; wall siliceous with finely disseminated dark material imparting sombre grey color to test, thickness of wall variable; apertures simple, the infilled ends of the tubes.

Dimensions:	Length (mm.)	Diameter (mm.)
Hypotype MF 5042 (fig. 4)	0.80	0.30
Hypotype MF 5043 (fig. 5)	—	0.49
Hypotype MF 5044 (fig. 6)	1.04	0.45
Hypotype MF 5045 (fig. 7)	1.55	0.87

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation.

Hypotype MF 5042 is from Ram River, 392 feet above the base of the formation.

Hypotypes MF 5043 to 5045 are from Thistle Creek, 525 feet above the base of the formation.

Distribution: In the Foothills this species is most prominent at the above levels and localities, with a total of about 30 specimens being recorded. It is much rarer at about the same stratigraphic level at Oldfort and Gorge Creeks. These Foothills occurrences appear to be from a some-

what lower stratigraphic level than the type occurrence from the middle part of the Lea Park Formation in east-central Alberta, which is late Santonian-early Campanian in age.

The author has collected this species in the Plains region from the Alberta Shale outcrop on Deer Creek, Montana, which straddles the International Boundary in Sec. 2, Tp. 37N., R. 1E., Montana and in Sec. 5, Tp. 1, R. 12, W. 4th Mer., Alberta (see Russell and Landes, 1940, p. 21). The associated strata are correlated by the author on the basis of the microfaunal assemblage with the middle unit of the Kevin Shale Member of the Marias River Formation exposed in the Kevin-Sunburst oil field of northern Montana.

B. vitta has also been reported from Cretaceous strata in Saskatchewan, Alaska, California and Japan. The Saskatchewan specimens recorded by North and Caldwell are from about the same stratigraphic position as Nauss' type material. According to Tappan, the Alaskan occurrences are from considerably older (Albian) strata than those from Alberta and Saskatchewan. The age of the beds in California and Japan from which this species has been reported appears to range from Turonian to Campanian.

Remarks: The Foothills specimens are much darker than the type-area specimens, tend to be somewhat thicker-walled, and appear to have undergone silicification. These differences are probably attributable to variations of the local environment. The specimens from the southern Plains are intermediate in appearance between those of the Foothills and the type area.

Genus HIPPOCREPINA Parker, 1870

HIPPOCREPINA sp.

Plate 8, figure 6; Plate 11, figure 11

Description: Test a single chamber, vase-shaped, strongly compressed, with weak transverse growth wrinkles visible on exterior; prominent apertural necks present in some specimens with marked constrictions between these and main portions of tests; wall agglutinated with moderately sized grains, surface somewhat rough; aperture elliptical, terminal; color greyish-brown.

Dimensions:	Length (mm.)	Width (mm.)
Specimen MF 5046 (pl. 8, fig. 6)	0.93	0.29
Specimen MF 5047 (pl. 11, fig. 11)	1.01	0.42

Types: The figured specimens are from the Wapiabi Formation on Mill Creek.

Specimen MF 5046 is from the Dowling Member, 504 feet above the base of the formation.

Specimen MF 5047 is from the Thistle Member, 879 feet above the base of the formation.

Distribution: This species seems rare and of little stratigraphic significance within the Wapiabi Formation. It was recorded from the Dowling Member on Mill Creek, and from the Thistle Member there and on the north fork of the Belly River in Waterton National Park.

Family SACCAMMINIDAE Brady, 1884

Genus SACCAMMINA M. Sars, 1869

SACCAMMINA sp. cf. S. ALEXANDERI (Loeblich and Tappan)

Plate 8, figures 16, 17; Plate 14, figures 17, 18

?*Proteonina alexanderi* Loeblich and Tappan, 1950, Univ. Kansas Paleont. Contrib., Protozoa, Art. 3, p. 5, pl. 1, figs. 1,2.

Proteonina cf. *P. alexanderi* Loeblich and Tappan. Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 52-53, pl. 1, figs. 5, 6.

?*Saccammina alexanderi* (Loeblich and Tappan). Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 55, pl. 3, figs. 1, 2—Crespin, 1963, Australia Bur. Min. Resources Bull. 66, p. 20-21, pl. 1, figs. 10-12—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 891-892, pl. 103, fig. 1.

Description: Test a single chamber, flask-shaped, somewhat compressed; wall coarsely agglutinated, small amount of cement, surface rough; aperture an elliptical slit at end of prominent neck; color greyish-brown to greyish-white.

Dimensions:	Length (mm.)	Width (mm.)
Specimen MF 5048 (pl. 8, fig. 16)	0.56	0.31
Specimen MF 5049 (pl. 8, fig. 17)	0.62	0.37
Specimen MF 5050 (pl. 14, fig. 17)	0.48	0.24
Specimen MF 5051 (pl. 14, fig. 18)	0.49	0.29

Types: Specimens MF 5048 and 5049 are from the Dowling Member of the Wapiabi Formation on Mill Creek, 564 feet above the base of the formation.

Specimens MF 5050 and 5051 are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: This species has been observed sporadically from the Dowling Member through the transition beds of the Wapiabi Formation in the Crowsnest Pass and Waterton areas.

It seems identical to a form compared with *P. alexanderi* by Stelck and Wall from the late Cenomanian portion of the Kaskapau Formation in the Peace River area of Alberta.

Remarks: The types of *S. alexanderi* from the Lower Cretaceous Kiowa Shale of Kansas appear to have a homogeneous wall structure with coarse,

neatly arranged grains. Specimens referred to this species by Crespin from the Lower Cretaceous of Australia also exhibit this feature. Eicher's illustrations of specimens from Albian-Cenomanian strata in the Wyoming-Colorado region show a heterogeneous wall structure of variously sized grains. The specimens figured herein appear transitional between the types and those illustrated by Eicher. It seems likely, however, that all of these forms belong to the same species.

As noted by Crespin, the generic name *Proteonina* has been suppressed as a synonym of *Reophax* by Loeblich and Tappan (1955, p. 8). Most forms previously referred to *Proteonina* have been transferred to *Saccammina* by various workers.

SACCAMMINA sp. 1

Plate 14, figure 16

Description: Test a single chamber, rounded pentagonal in outline, strongly compressed resulting in a large central depression; wall agglutinated with moderately sized grains, surface somewhat rough; aperture elliptical at end of a short, poorly defined neck; color greyish-brown.

Dimensions:	Length (mm.)	Width (mm.)
Specimen MF 5052	0.61	0.53

Types: The figured specimen is from the transition beds of the Wapiabi Formation on Mill Creek, 79 feet below a 30-foot massive sandstone unit regarded as the base of the Belly River Formation.

Distribution: This species seems rare with only one additional adult and two smaller specimens being observed at the above level and locality.

Family AMMODISCIDAE Reuss, 1862

Genus AMMODISCUS Reuss, 1862

AMMODISCUS sp. 1

Plate 1, figures 20, 21

Description: Test discoidal, planispiral, of four to five coils; inner portion obscured by dark included material rendering proloculum and early coils invisible; coiling apparently regular with slight increase in diameter of tube in outer whorls; spiral suture visible in part between outer whorls, depressed; wall finely agglutinated, surface smooth; aperture formed by open end of tube.

Dimensions:	Diameter (mm.)	Thickness (mm.)
Specimen MF 5053	0.36	0.06

Unfigured specimens range from 0.24 mm. to 0.37 mm. in diameter.

Types: The figured specimen is from the Sunkay Member of the Blackstone Formation in the railroad cut at Cadomin, 2 to 5 feet above the contact with the underlying Mountain Park Formation.

Distribution: This species was recorded only from the basal 15 feet of the Sunkay Member at Cadomin, where it is rare.

Ammodiscus sp. 2

Plate 8, figures 1-4

Involutina sp., Wall, 1960, Res. Coun. Alberta Bull. 6, p. 15-16, pl. 3, figs. 1, 2; pl. 4, figs. 1-5.

Description: Test medium to fairly large size, discoidal, planispiral, composed of proloculum and long undivided tube making three to four coils around proloculum; tube increasing gradually in diameter in early whorls but in most specimens widening markedly in ultimate whorl; coiling generally regular with the exception of some slight overlapping in final coil; spiral suture fairly distinct, slightly thickened, depressed; wall finely agglutinated, partly replaced by pyrite in many specimens, surface nearly smooth; aperture formed by open end of tube; color buff in non-pyritized specimens.

Dimensions:	Diameter (mm.)	Thickness (mm.)
Specimen MF 5054 (figs. 1, 2)	0.63	0.11
Specimen MF 5055 (figs. 3, 4)	0.71	0.11

Types: The figured specimens are from the Dowling Member of the Wapiabi Formation.

Specimen MF 5054 is from Thistle Creek, 409 feet above the base of the Wapiabi Formation.

Specimen MF 5055 is from Mistanusk Creek, 424 feet above the contact of the Cardium and Wapiabi Formations, or 138 feet above the top of the Bad Heart Sandstone.

Distribution: This species has been observed at most Foothills localities with the exception of those in the Crowsnest Pass and Waterton areas. Although it ranges from the Muskiki to the Thistle Member of the Wapiabi Formation, it is most prominent in the Dowling Member.

The author has described this species from the upper part of the Kaskapau Formation and lower part of the Puskwaskau Formation along the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: These Foothills specimens with their finely agglutinated walls and nearly smooth exteriors are readily identifiable with those specimens illustrated by the author from the lower part of the Puskwaskau Formation on the lower Smoky River, which is the approximate stratigraphic equivalent of the Dowling Member.

Superfamily LITUOLACEA de Blainville, 1825

Family HORMOSINIDAE Haeckel, 1894

Genus REOPHAX de Montfort, 1808

REOPHAX PEPPERENSIS Loeblich

Plate 7, figures 1, 2

Reophax pepperensis Loeblich, 1946, Jour. Paleont., vol. 20, no. 2, p. 133, pl. 22, figs. 1a-b—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 58, pl. 1, figs. 12a-b—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 133, pl. 30, fig. 14—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 892-893, pl. 105, fig. 8.

Description: Test small, elongate, straight to slightly curved, mainly round in cross section; six to seven chambers, the later four to five of nearly equal length and width; sutures fairly distinct, nearly transverse, considerably depressed; wall agglutinated, surface somewhat rough, replaced by pyrite in some specimens; aperture terminal, obscured, apparently an elliptical slit; color orange in nonpyritized specimens.

Dimensions:	Length (mm.)	Width (mm.)
Hypotype MF 5056 (fig. 1)	0.65	0.13
Hypotype MF 5057 (fig. 2)	0.51	0.13

Types: Hypotype MF 5056 is from the upper part of the Dowling Member of the Wapiabi Formation on Thistle Creek, 813 feet above the base of the formation.

Hypotype MF 5057 is from the Dowling Member on Mistanusk Creek, 470 feet above the contact of the Cardium and Wapiabi Formations, or 184 feet above the top of the Bad Heart Sandstone.

Distribution: This species seems rather rare and of little stratigraphic importance within the Wapiabi Formation. It was recorded at various Foothills localities from the Dowling, Thistle and Hanson Members.

R. pepperensis was described originally from the Pepper Shale (Cenomanian) of Texas. It has been subsequently reported by Tappan from the Seabee Formation (Turonian) of Alaska and by Eicher from the Graneros Shale (Cenomanian) of Colorado. If the Alberta specimens are correctly referred to this species, its range would be extended into Santonian strata.

Remarks: The Foothills specimens differ from the holotype in being about half the size and in tapering less. Forms subsequently referred to this species by Tappan and by Eicher, however, seem to differ little, if any, from the Alberta specimens.

REOPHAX sp. 1

Plate 5, figures 3-5

Reophax sp. A, Wall, 1960, Res. Coun. Alberta Bull. 6, p. 14, pl. 3, fig. 10.

Description: Test round to oval in cross section, of two to four chambers with three in most specimens, in a straight or nearly straight series, somewhat constricted; sutures indistinct, transverse or nearly transverse, deeply depressed; wall agglutinated, of coarse quartz, chert and other mineral grains, with little cement, surface very rough; aperture terminal, simple.

Dimensions:	Length (mm.)	Width (mm.)
Specimen MF 5058 (fig. 3)	0.66	0.28
Specmien MF 5059 (fig. 4)	0.66	0.26
Specimen MF 5060 (fig. 5)	0.70	0.29

Types: The figured specimens are from the Muskiki Member of the Wapiabi Formation on Thistle Creek, 75 feet above the base of the formation.

Distribution: This species is rare to fairly common in the Muskiki, Marshybank and Dowling Members of the Wapiabi Formation in the Foothills and is also present in the Cardium Formation on the Little Berland River.

The species was described by the author from the upper part of the Kaskapau Formation along the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: As noted by the author (1960), this species bears some similarity to *Reophax constrictus* (Reuss) Cushman (1946, p. 16, pl. 1, figs. 21, 22) from the Upper Cretaceous of the Gulf Coast region of the United States. The chambers in the Gulf Coast species seem more spherical, however, and the wall structure appears different with a larger amount of cement.

REOPHAX sp. 2

Plate 10, figures 5, 6

Reophax sp. B, Wall, 1960, Res. Coun. Alberta Bull. 6, p. 14, pl. 3, fig. 9.

Description: Test large, round to oval in cross section, of two to four chambers with three in most specimens, in straight series; chambers subglobular, slightly constricted, middle chamber smaller than others, terminal chamber extended as a neck-like projection in most specimens; sutures indistinct, transverse, deeply depressed; wall agglutinated, of coarse quartz, chert and other mineral grains, with little cement, surface rough; aperture terminal, elliptical.

Dimensions:	Length (mm.)	Width (mm.)
Specimen MF 5061 (fig. 5)	0.91	0.40
Specimen MF 5062 (fig. 6)	1.08	0.37

Types: The figured specimens are from the lowest part of the Thistle Member of the Wapiabi Formation on Mill Creek, in beds transitional to the underlying Dowling Member, 654 feet above the base of the formation.

Distribution: This species is most prominent at the above locality, with about 50 specimens being observed at the above level and through an approximate 100-foot interval of overlying beds. It is rare or was not recognized at other Foothills localities.

This species was described by the author from the upper part of the Kaskapau Formation along the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: As indicated by the author (1960), this species may be the same as *Reophax* sp. 1. It was then, as now, considered as a separate taxonomic entity because of its more robust test.

Reophax sp. 2 seems similar to a form referred to *R. recta* (Beissel) by Fox (1954, p. 110, pl. 24, fig. 1) from the basal part of the Upper Cretaceous Cody Shale at Greybull, Wyoming.

Reophax sp. 3

Plate 7, figure 3

Description: Test large, slightly curved in early portion, strongly compressed; four to six chambers, gradually increasing in length and width but irregularly developed in some specimens, typically scalloped in part; sutures somewhat oblique in early portion, transverse in later portion, depressed, indistinct to moderately prominent where their positions outlined by crushing; wall fairly coarsely agglutinated, surface rough; aperture terminal, at end of short neck; color greyish-brown.

Dimensions:	Length (mm.)	Width (mm.)
Specimen MF 5063	1.84	0.66

Types: The figured specimen is from the Dowling Member of the Wapiabi Formation on Mill Creek, 544 feet above the base of the formation.

Distribution: This species was observed only from the Dowling Member at the above locality.

Remarks: This species shows a general similarity to *R. deckeri* Tappan from the Lower Cretaceous Grayson Formation of Texas but it lacks the very prominent neck of the latter.

Reophax sp. 4

Plate 11, figures 9, 10

Description: Test elongate, strongly compressed, flat; six to seven chambers increasing very gradually in length and width beyond proloculum, somewhat constricted at the sutures, final chamber truncate; sutures indistinct, nearly transverse, considerably depressed; wall agglutinated, surface nearly smooth to somewhat rough; aperture terminal, a small elliptical slit; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5064 (fig. 9)	0.84	0.28
Specimen MF 5065 (fig. 10)	0.57	0.18

Types: Specimen MF 5064 is from the Hanson Member of the Wapiabi Formation on Mill Creek, about 275 feet below the base of the Belly River Formation.

Specimen MF 5065 is from the Thistle Member of the Wapiabi Formation on Dungarvan Creek.

Distribution: This species was recorded mainly from the Thistle and Hanson Members of the Wapiabi Formation in the Crowsnest Pass and Waterton areas.

Remarks: This species shows a considerable resemblance to *R. minuta* Tappan, described originally from the Lower Cretaceous Grayson Formation of Texas, and later reported by Tappan (1962) from Albian strata in Alaska and by Eicher (1965) from Cenomanian beds in Colorado. The two forms seem similar in size, shape of test and general wall structure, but the holotype of *R. minuta* as illustrated shows three or four more chambers.

Family Rzehakinidae Cushman, 1933

Genus Miliammina Heron-Allen and Earland, 1930

Miliammina awunensis Tappan

Plate 4, figures 14-19

Miliammina awunensis Tappan, 1957, U.S. Nat. Mus. Bull. 215, p. 210-211, pl. 67, figs. 19-21—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 159-160, pl. 36, figs. 20-24.

Description: Test small, subelliptical in outline, chamber arrangement quinqueloculine; chambers somewhat inflated with four visible on one side of test and three on opposite side; sutures distinct, depressed; wall

finely agglutinated with much cement, surface smooth; aperture obscure, apparently a restricted opening at end of last chamber; color buff to grey-white.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5066 (figs. 14-16)	0.26	0.14
Hypotype MF 5067 (figs. 17-19)	0.26	0.15

Types: The hypotypes are from the Opabin Member of the Blackstone Formation on Ghost River, 26 to 38 feet below the base of the overlying Cardium Formation.

Distribution: In the Foothills this species was observed only at the above locality and level with 12 specimens recorded.

Tappan described this species from Albian strata in northern Alaska, at a lower stratigraphic level than this Foothills occurrence in Turonian beds.

Remarks: The Foothills specimens are about one-third smaller than the holotype but come within the lowest size range of the paratypes and appear similar in other respects.

MILIAMMINA MANITOBENSIS Wickenden

Plate 1, figures 1-6

Miliammina manitobensis Wickenden, 1932, Trans. Roy. Soc. Can., 3rd ser., vol. 26, sec. 4, p. 90, pl. 1, figs. 11a-c—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 48, pl. 14, figs. 4-6—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 71, pl. 5, figs. 15, 16—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 160, pl. 36, figs. 12-18—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 893, pl. 103, figs. 8, 9.

Description: Test medium size, subquadrate in outline, compressed; chamber arrangement quinqueloculine, four chambers visible on one side of test, three on opposite side, sutures fairly distinct, depressed; wall very finely agglutinated or siliceous with much cement, surface smooth; aperture a simple opening, slightly produced at end of last chamber; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5068 (figs. 1-3)	0.43	0.24
Hypotype MF 5069 (figs. 4-6)	0.34	0.21

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotype MF 5068 is from just above a 1-foot sandstone bed marking the base of the exposure of the Blackstone Formation on Cripple Creek, about 15 feet above the exposed top of the underlying Blairmore Group.

Hypotype MF 5069 is from the railroad cut at Cadomin, 2 to 5 feet above the contact with the underlying Mountain Park Formation.

Distribution: In addition to its occurrences in the Sunkay Member of the Blackstone Formation of the central Foothills noted above, this species is also present in the basal beds of the Fort St. John Group on Little Berland River in the northern Foothills. It is absent from the southern Foothills, its temporal position in this area being cut out by the onlap of progressively younger marine beds on the Blairmore Group.

This species has a wide distribution in upper Albian strata of Western Canada, having been described by Wickenden from the Ashville Beds of Manitoba and reported by Nauss (1947) from the middle part of the Lloydminster (=Colorado) Shale of east-central Alberta. It is also present in correlative beds from the lower part of the Shaftesbury Formation in the Peace River Plains region in northwestern Alberta (Gleddie, 1954). Eicher recorded this species from the Shell Creek Shale of Wyoming and from the Mowry and Graneros Shales of Colorado. Tappan reported it, in ascending order, from the upper part of the Torok Formation, and the Topagoruk and Grandstand Formations of northern Alaska.

Family Lituolidae de Blainville, 1825

Genus Haplophragmoides Cushman, 1910

Haplophragmoides bonanzaense Stelck and Wall

Plate 4, figures 1, 2

Haplophragmoides bonanzaense Stelck and Wall, 1954, Res. Coun. Alberta Rept. 68, p. 24, pl. 2, figs. 10a-b.

Haplophragmoides bonanzaensis Stelck and Wall. Tappan, 1962 (part), U.S. Geol. Surv. Prof. Paper 236-C, p. 133-134, pl. 30, figs. 16, 18, 19 (not fig. 17).

Description: Test small to medium size, slightly compressed, planispiral, nearly involute with only small portion of penultimate whorl visible, shallow umbilici developed, periphery rounded; chambers of nearly equal size, somewhat inflated, six to seven in final whorl; sutures distinct, depressed, radial; wall agglutinated, with moderate amount of cement, surface fairly smooth; aperture obscure, a low arch at the base of the terminal face; color pale buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5070	0.30	0.12

Types: Hypotype MF 5070 is from the Haven Member of the Blackstone Formation on Ghost River, 10 feet below the top of the member and 116 feet below the base of the Cardium Formation.

Distribution: In the Foothills this species is most prominent in the upper part of the Blackstone Formation on Ghost River. It seems rare at the same level on Burnt Timber Creek and is questionably present at Cadomin.

This species was described from the central part (Turonian) of the Kaskapau Formation in the Peace River area of northwestern Alberta and northeastern British Columbia. Tappan recorded it from the Seabee Formation (Turonian) and Schrader Bluff Formation (Senonian) of northern Alaska.

Remarks: This species is somewhat similar to *H. howardense* Stelck and Wall from the Kaskapau Formation of the Peace River area but differs in being nearly involute with fewer chambers, as noted by these authors. Young specimens of *H. howardense* are difficult to distinguish from *H. bonanzaense*, however, and it may not be practical to continue recognition of both species.

Haplophragmoides crickmayi Stelck and Wall

Plate 4, figures 3, 4; Plate 5, figures 10, 11;

Plate 8, figures 12-15; Plate 10, figures 18, 19

Haplophragmoides crickmayi (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 10, 12, 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 47-49, pl. 2, figs 22, 23.

Description: Test medium size, somewhat compressed, planispiral, nearly involute, periphery angular to narrowly rounded; five to six and one-half chambers in outer whorl, the last four of approximately equal size; sutures distinct, flush, slightly curved with occasional sigmoidal deviations, thickened; wall finely agglutinated, replaced by pyrite in most specimens, considerable amount of cement, surface smooth; aperture obscure, a low slit-opening at the base of the terminal face; color usually green from pyritization, otherwise light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5071 (pl. 4, figs. 3, 4)	0.28	0.13
Hypotype MF 5072 (pl. 5, figs. 10, 11)	0.53	0.22
Hypotype MF 5073 (pl. 8, figs. 12, 13)	0.51	0.31
Hypotype MF 5074 (pl. 8, figs. 14, 15)	0.59	0.26
Hypotype MF 5075 (pl. 10, figs. 18, 19)	0.53	0.22

Types: Hypotype MF 5071 is from the Haven Member of the Blackstone Formation on Ghost River, 10 feet below the top of the member and 116 feet below the base of the Cardium Formation.

Hypotype MF 5072 is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Hypotype MF 5073 is from the Dowling Member of the Wapiabi Formation in the Canada Cement Company quarry at Seebe in the Morley area of the central Foothills, about 550 feet above the base of the formation.

Hypotype MF 5074 is from the Dowling Member of the Wapiabi Formation on Oldfort Creek, 461 feet above the base of the formation.

Hypotype MF 5075 is from the Thistle Member of the Wapiabi Formation on Mill Creek, 715 feet above the base of the formation.

Distribution: In the Foothills this species is erratically distributed from the upper part of the Blackstone Formation to the Thistle Member of the Wapiabi Formation.

It was described from a lower stratigraphic level, the basal part (Cenomanian) of the Kaskapau Formation, in the Peace River area of northwestern Alberta and northeastern British Columbia.

Remarks: Specimens from the Blackstone Formation tend to be smaller than those from the type locality of this species, whereas those from the Wapiabi Formation are somewhat larger than the types and may have an additional chamber. Such differences seem of insufficient magnitude to prevent assignment of these Foothills specimens to this species.

Although one hypotype (MF 5071) is illustrated with the fauna from the upper part of the Blackstone Formation, the species is not characteristic of this interval. This hypotype was mistakenly identified as *H. bonanzaense* in preliminary investigation and the error not discovered until the organization of plate 4 was completed in final form.

Haplophragmoides howardense Stelck and Wall

Plate 4, figures 5-7; Plate 5, figures 6-9; Plate 10, figures 16, 17

Haplophragmoides howardense Stelck and Wall, 1954, Res. Coun. Alberta Rept. 68, p. 25-26, pl. 1, fig. 20; pl. 2, figs. 5, 6.

Description: Test medium size, somewhat compressed, planispiral, evolute with penultimate whorl and proloculum usually visible, periphery normally rounded but subangular in the more compressed specimens; chambers of nearly equal size, somewhat inflated, between eight and nine in final whorl; sutures distinct, slightly depressed, slightly curved to radial, thickened; wall finely agglutinated, with much cement, surface smooth;

aperture obscure, an arched opening at the base of the terminal face; color light buff to light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5076 (pl. 4, figs. 5, 6)	0.29	0.09
Hypotype MF 5077 (pl. 4, fig. 7)	0.34	0.09
Hypotype MF 5078 (pl. 5, figs. 6, 7)	0.28	0.12
Hypotype MF 5079 (pl. 5, figs. 8, 9)	0.26	0.11
Hypotype MF 5080 (pl. 10, figs. 16, 17)	0.30	0.10

Types: Hypotypes MF 5076 and 5077 are from the Haven Member of the Blackstone Formation on Ghost River, 29 feet below the top of the member and 135 feet below the base of the Cardium Formation.

Hypotype MF 5078 is from the Muskiki Member of the Wapiabi Formation on Thistle Creek, 105 feet above the base of the formation.

Hypotype MF 5079 is from the Muskiki Member of the Wapiabi Formation on Little Berland River, 195 feet (estimated) above the base of the formation.

Hypotype MF 5080 is from the Thistle Member of the Wapiabi Formation on Belcourt Creek, 310 feet below the base of the Chinook Sandstone.

Distribution: This species ranges through most of the Alberta Group in the Foothills, being generally more prominent in the upper part of the Haven, the Opabin and Muskiki Members.

It was described from the central part (Turonian) of the Kaskapau Formation in the Peace River area of northwestern Alberta and northeastern British Columbia, from levels stratigraphically below those of the Foothills occurrences.

HAPLOPHRAGMOIDES HOWARDENSE MANIFESTUM Stelck and Wall

Plate 8, figures 10, 11; Plate 11, figures 12, 13

Haplophragmoides howardense manifestum Stelck and Wall, 1954, Res. Coun. Alberta Rept. 68, p. 26-28, pl. 1, figs. 3-5, 18; pl. 2, figs. 1, 2.

Description: Test medium to large size, somewhat compressed, planispiral, completely evolute with wide shallow umbilicus exposing all earlier chambers and proloculum on both sides of test, periphery rounded to narrowly rounded, peripheral outline straight to slightly indented; chambers

comprising two to three whorls, nine to twelve in outer whorl, of about the same size, somewhat inflated in some specimens; sutures distinct, slightly depressed, slightly curved, thickened; wall finely agglutinated, with much cement, surface smooth; aperture obscure, an arched opening at the base of the terminal face; color light buff to light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5081 (pl. 8, figs. 10, 11)	0.60	0.14
Hypotype MF 5082 (pl. 11, figs. 12, 13)	0.38	0.09

Types: Hypotype MF 5081 is from the Dowling Member of the Wapiabi Formation on Mistanusk Creek, 164 feet above the top of the Bad Heart Sandstone.

Hypotype MF 5082 is from the Hanson Member of the Wapiabi Formation on Belcourt Creek, 189 feet below the base of the Chinook Sandstone.

Distribution: The range of this subspecies coincides approximately with that of *H. howardense howardense,* but it is much less common than the latter.

Remarks: There are apparently many specimens transitional between this subspecies and *H. howardense howardense,* which factor may be reflected in some occurrence records being estimates rather than accurate counts.

HAPLOPHRAGMOIDES sp. cf. H. ROTA Nauss

Plate 14, figures 5-8

?*Haplophragmoides rota* Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 339, pl. 49, figs. 1a-b, 3a-b—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 134, pl. 31, figs. 16-18—North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 13, pl. 1, fig. 11.

Description: Test large, compressed, planispiral, partly evolute with portion of penultimate whorl and possibly the proloculum visible, very shallow umbilici developed, periphery narrowly rounded; chambers increasing gradually in size, nine to ten in outer whorl; sutures indistinct, flush, nearly radial, thickened; wall agglutinated with considerable range in size of grains, moderate amount of cement, surface somewhat rough; aperture obscure, apparently a low slit-opening at the base of the terminal face; color light brown to brownish-white.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5083 (fig. 5)	0.72	0.14
Specimen MF 5084 (fig. 6)	0.81	0.14
Specimen MF 5085 (figs. 7, 8)	1.04	0.24

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: This species is present in the Nomad Member or transition beds and the Hanson Member, and possibly occurs lower in the Wapiabi Formation in the Foothills.

Identical forms have been observed by the author from the "Upper Pakowki Formation" of the Milk River area in southeastern Alberta.

Remarks: This species may be identical to *H. rota* Nauss from the Grizzly Bear Member of the Belly River Formation in east-central Alberta but lacks the homogeneous wall structure of the latter and has thickened instead of plain sutures. It seems that this species or one closely related is a fairly constant component of several shallow, regressive, brackish-water faunas in Alberta.

HAPLOPHRAGMOIDES sp. 1

Plate 1, figures 22-24

Haplophragmoides sp. A, Stelck and Wall, 1958, *in* Stelck, Wall and Wetter, Res. Coun. Alberta Bull. 2, p. 27, pl. 3, figs. 15, 16.

?*Haplophragmoides* sp. A, Stelck and Wall, 1956, *in* Stelck, Wall, Bahan and Martin, Res. Coun. Alberta Rept. 75, p. 40, pl. 1, fig. 26.

Description: Test medium size, compressed, planispiral, partly evolute with portion of inner whorl exposed, shallow umbilici developed, periphery subangular; about ten nearly equal chambers in outer whorl, slightly scalloped; sutures indistinct, slightly depressed, nearly straight; wall very finely agglutinated, with much translucent cement imparting resinous luster to smooth surface; aperture obscure, a low arch at the base of the terminal face; color light brown.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5086 (figs. 22, 23)	0.46	0.11
Specimen MF 5087 (fig. 24)	0.49	0.11

Types: The figured specimens are from the Sunkay Member of the Blackstone Formation in the railroad cut at Cadomin, 2 to 5 feet above the contact with the underlying Mountain Park Formation.

Distribution: In the central Foothills this species is present also on Cripple Creek from the same level as at Cadomin. It was observed from the basal beds of the Fort St. John Group on Little Berland River in the northern Foothills.

It is present in the upper St. John Shale of northeastern British Columbia at a somewhat higher stratigraphic level, above the "fish-scale sand" (Stelck, Wall and Wetter, 1958).

Remarks: *Haplophragmoides* sp. 1 is probably the same as *Haplophragmoides* sp. A (questionable synonymic entry) from the stratigraphically lower Moosebar Shale of northeastern British Columbia but is larger and more evolute than the latter species.

This species is rather featureless and, as similar forms with the characteristic resinous luster appear at several levels in the Cretaceous of the general region, it is of little stratigraphic value.

Haplophragmoides sp. 2

Plate 11, figures 14-16

Description: Test medium to fairly large size, very strongly compressed and flattened, planispiral, evolute with portion of earlier whorls and proloculum visible, periphery angular, peripheral outline very slightly lobulate; eight to eleven chambers in outer whorl; sutures very indistinct, flush, nearly straight; wall very thin, finely agglutinated or siliceous, with considerable cement, surface smooth and vitreous; aperture not observed; color light brown.

Dimensions:

	Diameter (mm.)	Thickness (estimated) (mm.)
Specimen MF 5088 (fig. 14)	0.51	0.04
Specimen MF 5089 (figs. 15, 16)	0.75	0.05

The size of Specimen MF 5088 is average for the species.

Types: The figured specimens are from the Hanson Member of the Wapiabi Formation on Mill Creek, about 250 feet below the base of the Belly River Formation.

Distribution: This species is present in the Thistle and Hanson Members and the transition beds of the Wapiabi Formation in the Crowsnest Pass and Waterton areas. It is the most prominent component of many samples from these members.

Remarks: This collapsed, thin-walled form may represent a local type of preservation of some previously described species such as *H. collyra* or *H. rota* Nauss. It appears nearly featureless in reflected light, but some characters such as the sutures can be partly determined in transmitted light.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES FRAGMENTARIUS Cushman

Plate 1, figures 7-9

Ammobaculites fragmentaria Cushman, 1927, Trans. Roy. Soc. Can., 3rd ser., vol. 21, sec. 4, p. 130, pl. 1, fig. 8.

Ammobaculites fragmentarius Cushman. Stelck and Wall, 1956, *in* Stelck, Wall, Bahan and Martin, Res. Coun. Alberta Rept. 75, p. 21-22, pl. 5, fig. 18—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 61-62, pl. 4, fig. 11—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 136-138, pl. 32, figs. 8-11 (synonymy in part only; several species are included)—Crespin, 1963, Australia Bur. Min. Resources Bull. 66, p. 39, pl. 7, fig. 15.

Not *Ammobaculites fragmentarius* Cushman—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 23, pl. 3, figs. 10-16—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 62, pl. 2, figs. 16-18.

Description: Test strongly compressed; early portion close coiled, of four to five indistinct chambers; later portion uniserial, of three to six chambers wider than high, and in some specimens increasing gradually in width as added giving test tapered appearance; sutures indistinct, radial in coiled portion, fairly distinct in uniserial portion, essentially transverse, depressed; wall finely agglutinated or siliceous, with much cement, surface fairly smooth and semivitreous; aperture terminal, simple to elliptical; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5090 (fig. 7)	0.83	0.27
Hypotype MF 5091 (fig. 8)	0.83	0.30
Hypotype MF 5092 (fragment, fig. 9)	0.71	0.43

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation in the railroad cut at Cadomin, 2 to 10 feet above the contact with the underlying Mountain Park Formation.

Distribution: This species is probably present at Cripple Creek in the central Foothills from the same level as at Cadomin. It was also observed from the basal beds of the Fort St. John Group on Little Berland River in the northern Foothills.

This species is a common constituent of the microfauna above the Viking Sand in the subsurface Colorado Shale of central Alberta but also occurs at lower stratigraphic levels. It has been reported from a number of regions in the North American continent outside of Western

Canada, but it is doubtful if the specimens involved are properly referred to *A. fragmentarius* with the probable exception of those illustrated by Eicher and by Tappan.

Remarks: Tappan has proposed a lengthy synonymy embracing several names of species from the Cretaceous of Western Canada previously recognized as distinctive taxonomic units by various workers. The author concedes that *A. humei* Nauss is possibly a synonym of *A. fragmentarius* but after examining the types rejects the equating of *A. coprolithiforme* (Schwager) Cushman, 1927 and *A. tyrrelli* Nauss with this species. Tappan also included *Reophax texana* Cushman and Waters of Wickenden, 1932 (not Cushman and Waters, 1927) with *A. fragmentarius*, but the author believes it should be only compared with the latter and has done this herein.

Tappan's synonymy seems to be at least partly based on the practice of using suites of specimens from areas far distant from the type area of a species to alter or emend the characters of that species. In the author's opinion any such emendation should be based on topotype material; otherwise, the whole concept of recognizing a fossil species based on a morphological type or types with a designated type locality and stratigraphic level is rendered inoperable.

AMMOBACULITES sp. cf. A. FRAGMENTARIUS Cushman

Plate 7, figures 18-20

Reophax texana Cushman and Waters. Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 204, pl. 29, fig. 1 (not *Reophax texana* Cushman and Waters, 1927).

?*Ammobaculites coprolithiformis* (Schwager). Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 204-205, pl. 29, fig. 2.

Description: Test small to medium size, cylindrical to compressed; early portion close coiled, of about four indistinct chambers; later portion uniserial, of two to four chambers of about equal dimensions, somewhat constricted at the sutures; sides of test nearly parallel; sutures very indistinct in coiled portion, indistinct in uniserial portion, essentially transverse, depressed; wall agglutinated, moderate amount of siliceous-appearing cement, surface somewhat rough; aperture terminal, simple to slightly produced; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5093 (fig. 18)	0.46	0.21
Specimen MF 5094 (fig. 19)	0.57	0.20
Specimen MF 5095 (fig. 20)	0.75	0.20

Types: The figured specimens are from the Dowling Member of the Wapiabi Formation on Mill Creek, 564 feet above the base of the formation.

Distribution: This species was recorded in the Foothills from the Cardium Formation to the Thistle Member of the Wapiabi Formation. It is common to abundant in the Dowling and Thistle Members at Mill Creek.

Remarks: This species may be identical to *A. fragmentarius*, as suggested by Tappan, but a study of assemblages shows it to be somewhat smaller with fewer chambers in the uniserial portion, to have parallel sides with no tendency toward tapering, and to have a rougher finish with poorly defined features.

Although both of the above synonymic entries were included in the synonymy of *A. fragmentarius* by Tappan (1962), the author, after examing Wickenden's figured specimens, believes that there is some doubt as to whether these forms are identical. The figured specimen of *A. coprolithiformis* (Schwager) Wickenden is more slender and elongate, seems to have more chambers in the coiled portion, and its features are better defined than those in the specimen of *R. texana*. However, such differences should be regarded perhaps only as individual variations, and for practical purposes the two forms may be considered identical.

Ammobaculites sp. 1

Plate 5, figures 1, 2

Description: Test rather small, cylindrical; early portion close coiled but not completely involute, fairly distinct, with about five chambers visible in outer whorl, the coil forming the greatest width of the test; later portion uniserial, of three chambers of about equal dimensions; sides of test nearly parallel; sutures distinct, radial in coiled portion, transverse to oblique in uniserial portion, depressed; wall agglutinated, partly replaced by pyrite in some specimens, considerable amount of cement, surface somewhat rough; aperture terminal, simple; color buff to orange in non-pyritized specimens.

Dimensions:

	Length (mm.)	Diameter of coil (mm.)	Width of uniserial portion (mm.)
Specimen MF 5096 (fig. 1)	0.49	0.20	0.14
Specimen MF 5097 (fig. 2)	0.55	0.18	0.14

Types: The figured specimens are from the Wapiabi Formation on Thistle Creek.

Specimen MF 5096 is from the Muskiki Member, 105 feet above the base.

Specimen MF 5097 is from the Marshybank Member, 205 feet above the base of the formation.

Distribution: This form was identified only from the above members on Thistle Creek, but it may be present at other localities in the Foothills, its occurrences not having been separated from those of *Ammobaculites* sp. cf. *A. fragmentarius*.

Remarks: This form may represent a local superior type of preservation of *Ammobaculites* sp. cf. *A. fragmentarius*, but as its features are much more distinct, it is described and figured separately.

Ammobaculites sp. 2

Plate 10, figures 10-12

Description: Test medium to large size, robust to somewhat compressed; early portion close coiled, involute, indistinct, of three to four chambers, the coil forming the greatest width of the test in most specimens; later portion uniserial, of two to three, rarely four, chambers of approximately equal dimensions; sutures indistinct, depressed and nearly transverse in uniserial portion; wall agglutinated with fairly coarse grains, moderate amount of siliceous cement, surface rough; aperture round to elliptical, terminal, produced; color grey or colorless.

Dimensions:

	Length (mm.)	Diameter of coil (mm.)	Width of uniserial portion (mm.)
Specimen MF 5098 (fig. 10)	1.03	0.34	0.42
Specimen MF 5099 (fig. 11)	1.20	0.42	0.34
Specimen MF 5100 (fig. 12)	1.43	0.50	0.43

Types: The figured specimens are from the lowest part of the Thistle Member of the Wapiabi Formation on Mill Creek, in beds transitional to the underlying Dowling Member, 654 feet above the base of the formation.

Distribution: This species is most prominent in the Thistle Member on Mill Creek, but it was also recorded from the underlying Dowling and Marshybank Members at various localities in the southern and central Foothills.

Remarks: This species bears a general resemblance to *Reophax* sp. 2 of this publication but possesses a coiled portion although this is somewhat indistinct.

Ammobaculites? sp. 3

Plate 14, figures 1-4

Description: Test fairly large, compressed, consisting of a partly evolute coiled portion only; shallow umbilici developed, periphery sharp, per-

ipheral outline somewhat indented; about eight chambers in outer whorl, partly scalloped, final chamber rectangular in outline; sutures indistinct, radial, flush to slightly depressed, their positions emphasized in part by crushing of the chambers; wall agglutinated with fairly coarse grains, moderate amount of cement, surface rough; aperture an elongate slit on the narrow septal face extending from outer point of periphery to base of last chamber; color grey.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5101 (figs. 1, 2)	0.95	0.13
Specimen MF 5102 (figs. 3, 4)	0.95	0.18

Types: The figured specimens are from the transition beds of the Wapiabi Formation.

Specimen MF 5101 is from Mill Creek, 79 feet below a 30-foot massive sandstone unit regarded as the base of the Belly River Formation.

Specimen MF 5102 is from Dungarvan Creek.

Distribution: This species as herein described and illustrated is associated with the transition beds on Mill and Dungarvan Creeks, although it is probably present lower in the Wapiabi Formation. The latter representatives, however, are considerably smaller and may not belong to this species.

Genus Flabellammina Cushman, 1928

Flabellammina magna Alexander and Smith

Plate 8, figure 5; Plate 10, figures 1-4

Flabellammina magna Alexander and Smith, 1932, Jour. Paleont., vol. 6, no. 4, p. 306-307, pl. 46, figs. 10, 11—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 25, pl. 4, figs. 7-8—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 64, pl. 3, figs. 13, 14.

Description: Test large, thick, somewhat compressed; early portion coiled, indistinct, of three to four chambers; later portion uniserial, of three to six chambers, increasing in width as added, more rapidly in presumed microspheric form than in megalospheric form, where apertural end may be somewhat pointed (pl. 10, figs. 3, 4); sutures indistinct, arched and depressed in uniserial portion; wall agglutinated with generally coarse grains, moderate amount of cement, surface rough in most specimens; aperture terminal, elliptical, indistinct; color usually grey, occasionally light orange.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5103 (pl. 8 ,fig. 5) =microspheric? form	1.37	0.84	0.15
Hypotype MF 5104 (pl. 10, fig. 1) =juvenile, microspheric? form	1.38	0.99	0.22
Hypotype MF 5105 (pl. 10, fig. 2) =adult, microspheric? form	2.34	1.35	0.34
Hypotype MF 5106 (pl. 10, fig. 3) =juvenile, megalospheric? form	1.61	0.79	0.24
Hypotype MF 5107 (pl. 10, fig. 4) =adult, megalospheric? form	1.84	0.82	0.21

Types: Hypotype MF 5103 is from the Dowling Member of the Wapiabi Formation on Ram River, 356 feet above the base of the formation.

Hypotypes MF 5104 to 5107 are from the lowest part of the Thistle Member of the Wapiabi Formation on Mill Creek, in beds transitional to the underlying Dowling Member, 654 feet above the base of the formation.

Distribution: This species seems best developed near the upper boundary of the *Brachycythere-Bullopora* assemblage of this publication, which changes position along the Foothills with respect to the rock-stratigraphic units of the Wapiabi Formation. In the Crowsnest Pass and Turner Valley areas, this species is most prominent in the lower part of the Thistle Member or upper part of the Dowling Member, whereas to the north in the Nordegg and Cadomin areas, it is most prominent in the lower part of the Dowling Member or in the Marshybank Member. In the farthest north section studied, on Mistanusk Creek, this species is weakly developed in the Muskiki Member.

In Texas the species is reported by Cushman and by Frizzell from the Taylor Group of Late Cretaceous age.

Remarks: Hypotype MF 5103 from the Ram River differs somewhat from the Mill Creek specimens in being more compressed and in having more distinct sutures and a smoother, light orange surface.

Genus Coscinophragma Thalmann, 1951

Coscinophragma? codyensis (Fox)

Plate 7, figures 8-13

Clavulina? sp., Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 205-206, pl. 29, fig. 5.
Polyphragma sp., Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 51, pl. 15, figs. 15, 16.

Polyphragma codyensis Fox, 1954, U.S. Geol. Surv. Prof. Paper 254-E, p. 113-114, pl. 25, figs. 1-4.

Description: Test generally large, robust, cylindrical in cross section, some specimens curved; early portion close coiled, involute, indistinct, of about four chambers, broken off in nearly all specimens; later portion uniserial, with up to nine low chambers, gradually increasing in width in many specimens, last chamber usually longer than previous ones; sutures indistinct to very indistinct, depressed and nearly transverse in uniserial portion; wall thick, agglutinated with variable-size grains, moderate amount of siliceous cement, surface fairly smooth to somewhat rough; aperture terminal, obscure; color grey to greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5108 (fig. 8) =incomplete curved specimen	1.64	0.59
Hypotype MF 5109 (fig. 9) =incomplete curved specimen	1.07	0.45
Hypotype MF 5110 (fig. 10) =later portion of incomplete specimen	1.00	0.43
Hypotype MF 5111 (fig. 11) =complete specimen with coil	1.79	0.47
Hypotype MF 5112 (fig. 12) =later portion of incomplete specimen	1.55	0.50
Hypotype MF 5113 (fig. 13) =initial portion of incomplete specimen	0.99	0.32

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation on Mill Creek.

Hypotypes MF 5109, 5110, 5112 and 5113 are from 474 feet above the base of the formation.

Hypotypes MF 5108 and 5111 are from 544 and 614 feet, respectively, above the base.

Distribution: This species is common in the Dowling Member at Mill Creek and is also present in the underlying Marshybank Member there and at Oldfort Creek. It is rare in the Muskiki Member of the Wapiabi at Oldfort Creek, Ram River and Thistle Creek.

Wickenden reported this species in the subsurface Alberta Shale of the Plains of southern Alberta, about 420 to 530 feet below the top of the formation, and commented that it marks an easily recognized and consistent horizon. Fox described this species from the lower part of the Cody

Shale at Greybull, Wyoming, and drew attention to its widespread occurrence and stratigraphic significance. The author has collected this distinctive species from an exposure of the medial or second division of the Kevin Shale Member of the Marias River Formation on the MacGowan lease of the Kevin-Sunburst oil field, Toole County, northern Montana.

Remarks: There is some doubt as to whether this species is correctly assigned to the genus *Coscinophragma*. Although it seems to be identical to the one Fox described and assigned to *Polyphragma*, an invalid name replaced by *Coscinophragma* (Loeblich and Tappan, 1964, p. C248), it lacks or fails to reveal because of inferior preservation certain characters of this genus. For example, there is no indication of a cribrate aperture or labyrinthic wall structure, but it is likely that such characters, if present, would have been obliterated by the silicification which most or all of these Foothills specimens have undergone. Also, a few of these specimens seem to have an early coil, a character not included in the description of *Coscinophragma*.

Family TEXTULARIIDAE Ehrenberg, 1838

Genus SPIROPLECTAMMINA Cushman, 1927

SPIROPLECTAMMINA SEMICOMPLANATA (Carsey)

Plate 5, figures 22-29

Textularia semicomplanata Carsey, 1926, Univ. Texas Bull. 2612, p. 25, pl. 3, fig. 4.

Spiroplectammina semicomplanata (Carsey)—Plummer, 1931 (part), Univ. Texas Bull. 3101, p. 129, pl. 8, fig. 7 (not fig. 8)—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 28, pl. 6, figs. 5-14 (synonymy)—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 67, pl. 4, figs. 18a-b.

Description: Test elongate, tapering, compressed with greatest thickness median and edges usually rather sharp, diamond-shaped in cross section; early portion coiled, of about six chambers; later portion biserial, of five to seven pairs of interlocking chambers, considerably wider than high; sutures distinct, slightly depressed, gently curved in coil, curved gently backward toward periphery in biserial portion; wall finely agglutinated, much cement, surface smooth; aperture a broadly arched opening at the base of the last chamber; color buff to light orange.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5114 (figs. 22, 23)	0.37	0.24	0.14
Hypotype MF 5115 (figs. 24, 25)	0.39	0.23	0.13
Hypotype MF 5116 (figs. 26, 27)	0.49	0.25	0.18
Hypotype MF 5117 (figs. 28, 29)	0.59	0.30	0.21

Types: Hypotypes MF 5114 and 5115 are from the Marshybank Member of the Wapiabi Formation on Oldfort Creek, 213 feet above the base of the formation.

Hypotype MF 5116 is from the Muskiki Member of the Wapiabi Formation on Ram River, 214 feet above the base of the formation.

Hypotype MF 5117 is from the Muskiki Member of the Wapiabi Formation on Mistanusk Creek, 160 feet above the contact with the underlying Cardium Formation.

Distribution: This species is one of the most characteristic components of Wapiabi assemblages from the Foothills. Its range extends from the Muskiki into the Thistle Member, but it is rare in the latter except at the Mill Creek and Highwood River localities. It is also present in the Cardium Formation on Little Berland River but was nowhere observed in the underlying Blackstone Formation.

In the Gulf Coast region of the United States, Cushman and Frizzell both reported this species from the Taylor and Navarro Groups of Late Cretaceous age and from the Midway Group of Paleocene age.

Remarks: Hypotype MF 5117 from Mistanusk Creek represents a population in which the wall structure is coarser with the grains plainly visible, the sutures are quite indistinct and the edges tend to be rounded. This northern Foothills population could probably be distinguished from southern relatives and treated as a subspecies.

SPIROPLECTAMMINA sp. 1

Plate 7, figures 14-17

Description: Test small, tapering, very strongly compressed, with the edges sharp; early portion coiled, of five chambers; later portion biserial, of two to four pairs of interlocking chambers, considerably wider than high; sutures distinct, flush to very slightly depressed, curved in coil, oblique in biserial portion; wall thin, finely agglutinated, much cement, surface smooth; aperture a moderately arched opening at the base of the last chamber; color light buff.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5118 (figs. 14, 15) =megalospheric? form	0.21	0.17	0.07
Specimen MF 5119 (figs. 16, 17) =microspheric? form	0.23	0.13	0.07

Unfigured specimens range from 0.16 mm. to 0.32 mm. in length.

Types: The figured specimens are from the Dowling Member of the Wapiabi Formation on Thistle Creek, 667 feet above the base of the formation.

Distribution: In addition to about 12 specimens of this form observed at the above locality, representatives were also identified from the same member at Ram River. It is probably present at other Foothills localities, but as some specimens are gradational to S. *semicomplanata,* they may not have been distinguished from the latter.

Remarks: This form differs from S. *semicomplanata* in being smaller with a more strongly compressed, thin-walled test and in having fewer chambers.

SPIROPLECTAMMINA sp. 2

Plate 14, figures 9-12

Description: Test fairly small, elongate, slightly compressed with rounded periphery; sides of test only slightly tapering, nearly parallel; early portion coiled, of five to six chambers; later portion biserial, of about five pairs of interlocking chambers, somewhat wider than high; sutures distinct, slightly depressed, gently curved in coil, oblique in biserial portion; wall finely agglutinated, much cement, surface smooth; aperture a low opening at the base of the last chamber; color light buff.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5120 (figs. 9, 10) =microspheric? form	0.36	0.15	0.13
Specimen MF 5121 (figs. 11, 12) =megalospheric? form	0.26	0.16	0.11

Unfigured specimens range from 0.16 mm. to 0.45 mm. in length.

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: In addition to about 20 specimens of this form observed at the above locality, representatives were obtained from the underlying Hanson and Thistle Members in the Waterton area. It was also observed from the Thistle Member on Mistanusk Creek in the northern Foothills. It is probably present at other Foothills localities, but as some specimens are gradational to S. *semicomplanata,* they may not have been distinguished from the latter.

Remarks: This form differs from S. *semicomplanata* in having a rounded periphery and nearly parallel sides.

Genus Pseudobolivina Wiesner, 1931

Pseudobolivina rollaensis (Stelck and Wall)

Plate 4, figures 20-23; Plate 7, figures 21-26

Textularia rollaensis Stelck and Wall, 1954, Res. Coun. Alberta Rept. 68, p. 30-31, pl. 1, fig. 17—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 55, pl. 2, figs. 34, 35—Wall, 1960, Res. Coun. Alberta Bull. 6, p. 21-22, pl. 4, figs. 16-19.

Description: Test elongate, tapering, slightly to moderately compressed with the edges rounded to subrounded; initial portion slightly twisted in some specimens and broken off in many others; six to eight pairs of chambers in an interlocking biserial arrangement, of nearly equal dimensions, increasing regularly in size with the last two pairs comprising one third to nearly one half of length of test in most specimens; sutures distinct, oblique, depressed; wall finely agglutinated, partially replaced by pyrite in many specimens, much cement, surface smooth; aperture a prominent notch at the inner margin of the last-formed chamber extending well up onto the terminal face; color buff to light orange in nonpyritized specimens.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5122 (pl. 4, figs. 20, 21)	0.37	0.13	0.09
Hypotype MF 5123 (pl. 4, figs. 22, 23)	0.32	0.12	0.08
Hypotype MF 5124 (pl. 7, figs. 21, 22)	0.71	0.18	0.08
Hypotype MF 5125 (pl. 7, fig. 23)	0.50	0.18	0.07
Hypotype MF 5126 (pl. 7, figs. 24, 25) (initial portion broken off)	0.59	0.17	0.11
Hypotype MF 5127 (pl. 7, fig. 26)	0.53	0.16	0.11

Types: Hypotypes MF 5122 and 5123 are from the Opabin Member of the Blackstone Formation on Ghost River, 26 feet below the base of the overlying Cardium Formation.

Hypotypes MF 5124 and 5125 are from the Dowling Member on Meander Creek (tributary of Belcourt Creek), 150 feet above the Bad Heart Sandstone.

Hypotypes MF 5126 and 5127 are from the Dowling Member of the Wapiabi Formation on Mistanusk Creek, 138 and 164 feet, respectively, above the top of the Bad Heart Sandstone.

Distribution: In the Foothills this species was found to extend from the Haven Member of the Blackstone Formation to the Hanson Member of the Wapiabi Formation, being most prominent in the Dowling Member of the Wapiabi in the upper Wapiti River area.

Its occurrences in the Peace River area reported by Stelck and Wall (1954, 1955) and by Wall (1960) also indicate a long range, from the lower part of the Kaskapau Formation (late Cenomanian) to the lower part of the Puskwaskau Formation (early Santonian).

Remarks: The few specimens observed in the Blackstone are smaller than those from the Wapiabi Formation. A similar size differential was noted by the author (1960) in the Peace River area, where the type specimens from the Kaskapau are considerably smaller than those from the Puskwaskau Formation.

When the authors proposed this species they realized that its slender and slightly twisted test together with its high notch-like aperture were not typical characters of the genus *Textularia*. The author had not been aware of the existence of the genus *Pseudobolivina* Wiesner, to which this species should have been referred, until the publication of the foraminiferal portion of the Geological Society of America Treatise on Invertebrate Paleontology (Loeblich and Tappan, 1964).

Pseudobolivina sp. 1

Plate 4, figure 24; Plate 11, figures 17-24

Description: Test small to medium size, elongate, tapering, slightly compressed with the edges typically rounded, but extremely compressed with sharp periphery in some apparently collapsed specimens; five to six pairs of chambers in an interlocking biserial arrangement, the early pairs quite small and of about equal dimensions, the later pairs increasing regularly in height as added tending to be somewhat higher than wide; sutures distinct, depressed, moderately to strongly oblique; wall finely agglutinated, much cement, surface smooth, thin and collapsed in some specimens, partly replaced by pyrite in some others; aperture terminal, round, slightly produced, not in contact with the base of the last chamber; color light buff to buff in nonpyritized specimens.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5128 (pl. 4, fig. 24)	0.39	0.13	0.09
Specimen MF 5129 (pl. 11, figs. 17, 18)	0.47	0.17	0.11
Specimen MF 5130 (pl. 11, figs. 19, 20)	0.38	0.18	0.12
Specimen MF 5131 (pl. 11, figs. 21, 22)	0.50	0.15	0.10
Specimen MF 5132 (pl. 11, figs. 23, 24)	0.56	0.22	0.03

Types: Specimen MF 5128 is from the Haven Member of the Blackstone Formation on Luscar Creek near Cadomin, about 250 feet below the base of the Cardium Formation.

Specimen MF 5130 is from the Thistle Member of the Wapiabi Formation on Belcourt Creek, 310 feet below the base of the Chinook Sandstone.

Specimens MF 5129 and 5131 are from the Hanson Member of the Wapiabi Formation on Belcourt Creek, 170 feet below the base of the Chinook Sandstone.

Specimen MF 5132 is from the Hanson Member of the Wapiabi Formation on Mill Creek, about 200 feet below the base of the Belly River Formation.

Distribution: The range of this species in the Foothills extends from the Haven Member of the Blackstone Formation to the transition beds of the Wapiabi Formation. Small specimens with high chambers and strongly oblique sutures seem characteristic of the Haven Member. Collapsed specimens with indistinct features are fairly common in the Thistle and Hanson Members of the Wapiabi Formation in the Crowsnest Pass and Waterton areas. This species also was recorded in the upper part of the Kaskapau Formation on Mistanusk Creek, from beds approximately equivalent in stratigraphic position to the Haven Member to the south.

Remarks: This species is similar in chamber arrangement to *P. rollaensis* but has a definite terminal aperture. In poorly preserved material it may be difficult to separate these two species.

The specimens from the Haven Member of the Blackstone Formation with their higher chambers and more oblique sutures possibly should be regarded as representing another taxonomic unit.

Family Trochamminidae Schwager, 1877

Genus Trochammina Parker and Jones, 1859

Trochammina ribstonensis Wickenden

Plate 10, figures 20-25

Trochammina ribstonensis Wickenden, 1932, Trans. Roy. Soc. Can., 3rd ser., vol. 26, sec. 4, p. 90-91, pl. 1, figs. 12a-c—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 50, pl. 15, figs. 9a-c—Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 340, pl. 49, figs. 6a-c—Wall, 1960 (part), Res. Coun. Alberta Bull. 6, p. 27, pl. 5, figs. 10-12 (not figs. 7-9)—Tappan, 1962 (part), U.S. Geol. Surv. Prof. Paper 236-C, p. 154-155, pl. 39, figs. 16, 17 (not figs. 15a-c).

Description: Test very small, compressed, periphery somewhat narrowly rounded, peripheral margin nearly entire; test very low trochospiral, of two and one-half whorls, umbilical side partly evolute with shallow umbilicus; chambers increasing very gradually in size, seven to eight in final whorl; sutures distinct, depressed, curved on both sides of test; wall finely agglutinated, much cement, surface smooth; aperture obscure, apparently a slit at the base of the last chamber extending toward the umbilicus; color grey-buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5133 (figs. 20-22)	0.14	0.05
Hypotype MF 5134 (figs. 23-25)	0.16	0.04

Types: The hypotypes are from the Thistle Member of the Wapiabi Formation.

Hypotype MF 5133 is from Belcourt Creek, 327 feet below the base of the Chinook Sandstone.

Hypotype MF 5134 is from Mistanusk Creek, 390 feet above the top of the Bad Heart Sandstone.

Distribution: Most occurrences of this species were recorded from the Dowling, Thistle and Hanson Members of the Wapiabi Formation in the upper Wapiti River area, that is, from beds above the upper or first white-speckled shale "zone". The species is rare in the Foothills to the south, a few specimens being obtained from the Dowling Member at Little Berland River, Thistle Creek and Ram River.

In the central Foothills it is difficult to determine the relative positions of *T. ribstonensis* and the upper white-speckled shale "zone" or its associated pelagic microfauna, as one or both of the latter features may be absent or weakly developed. It would appear, however, that these positions are nearly coincident, with the range of this species perhaps extending below the upper white-speckled shale "zone".

This species has a wide distribution in the Plains region of Alberta and Saskatchewan, being recorded usually over a short interval above the top of the Colorado Group, which is marked by the uppermost occurrence of the first or upper white-speckled shale "zone". Nauss stated that it is restricted to the lower 40 feet of the Lea Park Formation in the Vermilion area of east-central Alberta, and Wickenden earlier (1941) had mentioned its common occurrence in the same strata of western Saskatchewan. The author reported this species from the Puskwaskau Formation along the lower Smoky River in northern Alberta in association with the upper white-speckled shale "zone" and in beds immediately below this zone. Tappan recorded this species from the Seabee and Schrader Bluff Formations of northern Alaska, but the hypotype (pl. 39, figs. 15a-c) from the latter formation shows such deviation from the holotype and topotypes of this species, that its identification appears doubtful.

Remarks: The Foothills specimens lack the chamber inflation of type-area specimens from east-central Alberta. This factor does not seem to be related to fossilization, as the former do not appear crushed and the peripheral margins are almost entire.

TROCHAMMINA sp. cf. T. RIBSTONENSIS Wickenden

Plate 8, figures 18-20; Plate 10, figures 13-15

Trochammina ribstonensis Wickenden. Wall, 1960 (part), Res. Coun. Alberta Bull. 6, p. 26-27, pl. 5, figs. 7-9 (not figs. 10-12).

Description: Test small to medium size, periphery subangular to narrowly rounded, peripheral margin nearly entire; test low to moderate trochospiral, of two and one-half whorls, umbilical side involute, flat to concave with fairly prominent umbilicus; chambers very gradually increasing in size, the five to seven in final whorl slightly inflated; sutures distinct, slightly depressed, curved on spiral side, slightly curved on umbilical side; wall finely agglutinated, much cement, surface smooth; aperture a low arched slit on the inner margin of the umbilical side of the last chamber extending into the umbilicus; color grey to light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5135 (pl. 8, figs. 18-20)	0.21	0.05
Specimen MF 5136 (pl. 10, figs. 13-15)	0.24	0.09

Types: Specimen MF 5135 is from the Dowling Member of the Wapiabi Formation on Mistanusk Creek, 262 feet above the top of the Bad Heart Sandstone.

Specimen MF 5136 is from the Thistle Member of the Wapiabi Formation on Belcourt Creek, 300 feet below the base of the Chinook Sandstone.

Distribution: This form was recorded from the Dowling, Thistle and Hanson Members of the Wapiabi Formation in the northern and central Foothills, and with a few exceptions it is restricted to strata above the level of the upper or first white-speckled shale "zone". It is rare to uncommon at most localities but is fairly prominent in the Thistle Member on Belcourt Creek. It is generally found in association with specimens referred to *T. ribstonensis* in this report.

Remarks: This form differs from *T. ribstonensis s.s.* in being somewhat larger and in lacking the subglobular chambers and lobulate peripheral margin of type-area specimens, which generally have more chambers. It is identical to a form from the upper white-speckled shale "zone" in the Puskwaskau Formation on the lower Smoky River, which the author (1960) assigned in error to *T. ribstonensis*.

Differences between this form, the one identified in this report as *T. ribstonensis* and type-area specimens, although perceptible, are perhaps of insufficient magnitude to warrant any taxonomic separation.

TROCHAMMINA RUTHERFORDI Stelck and Wall

Plate 2, figures 8-31; Plate 4, figures 8-13

Trochammina rutherfordi (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 10, 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 56-57, pl. 1, figs. 11, 12—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 899-900, pl. 105, figs. 1a-c.

Trochammina rutherfordi variety 1, Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 57-58, pl. 1, figs. 14a-c; pl. 3, figs. 20, 21.

Trochammina rutherfordi variety 2, Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 58-59, pl. 1, figs. 15, 16; pl. 3, figs. 36-37—Stelck and Wall, 1958, *in* Stelck, Wall and Wetter, Res. Coun. Alberta Bull. 2, p. 34, pl. 4, figs. 1-5.

Trochammina sp. cf. *T. rutherfordi* Stelck and Wall, 1958, *in* Stelck, Wall and Wetter, Res. Coun. Alberta Bull. 2, p. 33-34, pl. 4, figs. 6-10.

Trochammina ribstonensis Wickenden subspecies *rutherfordi* Stelck and Wall. Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 155-156, pl. 39, figs. 18-20.

Description: Test small to medium size, periphery rounded (except in compressed specimens), peripheral margin nearly straight to somewhat lobulate; test low trochospiral, of two to three whorls, umbilical side involute with fairly prominent umbilicus; chambers gradually enlarging in size, somewhat inflated, five to eight in final whorl; sutures distinct, depressed, slightly curved on spiral side, radial on umbilical side, thickened in some specimens; wall finely agglutinated, considerable cement, surface smooth; aperture a low opening on the umbilical side of the final chamber between umbilicus and periphery, obscure in most specimens; color buff to mottled buff-brown.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5137 (pl. 2, figs. 8-10)	0.50	0.13
Hypotype MF 5138 (pl. 2, figs. 11-13)	0.29	0.08
Hypotype MF 5139 (pl. 2, figs. 14-16)	0.30	0.07
Hypotype MF 5140 (pl. 2, figs. 17-19)	0.47	0.17
Hypotype MF 5141 (pl. 2, figs. 20-22)	0.40	0.15
Hypotype MF 5142 (pl. 2, figs. 23-25)	0.29	0.09
Hypotype MF 5143 (pl. 2, figs. 26-28)	0.32	0.11
Hypotype MF 5144 (pl. 2, figs. 29-31)	0.36	0.12
Hypotype MF 5145 (pl. 4, figs. 8-10)	0.38	0.16
Hypotype MF 5146 (pl. 4, figs. 11-13)	0.33	0.14

Types: Hypotypes MF 5137 to 5144 are from the Sunkay Member of the Blackstone Formation on Ghost River, 2 feet above the contact with the underlying Blairmore Group.

Hypotype MF 5145 is from the Haven Member of the Blackstone Formation on Ghost River, 241 feet below the base of the Cardium Formation.

Hypotype MF 5146 is from the Haven Member on Luscar Creek near Cadomin, about 270 feet below the base of the Cardium Formation.

Distribution: This species was recorded from the Sunkay and Haven Members of the Blackstone Formation in the Foothills.

It was described originally from the lower part of the Kaskapau Formation in the Peace River Plains region of northern Alberta, and was subsequently reported from the underlying Dunvegan Formation and upper part of the St. John Shale by Stelck, Wall and Wetter (1958). The author also has observed this species in the subsurface of central Alberta from that part of the Colorado Group between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above). Tappan reported this species from the Grandstand (upper Albian) and Ninuluk (Cenomanian) Formations of northern Alaska. Eicher recorded this species from the upper part of the Mowry Shale and from the Graneros Shale in Colorado.

Remarks: Hypotypes MF 5137, 5140, 5141 and 5144 are somewhat larger than the type specimens of *T. rutherfordi s.s.* from the Kaskapau Formation.

Hypotypes MF 5138 and 5139 are compressed and nearly flat but appear to belong to the same taxonomic unit as the previously mentioned hypotypes from the same assemblage.

Hypotypes MF 5142 and 5143 have eight chambers with thickened sutures and formerly would have been designated as *T. rutherfordi* variety 1. It now seems probable, however, as indicated by Tappan (1962), that this variety and also "variety 2" represent only individual variations within the species.

TROCHAMMINA WETTERI Stelck and Wall

Plate 8, figures 21-26; Plate 10, figures 7-9

Trochammina wetteri (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 10, 11, 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 59-60, pl. 2, figs. 1-3, 6a-c—Wall, 1960, Res. Coun. Alberta Bull. 6, p. 27-28, pl. 5, figs. 1-6.

Description: Test medium size, periphery fairly broad and round, peripheral margin lobulate; test low trochospiral in most specimens, of about two and one-half whorls, umbilical side involute with moderate umbilicus developed; four to five chambers in final whorl considerably larger than those in earlier whorls, inflated, globigerinoid; sutures distinct, depressed, very slightly curved on spiral side, straight on umbilical side; wall finely agglutinated, partially replaced by pyrite in some specimens,

much cement, surface smooth; aperture a broadly arched opening on the umbilical side at the base of the last chamber, obscure in these specimens; color grey to yellow-buff in nonpyritized specimens.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5147 (pl. 8, figs. 21-23)	0.28	0.20
Hypotype MF 5148 (pl. 8, figs. 24-26)	0.31	0.12
Hypotype MF 5149 (pl. 10, figs. 7-9)	0.33	0.13

Types: The hypotypes are from the Wapiabi Formation on Mistanusk Creek.

Hypotypes MF 5147 and 5148 are from the Dowling Member, 262 feet above the top of the Bad Heart Sandstone.

Hypotype MF 5149 is from the Thistle Member, 390 feet above the top of the Bad Heart Sandstone.

Distribution: The range of this species in the Foothills seems to extend through most of the Wapiabi Formation, although it is more prominent in the Dowling, Thistle and Hanson Members in the upper Wapiti River area.

This species was described originally from the lower part of the Kaskapau Formation in the Peace River area of the Plains region of northern Alberta and was also reported by the author (1960) from the Puskwaskau Formation on the lower Smoky River in northern Alberta.

Trochammina sp. 1

Plate 5, figures 12-20

Description: Test medium size, compressed, plano-convex with spiral side nearly flat, periphery angular, peripheral outline slightly lobulate; test trochospiral, of two and one-half whorls, umbilical side nearly involute with moderate umbilicus developed; chambers gradually enlarging in size, the six and one-half to seven in final whorl inflated on umbilical side; sutures distinct, slightly thickened, gently curved, flush on spiral side, depressed on umbilical side; wall finely agglutinated, much cement, surface smooth; aperture obscure, apparently a low slit-opening at the base of the last chamber; color light buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5150 (figs. 12-14)	0.28	0.08
Specimen MF 5151 (figs. 15-17)	0.28	0.11
Specimen MF 5152 (figs. 18-20)	0.29	0.09

Types: The figured specimens are from the Muskiki Member of the Wapiabi Formation.

Specimen MF 5150 is from Oldfort Creek, 52 feet above the base of the formation.

Specimens MF 5151 and 5152 are from Highwood River, 27 feet above the base of the formation.

Distribution: This species is a characteristic component of the microfauna of the Muskiki Member of the Wapiabi Formation in the southern and central Foothills, which has been designated as the *Trochammina* sp. 1 assemblage in this publication.

The author also has collected this species from an exposure of the middle unit of the Kevin Shale Member of the Marias River Formation, below the MacGowan concretionary bed, in the Kevin-Sunburst oil field, Toole County, northern Montana.

Remarks: This species with its plano-convex, *Gyroidina*-like outline is similar in this respect to *T. gyroides* Cushman and Waters from the Upper Cretaceous Navarro Group of Texas, but the Foothills form is considerably less convex and has more chambers and better defined sutures than the Texas species. *Trochammina* sp. 1 has probably not been hitherto described, but as new names are not being proposed herein, it is left as a *nomen apertum*.

TROCHAMMINA sp. 2

Plate 11, figures 1-8

Description: Test medium to fairly large size, strongly compressed, flattened, periphery acute, peripheral margin lobulate; whorls and chambers indistinct, between five and six chambers in outer whorl; sutures indistinct, nearly straight; wall thin, finely agglutinated, with much siliceous cement imparting resinous luster, surface smooth; aperture not observed; color light brown.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5153 (figs. 1-3)	0.41	0.05
Specimen MF 5154 (figs. 4, 5)	0.37	0.04
Specimen MF 5155 (figs. 6-8)	0.49	0.09

Unfigured specimens range from 0.23 mm. to 0.55 mm. in diameter.

Types: The figured specimens are from the Hanson Member of the Wapiabi Formation on Mill Creek, about 200 feet below the base of the Belly River Formation.

Distribution: This form apparently ranges through most of the Wapiabi Formation but is more prevalent in the upper part. It is quite common in some samples from the Thistle and Hanson Members and the transition beds in the Crowsnest Pass and Waterton areas.

Remarks: This rather featureless collapsed form probably represents a thin-walled variation of *T. wetteri* or a similar species. In the northern Foothills some specimens were observed which appear transitional to *T. wetteri*.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Genus VERNEUILINA d'Orbigny, 1839

VERNEUILINA CANADENSIS Cushman

Plate 1, figures 14, 15

Verneuilina canadensis Cushman, 1927, Trans. Roy. Soc. Can., 3rd ser., vol. 21, sec. 4, p. 131-132, pl. 1, fig. 11—Cushman, 1937, Cushman Lab. Foram. Res. Spec. Pub. 7, p. 13, pl. 1, figs. 16, 17—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 31, pl. 7, figs. 2,3—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 67-68, pl. 5, figs. 1, 2—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 901, pl. 105, fig. 5.

Description: Test triserial, tapering, triangular in cross section with the edges subrounded, the sides slightly concave resulting from depressions along the contacts of the vertical series; chambers inflated, increasing gradually in size, about five whorls in most specimens; sutures fairly distinct, depressed; wall agglutinated with mostly fine grains, considerable siliceous cement, surface fairly smooth to smooth; aperture an arched opening on the inner side of the last chamber; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5156 (fig. 14)	0.49	0.28
Hypotype MF 5157 (fig. 15)	0.47	0.24

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotype MF 5156 is from just above a 1-foot sandstone bed marking the base of the exposure of the Blackstone Formation on Cripple Creek, about 15 feet above the exposed top of the underlying Blairmore Group.

Hypotype MF 5157 is from the railroad cut at Cadomin, 13 to 15 feet above the contact with the underlying Mountain Park Formation.

Distribution: In the Foothills this species was observed only in the Sunkay Member at the above-mentioned localities in the Nordegg and Cadomin areas, where it is rare. It is more prominent in the Colorado

Shale in the subsurface of central Alberta, where it is an index component of the so-called *Miliammina manitobensis* microfauna from the interval between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above). The author has also observed it in the lower part of the Shaftesbury Formation in the Peace River Plains region of northern Alberta. Eicher (1960) reported this species as being one of the most common in the Shell Creek Shale of Wyoming. Further, Eicher (1965) remarked that it is abundant in three samples from the pre-*mellariolum* interval of the Graneros Shale in Colorado.

Genus VERNEUILINOIDES Loeblich and Tappan, 1949

VERNEUILINOIDES BEARPAWENSIS (Wickenden)

Plate 4, figures 31-34; Plate 5, figure 21; Plate 14, figures 13-15

Verneuilina bearpawensis Wickenden, 1932, Trans. Roy. Soc. Can., 3rd ser., vol. 26, sec. 4, p. 87, pl. 1, fig. 8—Cushman, 1937, Cushman Lab. Foram. Res. Spec. Pub. 7, p. 13, pl. 1, fig. 18—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 31, pl. 7, figs. 4-6.

Verneuilinoides bearpawensis (Wickenden). Wall, 1960, Res. Coun. Alberta Bull. 6, p. 22-23, pl. 4, figs. 20-21.

?*Verneuilinoides* cf. *bearpawensis* (Wickenden). North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 15-16, pl. 2, figs. 3a-b.

Description: Test elongate, tapering, nearly circular in transverse section in undeformed individuals; adult test consisting of from five to six convolutions of three chambers each, arranged in a *Buliminella*-like spiral; chambers very small in early whorls, somewhat inflated and gradually increasing in size in later whorls, those of the last two whorls comprising half or more of length of test; sutures indistinct to distinct, depressed; aperture an arched opening at the base of the last-formed chamber, obscure in most specimens; color light buff to dark brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5158 (pl. 4, fig. 31)	0.30	0.20
Hypotype MF 5159 (pl. 4, fig. 32)	0.42	0.22
Hypotype MF 5160 (pl. 4, figs. 33, 34)	0.47	0.25
Hypotype MF 5161 (pl. 5, fig. 21)	0.64	0.29
Hypotype MF 5162 (pl. 14, fig. 13)	0.31	0.14
Hypotype MF 5163 (pl. 14, fig. 14)	0.43	0.17
Hypotype MF 5164 (pl. 14, fig. 15)	0.49	0.20

Types: Hypotypes MF 5158 to 5160 are from the Opabin Member of the Blackstone Formation on Ghost River, 26 feet below the base of the overlying Cardium Formation.

Hypotype MF 5161 is from the Muskiki Member of the Wapiabi Formation on Little Berland River, 195 feet (estimated) above the base of the formation.

Hypotypes MF 5162 and 5163 are from the upper part of the Wapiabi Formation on Belcourt Creek, in beds herein regarded as the equivalent of the Nomad Member, 58 feet below the base of the Chinook Sandstone and 10 feet above a conglomerate bed.

Hypotype MF 5164 is from the Nomad Member of the Wapiabi Formation on Highwood River near Longview, 25 feet above the top of the Highwood Sandstone.

Distribution: In the Foothills the range of this species extends from the Opabin Member of the Blackstone Formation to the Nomad Member of the Wapiabi Formation. It is most prominent in the Nomad Member, where the specimens are generally dark brown with indistinct characters.

This species was described originally from the Bearpaw Formation (late Campanian) of southern Alberta and was also reported by Wickenden (1941, p. 154) from the upper part of the Lea Park Formation (early Campanian) in east-central Alberta. Wall (1960) illustrated it from the lower part of the Puskwaskau Formation (early Santonian) along the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: It is possible that the hypotypes from the Opabin Member of the Blackstone may differ sufficiently from Wickenden's type material to warrant removal from this species. They are somewhat less slender and elongate and show some deviation from the coiling pattern of the types.

This species appears to have limited stratigraphic value because of its extensive range, but is recurrences may have some ecological significance.

VERNEUILINOIDES KANSASENSIS Loeblich and Tappan

Plate 2, figures 1-7

Verneuilinoides kansasensis Loeblich and Tappan, 1950, Univ. Kansas Paleont. Contrib., Protozoa, Art. 3, p. 10, pl. 2, figs. 1, 2—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 69-70, pl. 5, figs. 6-10—Crespin, 1963, Australia Bur. Min. Resources Bull. 66, p. 57-58, pl. 15, figs. 4-7.

Verneuilinoides perplexus (Loeblich). Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 60-61, pl. 2, fig. 37; pl. 3, figs. 29, 30 (not *Verneuilina perplexa* Loeblich, 1946).

Verneuilinoides perplexus gleddiei Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 61-62, pl. 2, figs. 40, 41.

Description: Test elongate, tapering, subtriangular to nearly circular in cross section with the edges rounded; test triserial, of from five to seven whorls, the later whorls twisting in some specimens and appearing biserial

as exhibited in figures 3 to 5; chambers very small in the earliest whorls, inflated and increasing regularly in size in later whorls; sutures distinct, depressed; wall finely agglutinated, much cement, surface smooth; aperture a rather highly arched opening on the inner side of the last chamber; color usually light buff, occasionally light orange or dark brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5165 (figs. 1, 2)	0.40	0.18
Hypotype MF 5166 (fig. 3)	0.39	0.13
*Hypotype MF 5167 (fig. 4)	0.41	0.18
*Hypotype MF 5168 (fig. 5)	0.43	0.20
Hypotype MF 5169 (figs. 6, 7)	0.51	0.21

*Incomplete specimens with initial portions missing.

Unfigured specimens range from 0.22 mm. to 0.63 mm. in length.

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotypes MF 5165 to 5168 are from Ghost River, 2 feet above the contact with the underlying Blairmore Group.

Hypotype MF 5169 is from Cripple Creek, about 55 feet above the exposed top of the underlying Blairmore Group and 3 feet above a 12-foot sandstone bed, which is possibly the equivalent of the "fish-scale sand" of the Plains region.

Distribution: This species occurs regularly in the central Foothills above the *Miliammina manitobensis* microfauna, within the Sunkay Member of the Blackstone Formation. It is also present in the basal part of the Kaskapau Formation (=Sunkay Member) above the Dunvegan Sandstone on Little Berland River. Its occurrence at the extreme base of the Blackstone on Ghost River in the Morley area indicates it is probably absent south of here because of the onlap of younger marine beds on the Blairmore Group.

This species is present in the Peace River Plains region of northwestern Alberta in the lower part (Cenomanian) of the Kaskapau Formation. The species was described originally from the Lower Cretaceous Kiowa Shale of Kansas and also reported (Eicher, 1960) from the Lower Cretaceous Thermopolis and Skull Creek Shales of Wyoming.

Remarks: It appears that the specimens from the Kaskapau Formation identified as *V. perplexus* (Loeblich and Tappan) by Stelck and Wall should instead be referred to this species.

Although the figured hypotypes from the Ghost River locality are larger than the specimens from Kansas and Wyoming, some of the unfigured smaller specimens in the former suite are of comparable size.

Eicher (1965, pl. 105, figs. 10, 11, 14, 15) has illustrated specimens referred to *V. perplexus*, some of which (figs. 10, 14) the present author would have been inclined to assign to *V. kansasensis*. However, Dr. Eicher (oral communication, November, 1965) informed the writer that he had examined the types of these species and considered them identical. The author is, however, provisionally retaining the name *V. kansasensis* for these specimens with the realization that it very likely should be placed in the synonymy of *V. perplexus*.

Genus Uvigerinammina Majzon, 1943

Uvigerinammina sp. cf. U. athabascensis (Mellon and Wall)

Plate 1, figures 10-13

?*Tritaxia athabascensis* Mellon and Wall, 1956, Res. Coun. Alberta Rept. 72, p. 27, pl. 1, figs. 16, 17—Stelck and Wall *in* Stelck, Wall, Bahan and Martin, Res. Coun. Aberta Rept. 75, p. 53, pl. 2, figs. 15, 16.

?*Uvigerinammina athabascensis* (Mellon and Wall). Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 144-145, pl. 33, fig. 12.

Description: Test variable in size, compressed; initial end rounded, sides of test nearly parallel in most specimens; chamber arrangement obscure, early triserial portion of about two whorls followed by five or six chambers in an interlocking biserial pattern much larger than earlier chambers; sutures somewhat indistinct, depressed; wall very finely agglutinated or siliceous, with much cement, surface smooth; aperture terminal, constricted, slightly produced in some specimens; colorless.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5170 (fig. 10)	0.39	0.32
Specimen MF 5171 (fig. 11)	0.36	0.21
Specimen MF 5172 (fig. 12)	0.50	0.26
Specimen MF 5173 (fig. 13)	0.60	0.25

Types: The figured specimens are from the basal part of the Sunkay Member of the Blackstone Formation on Cripple Creek, 20 to 32 feet above the top of the underlying Blairmore Group.

Distribution: In the Foothills this species was observed only in the Sunkay Member at the above locality, where about 25 specimens were recorded.

A somewhat similar form has been observed by the author in the subsurface Colorado Group in central Alberta from the interval between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above).

Remarks: This form differs from *U. athabascensis* (Mellon and Wall), described originally from the Clearwater Formation of northeastern Alberta, in having a rounded rather than a pointed initial end followed by an adult test with nearly parallel as compared with divergent sides, and in lacking the distinct lipped aperture of the latter.

This form also differs from *U. manitobensis* (Wickenden), described originally from the Ashville Formation of Manitoba, in becoming biserial in the later portion and in lacking a distinct neck.

Uvigerinammina? sp. 1

Plate 14, figures 19, 20

Description: Test medium size, compressed, flaring slightly from bluntly pointed initial end; chamber arrangement obscure, early portion triserial although appearing biserial because of flattening, later portion irregularly biserial; chambers small in triserial portion of about three whorls, much enlarged in biserial part of three to four chambers; sutures indistinct, slightly depressed; wall finely agglutinated, moderate amount of cement, surface fairly smooth and vitreous; aperture a simple opening at end of a pronounced neck; color light brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5174 (fig. 19)	0.53	0.26
Specimen MF 5175 (fig. 20)	0.53	0.29

Unfigured specimens range from 0.39 mm. to 0.63 mm. in length.

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Mill Creek, 79 feet below a 30-foot massive sandstone unit regarded as the base of the Belly River Formation.

Distribution: This species seems best developed in the transition beds at the above locality, but it is also present in the underlying Hanson and Thistle Members in the Crowsnest Pass and Waterton areas.

Remarks: This somewhat nondescript species with its obscure chamber arrangement is questionably referred to *Uvigerinammina.* It does not appear similar to any previously published species, but it is difficult to make comparisons as representatives of this genus are subject to considerable distortion on fossilization.

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA SPIRITENSIS Stelck and Wall

Plate 1, figures 16-19

Gaudryina spiritensis (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 43-44, pl. 2, figs. 9, 10; pl. 3, figs. 8-12—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 902-903, pl. 105, figs. 17a-b.

Description: Test small to medium size, twisted; early portion triserial, of about three whorls; later portion biserial, of about two whorls; chambers very small in triserial portion, somewhat inflated and much larger in biserial portion, the terminal chamber rather sharply rectangular in outline; sutures somewhat indistinct, depressed; wall agglutinated, moderate amount of cement, surface fairly smooth; aperture a prominent notch at the inner margin of the final chamber, extending well up onto the terminal face; color buff to light brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5176 (figs. 16, 17)	0.42	0.18
Hypotype MF 5177 (figs. 18, 19)	0.32	0.13

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotype MF 5176 is from just above a 1-foot sandstone bed marking the base of the exposure of the Blackstone Formation on Cripple Creek, about 15 feet above the exposed top of the underlying Blairmore Group.

Hypotype MF 5177 is from the railroad cut at Cadomin, 19 to 22 feet above the contact with the underlying Mountain Park Formation.

Distribution: In the Foothills this species was recorded only from the Sunkay Member at the above localities, where it is rather rare.

It has been observed by the author in the subsurface Colorado Group in central Alberta from the interval between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above). The species was described from the lower part (Cenomanian) of the Kaskapau Formation in the Peace River Plains region of northwestern Alberta. Eicher recorded this species from the pre-*mellariolum* interval of the Graneros Shale in Colorado.

Genus DOROTHIA Plummer, 1931

DOROTHIA GLABRATA Cushman

Plate 12, figures 1-8

Dorothia glabrata Cushman, 1933, Cushman Lab. Foram. Res. Contrib., vol. 9, pt. 3, p. 56-57, pl. 6, figs. 10a-c—Cushman, 1937, Cushman Lab. Foram. Res. Spec.

Pub. 8, p. 85, pl. 9, fig. 15—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 46-47, pl. 13, figs. 5a-c—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 75, pl. 6, figs. 22a-b.

Description: Test elongate, initial portion tapering to a rather sharp point, the sides nearly parallel in later portion; earliest portion obscure with apparently four or more chambers per whorl; intermediate portion somewhat indistinct, triserial; latest portion biserial, of about six interlocking chambers comprising at least half of length of test; chambers inflated and increasing fairly rapidly in size in biserial portion; sutures indistinct in early and intermediate portions, fairly distinct and depressed in latest portion; wall finely agglutinated, with much cement seemingly more calcareous in apertural end, surface smooth with disseminated minute black specks; aperture a large semicircular opening at the base of the last chamber; color greyish-white.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5178 (figs. 1, 2)	0.46	0.20
Hypotype MF 5179 (figs. 3, 4)	0.36	0.20
Hypotype MF 5180 (figs. 5, 6)	0.30	0.20
Hypotype MF 5181 (figs. 7, 8)	0.80	0.26

Types: The hypotypes are from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species was not recorded in the Alberta Foothills outside of the Waterton area, where it is fairly prominent in the Hanson Member.

Remarks: The Alberta specimens in general seem to fit the original description of this Gulfian species from Texas, although the sutures of the former are somewhat indistinct.

The restriction of this species to the extreme southern Alberta Foothills and its association with other species from the Gulf Coast area such as *Anomalinoides henbesti* (Plummer) suggest that the microfauna in this area is approaching in composition those of the apparently normal neritic marine environment of the Niobrara seaway.

Dorothia smokyensis Wall

Plate 11, figures 25-28

Gaudryina filiformis Berthelin. Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 205, pl. 29, fig. 4 (not *Gaudryina filiformis* Berthelin, 1880).

Dorothia smokyensis Wall, 1960, Res. Coun. Alberta Bull. 6, p. 23-25, pl. 4, figs. 22-28.

Description: Test mostly elongate, fairly robust, twisted slightly; early portion of test of four to five whorls beginning with at least four chambers per whorl and reducing to three per whorl; later adult portion biserial with an average of about five pairs of interlocking chambers; chambers very small but increasing rapidly in size in early portion, inflated and increasing very gradually in size in adult portion; sutures usually somewhat indistinct in early portion, in later portion distinct, depressed, nearly horizontal; wall finely agglutinated, replaced or partially replaced by pyrite in most specimens, much cement, surface smooth; aperture a rather highly arched opening at the base of the inner margin of the final chamber; color greyish-white to light orange in nonpyritized specimens.

Dimensions:

	Length (mm.)	Maximum Width (mm.)
Hypotype MF 5182 (figs. 25, 26)	0.57	0.20
Hypotype MF 5183 (figs. 27, 28)	0.41	0.18

Types: The hypotypes are from the Hanson Member of the Wapiabi Formation on Belcourt Creek, 179 feet below the base of the Chinook Sandstone.

Distribution: In the Foothills the range of this species extends from the Haven Member of the Blackstone Formation to the Hanson and possibly into the Nomad Members of the Wapiabi Formation. It is rare in the Blackstone but is present in nearly every Wapiabi section sampled, and may be locally common in the Dowling and Hanson Members.

Wickenden recorded this species in the upper part of the Alberta Shale in the subsurface of the Plains of southern Alberta. The author, in describing this species from the lower Smoky River area of the Plains region of northwestern Alberta, noted its presence in both the Kaskapau and Puskwaskau Formations with it being more common in the latter.

Dorothia sp. 1

Plate 4, figures 35-40

Dorothia sp. Wall, 1960, Res. Coun. Alberta Bull. 6, p. 25-26, pl. 3, figs. 5-7.

Description: Test rather stubby to elongate, medium size, fairly robust, slightly tapering; early portion of test spiral, of about two whorls with four chambers per whorl, the chambers enlarging rapidly; later portion biserial, of up to five pairs of interlocking, nearly equidimensional chambers, inflated and increasing very gradually in size; sutures indistinct to distinct, slightly depressed, thickened in biserial portion of some specimens; wall agglutinated, of mostly fine material with the occasional coarse grain, considerable amount of cement, surface nearly smooth to somewhat rough;

aperture a deep notch at the inner margin of the final chamber extending well up onto the terminal face; color light orange to reddish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5184 (figs. 35, 36)	0.45	0.24
Specimen MF 5185 (figs. 37, 38)	0.50	0.22
Specimen MF 5186 (figs. 39, 40)	0.53	0.21

Types: The figured specimens are from the Opabin Member of the Blackstone Formation on Indian Creek, 50 feet below the base of the overlying Cardium Formation.

Distribution: This species is present in the Haven and Opabin Members of the Blackstone Formation in the central and southern Foothills, and in the Muskiki Member of the Wapiabi Formation on Highwood River. A few specimens were also collected from the Cardium Formation in the central Foothills.

Remarks: This form appears the same as that illustrated by the author from the upper part of the Kaskapau Formation on the lower Smoky River in the Plains region of northwestern Alberta, although the wall structure and preservation are quite different. The Smoky River specimens are rather coarsely arenaceous with only moderate amounts of cement and somewhat rough exteriors, whereas the Foothills individuals tend to be finely arenaceous with considerable amounts of cement and generally smooth exteriors. The Foothills specimens show a color gradation from light orange to dark brown, the characters of the test being quite distinct in the former (figs. 39, 40) but indistinct in the latter (figs. 35, 36). Gradational specimens such as in figures 37 and 38 indicate, however, that all of these individuals belong to the same species.

A peculiar feature visible in the better preserved Foothills specimens is the change directly from a spiral to a biserial pattern in which the triserial stage has apparently been bypassed.

Genus Marssonella Cushman, 1933

Marssonella oxycona (Reuss)

Plate 8, figures 7-9

Gaudryina oxycona Reuss, 1860, K. Akad. Wiss. Wien, Math.-Naturwiss. Cl., Sitzungsber., vol. 40, p. 229, pl. 12, figs. 3a-b—Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 205, pl. 29, figs. 3a-b.

Marssonella oxycona (Reuss). Cushman, 1933, Cushman Lab. Foram. Res. Contrib., vol. 9, pt. 2, p. 36, pl. 4, figs. 13a-b—Loetterle, 1937, Nebraska Geol. Surv.,

2nd ser., Bull. 12, p. 59-60, pl. 10, figs. 7a-b—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 43-44, pl. 12, figs. 3-5 (synonymy including several species, according to Frizzell)—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 75, pl. 6, figs. 17a-b.

Dorothia oxycona (Reuss). Trujillo, 1960, Jour. Paleont., vol. 34, no. 2, p. 309-310, pl. 44, figs. 5a-b.

Marrsonella [*sic*] *conica* Gauger, 1953,*in* Peterson, Gauger and Lankford, Utah. Geol. and Mineral. Surv. Bull. 47 (Contrib. Micropaleont. 1), p. 62, pl. 6, figs. 14-16.

Description: Test conical, tending to flare from the bluntly rounded initial end to the wide apertural surface; chambers spirally arranged in the earliest portion beginning with four to a whorl and reducing to three; adult portion biserial with about three pairs of interlocking chambers, much larger than those in early portion; sutures somewhat indistinct in most specimens, depressed and nearly horizontal in biserial portion; wall finely agglutinated, considerable amount of cement, surface smooth; aperture a low opening at the inner margin of the final chamber, obscure in these specimens; color brown.

Dimensions:

	Length (mm.)	Width (mm.)
*Hypotype MF 5187 (figs. 7, 8)	0.32	0.68
Hypotype MF 5188 (fig. 9)	0.61	0.48

*Specimen crushed.

Types: Hypotypes MF 5187 and 5188 are from the Dowling Member of the Wapiabi Formation on Mill Creek, 474 and 554 feet, respectively, above the base of the formation.

Distribution: In the Foothills this species seems restricted stratigraphically to the lower part of the Wapiabi Formation and geographically to the country from Nordegg south.

In the subsurface of the Plains of southern Alberta, Wickenden recorded this species about 300 feet below the top of the Alberta Shale. The present author also collected it from an exposure of the medial division of the Kevin Shale Member of the Marias River Formation in the Kevin-Sunburst oil field, northern Montana. It has been reported from various levels in the Cretaceous of several regions of this continent and of South America and Europe (Cushman, 1946; Trujillo, 1960).

Remarks: Most specimens are crushed with indistinct sutures, but as noted by Wickenden, "the broad flare of the apertural end of this species makes it easily recognized".

M. conica Gauger from the Upper Cretaceous Hilliard Formation of southwestern Wyoming probably represents a distorted form of fossilization or at most an aberrant variation of *M. oxycona* entitled to no more than subspecific status.

Trujillo proposed suppressing *Marssonella* as a junior synonym of *Dorothia* on the basis that there is no distinction in the generic descriptions between the number of chambers per whorl in the early stages and that the flat or concave apertural end of *Marssonella* is not excluded as a characteristic of *Dorothia*. Loeblich and Tappan (1964) accepted Trujillo's conclusions and similarly placed *Marssonella* in the synonymy of *Dorothia*. While conceding the validity of these arguments, the author holds that the characteristic flaring conical shape of this and closely related species, such as *M. trochus* (d'Orbigny), is sufficiently distinctive to warrant the continued recognition of a higher taxonomic unit—the genus *Marssonella* —to embrace these forms.

Genus Pseudoclavulina Cushman, 1936

Pseudoclavulina sp.

Plate 4, figures 25-30

?*Pseudoclavulina hastata* (Cushman). Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 151, pl. 36, figs. 10, 11.

Not *Bigenerina hastata* Cushman, 1927, Trans. Roy. Soc. Can., 3rd ser., vol. 21, sec. 4, p. 131, pl. 1, fig. 9—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 30, pl. 6, fig. 25.

Description: Test medium size, elongate, fairly robust; early portion triserial, of about four whorls of small chambers, increasing rapidly in width with the widest part of the test at the distal end of this portion; later portion uniserial, cylindrical in cross section, of two to four nearly equal-sized chambers, about twice as wide as high; sutures distinct, flush, horizontal and thickened in the uniserial portion; wall finely agglutinated, much cement, surface smooth; aperture terminal, central, a simple round opening; color light brown.

Dimensions:

	Length (mm.)	Maximum Width (mm.)
Specimen MF 5189 (figs. 25, 26) =incomplete specimen	0.31	0.15
Specimen MF 5190 (figs. 27, 28)	0.46	0.15
Specimen MF 5191 (figs. 29, 30) =uniserial portion only.	0.46	0.20

Types: The specimens are from the upper part of the Haven Member of the Blackstone Formation on Ghost River, 135 feet below the base of the Cardium Formation.

Distribution: In the Foothills from Nordegg south, this species is restricted to a fairly short interval embracing the upper beds of the Haven

Member and the lower beds of the Opabin Member of the Blackstone Formation. At Cadomin it appears somewhat higher stratigraphically, being found in the Opabin Member within 50 feet of the base of the overlying Cardium Formation.

In the Peace River Plains region of northwestern Alberta, this species seems to be present in the upper part of the Kaskapau Formation, about 50 feet below the overlying Bad Heart Sandstone, although the author had previously stated that the form recorded here was probably not identical (Wall and Germundson, 1963, p. 337).

Remarks: Tappan referred a form from the Ayiyak Member (Turonian) of the Seabee Formation, which is about the stratigraphic equivalent of the upper parts of the Blackstone and Kaskapau Formations of Alberta, to *Bigenerina hastata* Cushman=*Pseudoclavulina hastata* (Cushman) Tappan. Although the author has not seen the Alaskan specimens, Tappan's illustrations suggest that they are closely related, if not identical, to this Foothills form. The author has, however, compared the Foothills form with the holotype of *Bigenerina hastata,* from an unknown depth and stratigraphic level of a well in Manitoba, and is convinced that they belong to different species. Cushman's type is considerably more elongate with additional chambers in the uniserial part; its outline differs in lacking the constriction at the junction of the triserial and uniserial portions in the Foothills specimens; its sutures are very indistinct and lack the pronounced thickening present in the uniserial portion of the Foothills form.

Although *Pseudoclavulina* has been placed in the synonymy of *Clavulina* by Loeblich and Tappan (1964), it is herein retained provisionally to embrace this and other species lacking the apertural valvular tooth and sharply triangular triserial portion, typical characters of *Clavulina,* which reportedly appears in the early Tertiary.

This species is of considerable value in the recognition of upper Blackstone beds in the Foothills. Some specimens are broken near the junction of the triserial and uniserial portions, but the wide distinct sutures permit identification of the detached later portions.

Suborder MILIOLINA Delage and Hérouard, 1896

Superfamily MILIOLACEA Ehrenberg, 1839

Family MILIOLIDAE Ehrenberg, 1839

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA SPHAERA Nauss

Plate 6, figures 16-18

Quinqueloculina sphaera Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 340, pl. 48, figs. 14a-c—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 157, pl. 37, figs. 6a-c—North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 17, pl. 3, figs. 1a-c.

Description: Test small, nearly circular in side view, moderately robust with the edges subround; chambers arranged in a quinqueloculine pattern, four visible from one side, three on the other side; sutures fairly distinct, slightly depressed; wall calcareous, porcellaneous, some specimens represented only by recrystallized internal casts, surface smooth; aperture a slit at the end of the last chamber, obscure in these specimens; colorless or brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5192	0.28	0.22

Types: The hypotype is from the Muskiki Member of the Wapiabi Formation on Thistle Creek, 105 feet above the base of the formation.

Distribution: In the Foothills eight representatives of this species were recorded from the Muskiki Member and one from the overlying Marshybank Member on Thistle Creek. One specimen was obtained from the Cardium Formation on Cripple Creek.

Occurrences in other regions are from somewhat higher stratigraphic levels in the Upper Cretaceous. Nauss originally described the species from the lower part of the Lea Park Formation in east-central Alberta. North and Caldwell considered it a guide fossil for the microfauna from the middle portion of the Lea Park in south-central Saskatchewan. Tappan reported it from the Seabee and Schrader Bluff Formations of northern Alaska.

Remarks: The Foothills specimens in general seem less robust than those from the type area. Some of them also have a rather deep longitudinal depression on the side with three chambers visible, which appears accentuated through some distortion of the test.

Suborder ROTALIINA Delage and Hérouard, 1896

Superfamily NODOSARIACEA Ehrenberg, 1838

Family NODOSARIIDAE Ehrenberg, 1838

Genus LENTICULINA Lamarck, 1804

LENTICULINA sp. 1

Plate 15, figures 27, 28

Description: Test rather small, compressed, planispiral, periphery sharply rounded; proloculum and early chambers obscure, about six chambers in final whorl, with the later chambers showing tendency to uncoil; sutures strongly curved, depressed; wall calcareous, perforate, with specimens preserved as recrystallized internal casts; aperture at the peripheral angle, obscure but apparently radiate; colorless to red-tinged.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5193	0.43	0.10

Types: The figured specimen is from the upper part of the Wapiabi Formation on Belcourt Creek, in beds herein regarded as the equivalent of the Nomad Member, 58 feet below the base of the Chinook Sandstone and 10 feet above a conglomerate bed.

Distribution: This form is rare with only one specimen being observed from the Nomad Member at Longview in addition to the one figured.

LENTICULINA sp. 2

Plate 15, figures 23, 24, 29, 30

Description: Test medium size, lenticular, robust, biumbonate, planispiral, periphery subacute; proloculum and early chambers obscure, nine to ten chambers in final whorl; sutures gently curved, flush; wall calcareous, perforate; aperture not observed; colorless to grey-buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5194 (figs. 23, 24)	0.59	0.34
Specimen MF 5195 (figs. 29, 30)	0.58	0.38

Types: Specimen MF 5194 is from the upper part of the Wapiabi Formation on Mistanusk Creek, in beds herein regarded as the equivalent of the Nomad Member, 26 feet above the top of a sandstone unit designated by Wall and Germundson (1963) as "lower Chinook", and 60 feet below the base of the main Chinook Sandstone.

Specimen MF 5195 is from the Nomad Member of the Wapiabi Formation on Thistle Creek, 85 feet below the base of the overlying Brazeau Formation.

Distribution: This form is rare with one questionable specimen being observed from the Nomad Member on Thistle Creek in addition to the two figured.

Remarks: Specimen MF 5194 is a recrystallized internal cast.

Genus NODOSARIA Lamarck, 1812

NODOSARIA sp. 1

Plate 12, figure 15

Description: Test elongate, tapering, the chambers increasing gradually in width while maintaining approximately the same height as added;

sutures horizontal, depressed, constricted; wall calcareous, finely perforate, surface ornamented with continuous slightly elevated costae, about eight on proloculum, twelve to fourteen on last chambers of incomplete tests; aperture terminal, central, round; color light grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5196 (incomplete)	0.54	0.14

Types: The figured specimen is from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species is rare, only one specimen being observed in the Thistle Member of the Wapiabi Formation at Mill Creek in addition to the one figured.

NODOSARIA sp. 2

Plate 12, figure 16

Description: Tests found as two-chambered fragments, the chambers elongate with the final chamber produced at apertural end; sutures horizontal, depressed, somewhat constricted; wall calcareous, finely perforate, surface ornamented with fourteen continuous slightly elevated costae; aperture terminal, at end of neck; color grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5197 (fragment)	0.51	0.20

Types: The figured specimen is from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species is rare, five specimens being recorded from the above locality and two from the Thistle and Dowling Members of the Wapiabi Formation on Mill Creek.

Genus DENTALINA Risso, 1826

DENTALINA SUMMITENSIS Peterson

Plate 9, figure 21

Dentalina summitensis Peterson, 1953, *in* Peterson, Gauger and Lankford, Utah Geol. and Mineral. Surv. Bull 47 (Contrib. Micropaleont. 1), p. 39, pl. 2, figs. 5, 6.

Description: Test large, elongate, slightly arcuate, robust; eight chambers in most complete specimen found, increasing slightly in width as added; sutures oblique, somewhat obscured by the costae, flush between earlier chambers, depressed in later portion; wall calcareous, finely perforate, surface ornamented with numerous continuous slightly elevated longitudinal costae; aperture not observed in available material; color buff-brown mottled.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5198	2.54	0.45

Types: The hypotype is from the Wapiabi Formation on Castle River in the Crowsnest Pass area, from either the upper part of the Dowling or lower part of the Thistle Member.

Distribution: This species seems rare in the Foothills with two additional specimens being observed at the above locality and two at Highwood River from about the same stratigraphic level.

It is common to the south in northeastern Utah, where it was described from the upper middle part of the Frontier Formation (Upper Cretaceous).

Dentalina sp. 1

Plate 6, figure 27

Description: Test arcuate, found in fragmentary state of three to four chambers, with the final chamber produced at apertural end; sutures distinct, slightly oblique, depressed; wall calcareous, finely perforate, surface smooth; aperture terminal, radiate, produced; colorless to grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5199	0.46	0.19

Types: The figured specimen is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Distribution: This species is rare with only one other specimen being recorded from the Thistle Member of the Wapiabi Formation on Mill Creek.

Genus Vaginulina d'Orbigny, 1826

Vaginulina sp.

Plate 15, figures 25, 26

Description: Test elongate, moderately compressed, nearly rectilinear; subovate proloculum followed by five low chambers increasing gradually

in height as added; sutures thickened, flush, oblique; wall calcareous, finely perforate, surface smooth; aperture radiate, somewhat produced at the dorsal angle; color buff-yellow.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5200	0.87	0.27	0.14

Types: The figured specimen is from the Nomad Member of the Wapiabi Formation on Burnt Timber Creek, about 35 feet below the base of the overlying Brazeau Formation.

Distribution: This species was recorded only from the Nomad Member at Burnt Timber and Thistle Creeks, where it is rare with most of the specimens being broken.

Genus Frondicularia Defrance, 1826

Frondicularia sp. cf. F. greybullensis Fox

Plate 12, figure 14

?*Frondicularia greybullensis* Fox, 1954, U.S. Geol. Surv. Prof. Paper 254-E, p. 118, pl. 26, figs. 4-6.

Description: Test elongate-palmate, somewhat asymmetrical, compressed; chambers uniserial, strongly equitant, slightly inflated, of nearly equal height; sutures fairly distinct, depressed; wall calcareous, finely perforate, surface smooth; color buff-grey.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5201 (fragment)	0.80	0.47	0.09

Types: The figured specimen is from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: In the Foothills this species was observed only at the above level and locality, where it is found in a fragmentary condition.

Remarks: The description is based on two joined fragments representing five chambers from the intermediate part of the test, with neither the initial nor the terminal portions being available. Nevertheless, the close relationship, if not identity, with *F. greybullensis* from the basal part of the Cody Shale near Greybull, Wyoming, is quite apparent as shown by the similarity of outline, the slightly inflated chambers and the highly arched sutures.

Family Polymorphinidae d'Orbigny, 1839

Genus Bullopora Quenstedt, 1856

Bullopora laevis (Sollas)

Plate 9, figures 12-16

Webbina laevis Sollas, 1877, Geol. Mag., n.s., 2nd dec., vol. 4, p. 103, pl. 6, figs. 1-3.

Vitriwebbina laevis (Sollas). Chapman, 1896, Jour. Roy. Micr. Soc., p. 585, pl. 12, fig. 12—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 107, pl. 15, fig. 5 (synonymy).

Bullopora laevis (Sollas). Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 206, pl. 29, figs. 6-8.

Description: Test usually found in free condition, rarely attached, consisting of a series of subglobular to fusiform chambers apparently connected by stoloniferous necks in original state, but almost invariably found as individuals; wall calcareous, finely perforate, smooth in most specimens, slightly rough or finely spinose in others; aperture simple, the open end of the stoloniferous neck; usually colorless, some specimens light orange.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5202 (fig. 12)	0.64	0.20
Hypotype MF 5203 (fig. 13)	0.56	0.22
Hypotype MF 5204 (fig. 14)	0.58	0.20
Hypotype MF 5205 (fig. 15)	0.58	0.28
Hypotype MF 5206 (fig. 16)	0.41	0.22

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation on Mill Creek, 564 feet above the base of the formation.

Distribution: In the Foothills this species was recorded from the Muskiki to the Thistle Member of the Wapiabi Formation, being most prominent in the Dowling Member at Mill Creek. Its maximum development occurs consistently in the lower part of the *Brachycythere-Bullopora* assemblage of this publication, which falls within the Dowling Member in the southern area and the Muskiki Member in the central and northern areas.

Wickenden reported this species from the Alberta Shale in the subsurface of the Plains of southern Alberta and commented on its being a "good guide fossil for a horizon about 420 feet below the top . . . . ." This would place it at the same stratigraphic level as in the Foothills, where, however, it may be farther below the upper or first white-speckled shale "zone" because of thickening of the strata within this interval toward the west.

Fox (1954) listed this species as a component of his faunal assemblages 3 and 4 from the basal part of the Cody Shale near Greybull, Wyoming. The author has obtained this species from an exposure of the medial division of the Kevin Shale Member of the Marias River Formation in the Kevin-Sunburst oil field, northern Montana.

Superfamily BULIMINACEA Jones, 1875

Family TURRILINIDAE Cushman, 1927

Genus NEOBULIMINA Cushman and Wickenden, 1928

NEOBULIMINA sp.

Plate 6, figures 19-21; Plate 13, figures 32, 33

Neobulimina sp. Wall, 1960, Res. Coun. Alberta Bull. 6, p. 31-32, pl. 5, figs. 15-22.

Description: Test small, elongate, twisted, slightly tapering; early portion of test triserial, of about three whorls comprising from one third to one half of length of test; later portion biserial, of two to three whorls; chambers in triserial portion small and low, in biserial portion more inflated and longer than wide; sutures distinct, depressed; wall calcareous, perforate, smooth, replaced or partially replaced by pyrite in some specimens; aperture a highly arched opening in a large oval depression in the inner face of the terminal chamber; colorless in nonpyritized specimens.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5207 (pl. 6, figs. 19, 20)	0.28	0.09
Specimen MF 5208 (pl. 6, fig. 21)	0.22	0.09
Specimen MF 5209 (pl. 13, fig. 32)	0.17	0.08
Specimen MF 5210 (pl. 13, fig. 33)	0.22	0.08

Types: Specimens MF 5207 and 5208 are from the first or upper white-speckled shale "zone" in the Dowling Member of the Wapiabi Formation on Meander Creek (tributary of Belcourt Creek), 112 to 116 feet above the Bad Heart Sandstone.

Specimens MF 5209 and 5210 are from the same "zone" in the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species is characteristically associated with the microfauna of the first or upper white-speckled shale "zone", which is found in the Hanson Member of the Wapiabi Formation in the southern Foothills and in the Dowling Member in the northern area. There are also a few occurrences both below and above this level in the Wapiabi of the Foothills.

The author described this species from the upper white-speckled shale "zone" in the Puskwaskau Formation on the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: As noted by the author (1960) this species differs from *N. canadensis* Cushman and Wickenden, described originally from the Lea Park Formation of east-central Alberta, in having much longer chambers in its biserial portion.

Genus PRAEBULIMINA Hofker, 1953

PRAEBULIMINA VENUSAE (Nauss)

Plate 15, figures 19-22

Bulimina venusae Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 334-335, pl. 48, fig. 10—Tappan, 1951 (part), Cushman Found. Foram. Res. Contrib., vol. 2, pt. 1, p. 6, pl. 1, figs. 23, 25, 26 (not fig. 24)—Tappan, 1951, *in* Payne and others, U.S. Geol. Surv. Oil and Gas Invest. Map OM-126, sheet 3, fig. 21(7).

Praebulimina venusae (Nauss). Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 188, pl. 49, figs. 19-21.

Not *Praebulimina venusae* (Nauss). North and Caldwell, Saskatchewan Res. Coun. Rept. 5, p. 21, pl. 3, figs. 13a-b.

Description: Test small, tapering, triserial, of four to five whorls; early chambers low, those of last one to two whorls inflated and increasing rapidly in height; sutures fairly distinct, depressed; wall calcareous, perforate, smooth; aperture a comma-shaped opening on the inner face of the last chamber; colorless.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5211 (figs. 19, 20)	0.24	0.13
Hypotype MF 5212 (figs. 21, 22)	0.26	0.14

Types: The hypotypes are from the Nomad Member of the Wapiabi Formation on Thistle Creek, 85 feet below the base of the overlying Brazeau Formation.

Distribution: In the Foothills this species was observed only at the above locality where six specimens were recorded.

In east-central Alberta, Nauss reported it as common in the upper part of the Lea Park Formation and in the Vanesti marine tongue of the lower part of the Belly River Formation. Tappan (1962) recorded this species from the Schrader Bluff Formation of northern Alaska.

Remarks: The form which North and Caldwell assigned to this species seems identical to *Neobulimina canadensis* Cushman and Wickenden, illustrated by Nauss (1947, pl. 48, fig. 5) from the Lea Park Formation of east-central Alberta.

PRAEBULIMINA sp. 1

Plate 15, figures 13-18

Description: Test tiny, tapering, triserial, of four to five whorls; chambers increasing gradually in size and becoming more inflated as added; sutures distinct, depressed; wall calcareous, perforate, smooth; aperture distinct, a small but deeply notched opening on the inner face of the last chamber; color white.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5213 (figs. 13, 14)	0.14	0.08
Specimen MF 5214 (figs. 15, 16)	0.20	0.09
Specimen MF 5215 (figs. 17, 18)	0.16	0.08

Unfigured specimens range from 0.11 mm. to 0.18 mm. in length.

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: This species was positively recognized only at the above level and locality where 18 specimens were recorded. There are a few questionable specimens present in the Hanson Member of the Wapiabi Formation on Mill Creek.

Remarks: This species seems closely related to *Praebulimina venusae* (Nauss) but differs in being somewhat smaller, in showing a more gradual increase in the size of the chambers and in having a more distinct, deeply notched aperture.

Family BOLIVINITIDAE Cushman, 1927

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA ELKENSIS Nauss

Plate 6, figures 4, 5

Bolivina elkensis Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 334, pl. 48, figs. 7a-b.

Description: Test small to medium size, elongate, tapering, compressed; early portion twisted and generally broken; edges rounded; ten to twelve chambers in biserial arrangement, the last three pairs considerably higher than earlier ones; sutures fairly distinct, depressed; wall presumed calcareous, perforate, smooth, replaced by pyrite in all specimens observed; aperture a large arched opening on the inner face of the last chamber.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5216 (fig. 4)	0.27	0.10	0.08
Hypotype MF 5217 (fig. 5)	0.31	0.10	0.07

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation on Highwood River, 424 and 463 feet, respectively, above the base of the formation.

Distribution: In the Foothills this species has been observed from the Muskiki to the Thistle Members of the Wapiabi Formation. It seems rare except in the Dowling Member on Highwood River where 40 specimens were obtained. The small pyritized tests, however, may have been overlooked at other localities.

Nauss described this species from the Lea Park Formation of east-central Alberta which marks a somewhat higher stratigraphic level than these Foothills occurrences.

Bolivina sp. cf. B. elkensis Nauss

Plate 12, figures 9-11

Gumbelina sp. Wall, 1960 (part), Res. Coun. Alberta Bull. 6, p. 28-30, pl. 5, figs. 23, 24, 29, 30 (not figs. 25-28).

Description: Test elongate, compressed, flaring slightly in early portion from bluntly pointed twisted initial end, sides nearly parallel in later portion; test biserial, of about nine pairs of chambers, partially inflated but appearing flat in most specimens as a result of the fossilization process; early chambers very low, later chambers increasing gradually in height with dimensions nearly equal in last two pairs; sutures distinct, depressed, slightly oblique; wall calcareous, hyaline, perforate, smooth; aperture a highly arched opening at the inner margin of the last chamber; colorless to buff-grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5218 (fig. 9)	0.32	0.10
Specimen MF 5219 (fig. 10)	0.26	0.09
Specimen MF 5220 (fig. 11)	0.28	0.08

Types: The figured specimens are from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: In the Foothills this species was observed in quantity only at the above locality from beds in or just below the upper or first white-speckled shale "zone".

In the Plains region of northwestern Alberta, the author (1960) obtained this species from the upper white-speckled shale "zone" in the Puskwaskau Formation.

Remarks: This species seems closely related to *B. elkensis*, but has more chambers which are somewhat lower than those of *B. elkensis*.

The author's (1960) description of *Gümbelina* sp. from the upper white-speckled shale "zone" embraced some quite elongate forms which appear identical to this Foothills form. The author also included under *Gümbelina* sp. some shorter forms (*op. cit.*, pl. 5, figs. 25-28) that are identical to *Heterohelix* sp. 1 of this publication, which is present in both the so-called lower and upper pelagic faunal assemblages in the Foothills. It seems that *Gümbelina* sp. was based perhaps on too broad a concept and it may now be split to advantage.

Bolivina sp. 1

Plate 6, figure 6; Plate 12, figures 12, 13

Description: Test elongate, slender, compressed, slightly tapering, initial portion slightly twisted; test biserial, chambers increasing regularly in height as added, higher than wide in all but earliest portion, about 8 pairs present, partially inflated but appearing flat in most specimens as a result of the fossilization process; sutures fairly distinct, depressed, nearly horizontal; wall calcareous, finely perforate, smooth; aperture a high slit-opening on the inner face of the last chamber, obscure in most specimens as a result of flattening; grey to grey-buff.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5221 (pl. 6, fig. 6)	0.41	0.11
Specimen MF 5222 (pl. 12, fig. 12)	0.48	0.13
Specimen MF 5223 (pl. 12, fig. 13)	0.56	0.12

Types: Specimen MF 5221 is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Specimens MF 5222 and 5223 are from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: In the Foothills this species was collected mainly from the Hanson Member of the Wapiabi Formation in Waterton National Park, with 35 specimens being recorded there. It is also present, but much rarer, to the north at Highwood River and Thistle Creek in lower members of the Wapiabi Formation, where it is invariably pyritized.

Remarks: This species appears similar to *Loxostomum tegulatum* (Reuss), a species of wide distribution in the Upper Cretaceous of Europe and North America including the Niobrara Formation of Nebraska (Loetterle, 1937). The aperture in this Foothills form apparently does not become terminal, however, and the author is reluctant to refer it to *L. tegulatum.*

This species is also rather similar to *B. elkensis* Nauss but is considerably more elongate with higher chambers. There are, however, pyritized specimens from the lower part of the Wapiabi Formation (Pl. 6, fig. 6) which appear transitional to *B. elkensis* and may not be readily distinguished from it.

Superfamily DISCORBACEA Ehrenberg, 1838

Family DISCORBIDAE Ehrenberg, 1838

Genus EOEPONIDELLA Wickenden, 1949

EOEPONIDELLA sp. cf. E. LINKI Wickenden

Plate 15, figures 34-39

?*Eoeponidella linki* Wickenden, 1949, Trans. Roy. Soc. Can., 3rd ser., vol. 42 (1948), sec. 4, p. 81-82, figs. 1a-c—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 195, pl. 54, figs. 9, 10.

Description: Test small, planoconvex, spiral side convex and umbilical side slightly concave, periphery subrounded, peripheral margin slightly indented; two to three whorls of chambers with all regular chambers visible on spiral side, only those of last formed coil and some supplementary ones forming an inner coil visible on umbilical side; six chambers in outer whorl and same number of supplementary stellar chambers; sutures indistinct, slightly curved, flush to slightly depressed on spiral side, straight, radial and moderately depressed on umbilical side; wall calcareous, perforate, smooth; aperture obscure, apparently a small arch on umbilical side of last chamber.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5224 (figs. 34-36)	0.22	0.11
Specimen MF 5225 (figs. 37-39)	0.22	0.13

Types: The figured specimens are from the Nomad Member of the Wapiabi Formation on Thistle Creek, 85 feet below the base of the overlying Brazeau Formation.

Distribution: In the Foothills this species was observed only in the Nomad Member on Thistle Creek, where it is rare.

Remarks: Although closely related to *E. linki* from the upper part of the Lea Park Formation and marine tongues in the lower part of the overlying Belly River Formation in the Alberta-Saskatchewan Plains region, this Foothills form lacks the more inflated chambers and apparently also the very prominent umbilical aperture of *E. linki*.

Genus VALVULINERIA Cushman, 1926

VALVULINERIA sp. cf. V. UMBILICATA (d'Orbigny)

Plate 6, figures 28-33; Plate 9, figures 22-24

?*Rotalina* (*Rotalina*) *umbilicata* d'Orbigny, 1840, Mem. Soc. Geol. France, tome 4, no. 1, p. 32, pl. 3, figs. 4-6.

Gyroidina umbilicata (d'Orbigny). Cushman, 1931, Cushman Lab. Foram. Res. Contrib., vol. 7, pt. 2, p. 43, pl. 6, figs. 3a-c.

Valvulineria cf. *umbilicata* (d'Orbigny). Cushman, 1931 (part), Tennessee Div. Geol. Bull. 41, p. 53, pl. 9, figs. 2-4 (not fig. 5; figs. 2c and 3c transposed)—Cushman, 1946 (part), U.S. Geol. Surv. Prof. Paper 206, p. 139, pl. 57, figs. 10-12 (not fig. 9; figs. 11c and 12c transposed; synonymy)—Frizzell, 1954, Texas. Bur. Econ. Geol. Rept. Invest. 22, p. 123, pl. 18, figs. 38, 39.

Description: Test small, rotaloid, planoconvex with spiral side flat to slightly concave and umbilical side strongly convex, periphery broadly rounded, peripheral outline slightly lobulate; two whorls of chambers, the six to eight chambers in outer whorl much larger than earlier chambers, final chamber with a large flap or extension covering the umbilicus and the ends of the previous chambers; sutures distinct, slightly curved, slightly depressed; wall calcareous, replaced or partially replaced by pyrite in many specimens, finely perforate, smooth; aperture a low slit at the base of the last chamber extending from near the periphery into the umbilicus, obscure in these specimens; colorless in nonpyritized specimens.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5226 (pl. 6, figs. 28-30)	0.22	0.13
Specimen MF 5227 (pl. 6, figs. 31-33)	0.22	0.14
Specimen MF 5228 (pl. 9, figs. 22-24)	0.20	0.13

Types: Specimen MF 5226 is from the Muskiki Member of the Wapiabi Formation on Mistanusk Creek, 102 feet above the top of the underlying Cardium Formation.

Specimen MF 5227 is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Specimen MF 5228 is from the Dowling Member of the Wapiabi Formation on Highwood River, 424 feet above the base of the formation.

Distribution: This species seems rather rare in the Dowling Member in the southern Foothills and in the Marshybank Member in the central Foothills. It is present in the Muskiki Member on Mistanusk Creek in association with a similar form which lacks the umbilical flap of this species.

Remarks: The Foothills representatives of this species seem identical to those from the Upper Cretaceous Ripley Formation of Tennessee illustrated by Cushman (1946, figs. 10, 11 and 12). As noted by Frizzell (1954), Cushman apparently included more than one species under his comparison with *R.* (*R.*) *umbilicata* d'Orbigny, as shown by the variation in form from planoconvex to almost equally biconvex (figure 9 of Cushman).

Valvulineria sp. 1

Plate 6, figures 7-9

Description: Test medium to fairly large size, rotaloid, planoconvex with spiral side nearly flat and umbilical side moderately convex and umbilicate, periphery rounded, peripheral margin entire to slightly lobulate; two whorls of chambers increasing gradually in size as added, inflated, seven to eight in final whorl, last chamber with a large flap or extension covering the umbilicus and the ends of the previous chambers; sutures fairly distinct, somewhat thickened and slightly depressed between early chambers of outer whorl, plain and depressed between later chambers, curved on spiral side, nearly straight or radial on umbilical side; wall calcareous, distinctly perforate, smooth; aperture a slit at the base of the septal face between the periphery and umbilicus.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5229	0.32	0.13

Types: The figured specimen is from the Muskiki Member of the Wapiabi Formation on Mistanusk Creek, 120 feet above the top of the underlying Cardium Formation.

Distribution: This species is rare with only two additional specimens, somewhat smaller than the one figured, being observed in the same member at the above locality.

aperture obscure, an arched opening at the base of the terminal face; color light buff to light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5076 (pl. 4, figs. 5, 6)	0.29	0.09
Hypotype MF 5077 (pl. 4, fig. 7)	0.34	0.09
Hypotype MF 5078 (pl. 5, figs. 6, 7)	0.28	0.12
Hypotype MF 5079 (pl. 5, figs. 8, 9)	0.26	0.11
Hypotype MF 5080 (pl. 10, figs. 16, 17)	0.30	0.10

Types: Hypotypes MF 5076 and 5077 are from the Haven Member of the Blackstone Formation on Ghost River, 29 feet below the top of the member and 135 feet below the base of the Cardium Formation.

Hypotype MF 5078 is from the Muskiki Member of the Wapiabi Formation on Thistle Creek, 105 feet above the base of the formation.

Hypotype MF 5079 is from the Muskiki Member of the Wapiabi Formation on Little Berland River, 195 feet (estimated) above the base of the formation.

Hypotype MF 5080 is from the Thistle Member of the Wapiabi Formation on Belcourt Creek, 310 feet below the base of the Chinook Sandstone.

Distribution: This species ranges through most of the Alberta Group in the Foothills, being generally more prominent in the upper part of the Haven, the Opabin and Muskiki Members.

It was described from the central part (Turonian) of the Kaskapau Formation in the Peace River area of northwestern Alberta and northeastern British Columbia, from levels stratigraphically below those of the Foothills occurrences.

HAPLOPHRAGMOIDES HOWARDENSE MANIFESTUM Stelck and Wall

Plate 8, figures 10, 11; Plate 11, figures 12, 13

Haplophragmoides howardense manifestum Stelck and Wall, 1954, Res. Coun. Alberta Rept. 68, p. 26-28, pl. 1, figs. 3-5, 18; pl. 2, figs. 1, 2.

Description: Test medium to large size, somewhat compressed, planispiral, completely evolute with wide shallow umbilicus exposing all earlier chambers and proloculum on both sides of test, periphery rounded to narrowly rounded, peripheral outline straight to slightly indented; chambers

comprising two to three whorls, nine to twelve in outer whorl, of about the same size, somewhat inflated in some specimens; sutures distinct, slightly depressed, slightly curved, thickened; wall finely agglutinated, with much cement, surface smooth; aperture obscure, an arched opening at the base of the terminal face; color light buff to light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5081 (pl. 8, figs. 10, 11)	0.60	0.14
Hypotype MF 5082 (pl. 11, figs. 12, 13)	0.38	0.09

Types: Hypotype MF 5081 is from the Dowling Member of the Wapiabi Formation on Mistanusk Creek, 164 feet above the top of the Bad Heart Sandstone.

Hypotype MF 5082 is from the Hanson Member of the Wapiabi Formation on Belcourt Creek, 189 feet below the base of the Chinook Sandstone.

Distribution: The range of this subspecies coincides approximately with that of *H. howardense howardense,* but it is much less common than the latter.

Remarks: There are apparently many specimens transitional between this subspecies and *H. howardense howardense,* which factor may be reflected in some occurrence records being estimates rather than accurate counts.

HAPLOPHRAGMOIDES sp. cf. H. ROTA Nauss

Plate 14, figures 5-8

?*Haplophragmoides rota* Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 339, pl. 49, figs. 1a-b, 3a-b—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 134, pl. 31, figs. 16-18—North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 13, pl. 1, fig. 11.

Description: Test large, compressed, planispiral, partly evolute with portion of penultimate whorl and possibly the proloculum visible, very shallow umbilici developed, periphery narrowly rounded; chambers increasing gradually in size, nine to ten in outer whorl; sutures indistinct, flush, nearly radial, thickened; wall agglutinated with considerable range in size of grains, moderate amount of cement, surface somewhat rough; aperture obscure, apparently a low slit-opening at the base of the terminal face; color light brown to brownish-white.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5083 (fig. 5)	0.72	0.14
Specimen MF 5084 (fig. 6)	0.81	0.14
Specimen MF 5085 (figs. 7, 8)	1.04	0.24

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: This species is present in the Nomad Member or transition beds and the Hanson Member, and possibly occurs lower in the Wapiabi Formation in the Foothills.

Identical forms have been observed by the author from the "Upper Pakowki Formation" of the Milk River area in southeastern Alberta.

Remarks: This species may be identical to *H. rota* Nauss from the Grizzly Bear Member of the Belly River Formation in east-central Alberta but lacks the homogeneous wall structure of the latter and has thickened instead of plain sutures. It seems that this species or one closely related is a fairly constant component of several shallow, regressive, brackish-water faunas in Alberta.

HAPLOPHRAGMOIDES sp. 1

Plate 1, figures 22-24

Haplophragmoides sp. A, Stelck and Wall, 1958, *in* Stelck, Wall and Wetter, Res. Coun. Alberta Bull. 2, p. 27, pl. 3, figs. 15, 16.

?*Haplophragmoides* sp. A, Stelck and Wall, 1956, *in* Stelck, Wall, Bahan and Martin, Res. Coun. Alberta Rept. 75, p. 40, pl. 1, fig. 26.

Description: Test medium size, compressed, planispiral, partly evolute with portion of inner whorl exposed, shallow umbilici developed, periphery subangular; about ten nearly equal chambers in outer whorl, slightly scalloped; sutures indistinct, slightly depressed, nearly straight; wall very finely agglutinated, with much translucent cement imparting resinous luster to smooth surface; aperture obscure, a low arch at the base of the terminal face; color light brown.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5086 (figs. 22, 23)	0.46	0.11
Specimen MF 5087 (fig. 24)	0.49	0.11

Types: The figured specimens are from the Sunkay Member of the Blackstone Formation in the railroad cut at Cadomin, 2 to 5 feet above the contact with the underlying Mountain Park Formation.

Distribution: In the central Foothills this species is present also on Cripple Creek from the same level as at Cadomin. It was observed from the basal beds of the Fort St. John Group on Little Berland River in the northern Foothills.

It is present in the upper St. John Shale of northeastern British Columbia at a somewhat higher stratigraphic level, above the "fish-scale sand" (Stelck, Wall and Wetter, 1958).

Remarks: *Haplophragmoides* sp. 1 is probably the same as *Haplophragmoides* sp. A (questionable synonymic entry) from the stratigraphically lower Moosebar Shale of northeastern British Columbia but is larger and more evolute than the latter species.

This species is rather featureless and, as similar forms with the characteristic resinous luster appear at several levels in the Cretaceous of the general region, it is of little stratigraphic value.

Haplophragmoides sp. 2

Plate 11, figures 14-16

Description: Test medium to fairly large size, very strongly compressed and flattened, planispiral, evolute with portion of earlier whorls and proloculum visible, periphery angular, peripheral outline very slightly lobulate; eight to eleven chambers in outer whorl; sutures very indistinct, flush, nearly straight; wall very thin, finely agglutinated or siliceous, with considerable cement, surface smooth and vitreous; aperture not observed; color light brown.

Dimensions:

	Diameter (mm.)	Thickness (estimated) (mm.)
Specimen MF 5088 (fig. 14)	0.51	0.04
Specimen MF 5089 (figs. 15, 16)	0.75	0.05

The size of Specimen MF 5088 is average for the species.

Types: The figured specimens are from the Hanson Member of the Wapiabi Formation on Mill Creek, about 250 feet below the base of the Belly River Formation.

Distribution: This species is present in the Thistle and Hanson Members and the transition beds of the Wapiabi Formation in the Crowsnest Pass and Waterton areas. It is the most prominent component of many samples from these members.

Remarks: This collapsed, thin-walled form may represent a local type of preservation of some previously described species such as *H. collyra* or *H. rota* Nauss. It appears nearly featureless in reflected light, but some characters such as the sutures can be partly determined in transmitted light.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES FRAGMENTARIUS Cushman

Plate 1, figures 7-9

Ammobaculites fragmentaria Cushman, 1927, Trans. Roy. Soc. Can., 3rd ser., vol. 21, sec. 4, p. 130, pl. 1, fig. 8.

Ammobaculites fragmentarius Cushman. Stelck and Wall, 1956, *in* Stelck, Wall, Bahan and Martin, Res. Coun. Alberta Rept. 75, p. 21-22, pl. 5, fig. 18—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 61-62, pl. 4, fig. 11—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 136-138, pl. 32, figs. 8-11 (synonymy in part only; several species are included)—Crespin, 1963, Australia Bur. Min. Resources Bull. 66, p. 39, pl. 7, fig. 15.

Not *Ammobaculites fragmentarius* Cushman—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 23, pl. 3, figs. 10-16—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 62, pl. 2, figs. 16-18.

Description: Test strongly compressed; early portion close coiled, of four to five indistinct chambers; later portion uniserial, of three to six chambers wider than high, and in some specimens increasing gradually in width as added giving test tapered appearance; sutures indistinct, radial in coiled portion, fairly distinct in uniserial portion, essentially transverse, depressed; wall finely agglutinated or siliceous, with much cement, surface fairly smooth and semivitreous; aperture terminal, simple to elliptical; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5090 (fig. 7)	0.83	0.27
Hypotype MF 5091 (fig. 8)	0.83	0.30
Hypotype MF 5092 (fragment, fig. 9)	0.71	0.43

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation in the railroad cut at Cadomin, 2 to 10 feet above the contact with the underlying Mountain Park Formation.

Distribution: This species is probably present at Cripple Creek in the central Foothills from the same level as at Cadomin. It was also observed from the basal beds of the Fort St. John Group on Little Berland River in the northern Foothills.

This species is a common constituent of the microfauna above the Viking Sand in the subsurface Colorado Shale of central Alberta but also occurs at lower stratigraphic levels. It has been reported from a number of regions in the North American continent outside of Western

Canada, but it is doubtful if the specimens involved are properly referred to *A. fragmentarius* with the probable exception of those illustrated by Eicher and by Tappan.

Remarks: Tappan has proposed a lengthy synonymy embracing several names of species from the Cretaceous of Western Canada previously recognized as distinctive taxonomic units by various workers. The author concedes that *A. humei* Nauss is possibly a synonym of *A. fragmentarius* but after examining the types rejects the equating of *A. coprolithiforme* (Schwager) Cushman, 1927 and *A. tyrrelli* Nauss with this species. Tappan also included *Reophax texana* Cushman and Waters of Wickenden, 1932 (not Cushman and Waters, 1927) with *A. fragmentarius*, but the author believes it should be only compared with the latter and has done this herein.

Tappan's synonymy seems to be at least partly based on the practice of using suites of specimens from areas far distant from the type area of a species to alter or emend the characters of that species. In the author's opinion any such emendation should be based on topotype material; otherwise, the whole concept of recognizing a fossil species based on a morphological type or types with a designated type locality and stratigraphic level is rendered inoperable.

AMMOBACULITES sp. cf. A. FRAGMENTARIUS Cushman

Plate 7, figures 18-20

Reophax texana Cushman and Waters. Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 204, pl. 29, fig. 1 (not *Reophax texana* Cushman and Waters, 1927).

?*Ammobaculites coprolithiformis* (Schwager). Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 204-205, pl. 29, fig. 2.

Description: Test small to medium size, cylindrical to compressed; early portion close coiled, of about four indistinct chambers; later portion uniserial, of two to four chambers of about equal dimensions, somewhat constricted at the sutures; sides of test nearly parallel; sutures very indistinct in coiled portion, indistinct in uniserial portion, essentially transverse, depressed; wall agglutinated, moderate amount of siliceous-appearing cement, surface somewhat rough; aperture terminal, simple to slightly produced; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5093 (fig. 18)	0.46	0.21
Specimen MF 5094 (fig. 19)	0.57	0.20
Specimen MF 5095 (fig. 20)	0.75	0.20

Types: The figured specimens are from the Dowling Member of the Wapiabi Formation on Mill Creek, 564 feet above the base of the formation.

Distribution: This species was recorded in the Foothills from the Cardium Formation to the Thistle Member of the Wapiabi Formation. It is common to abundant in the Dowling and Thistle Members at Mill Creek.

Remarks: This species may be identical to *A. fragmentarius*, as suggested by Tappan, but a study of assemblages shows it to be somewhat smaller with fewer chambers in the uniserial portion, to have parallel sides with no tendency toward tapering, and to have a rougher finish with poorly defined features.

Although both of the above synonymic entries were included in the synonymy of *A. fragmentarius* by Tappan (1962), the author, after examing Wickenden's figured specimens, believes that there is some doubt as to whether these forms are identical. The figured specimen of *A. coprolithiformis* (Schwager) Wickenden is more slender and elongate, seems to have more chambers in the coiled portion, and its features are better defined than those in the specimen of *R. texana*. However, such differences should be regarded perhaps only as individual variations, and for practical purposes the two forms may be considered identical.

Ammobaculites sp. 1

Plate 5, figures 1, 2

Description: Test rather small, cylindrical; early portion close coiled but not completely involute, fairly distinct, with about five chambers visible in outer whorl, the coil forming the greatest width of the test; later portion uniserial, of three chambers of about equal dimensions; sides of test nearly parallel; sutures distinct, radial in coiled portion, transverse to oblique in uniserial portion, depressed; wall agglutinated, partly replaced by pyrite in some specimens, considerable amount of cement, surface somewhat rough; aperture terminal, simple; color buff to orange in non-pyritized specimens.

Dimensions:

	Length (mm.)	Diameter of coil (mm.)	Width of uniserial portion (mm.)
Specimen MF 5096 (fig. 1)	0.49	0.20	0.14
Specimen MF 5097 (fig. 2)	0.55	0.18	0.14

Types: The figured specimens are from the Wapiabi Formation on Thistle Creek.

Specimen MF 5096 is from the Muskiki Member, 105 feet above the base.

Specimen MF 5097 is from the Marshybank Member, 205 feet above the base of the formation.

Distribution: This form was identified only from the above members on Thistle Creek, but it may be present at other localities in the Foothills, its occurrences not having been separated from those of *Ammobaculites* sp. cf. *A. fragmentarius*.

Remarks: This form may represent a local superior type of preservation of *Ammobaculites* sp. cf. *A. fragmentarius*, but as its features are much more distinct, it is described and figured separately.

Ammobaculites sp. 2

Plate 10, figures 10-12

Description: Test medium to large size, robust to somewhat compressed; early portion close coiled, involute, indistinct, of three to four chambers, the coil forming the greatest width of the test in most specimens; later portion uniserial, of two to three, rarely four, chambers of approximately equal dimensions; sutures indistinct, depressed and nearly transverse in uniserial portion; wall agglutinated with fairly coarse grains, moderate amount of siliceous cement, surface rough; aperture round to elliptical, terminal, produced; color grey or colorless.

Dimensions:

	Length (mm.)	Diameter of coil (mm.)	Width of uniserial portion (mm.)
Specimen MF 5098 (fig. 10)	1.03	0.34	0.42
Specimen MF 5099 (fig. 11)	1.20	0.42	0.34
Specimen MF 5100 (fig. 12)	1.43	0.50	0.43

Types: The figured specimens are from the lowest part of the Thistle Member of the Wapiabi Formation on Mill Creek, in beds transitional to the underlying Dowling Member, 654 feet above the base of the formation.

Distribution: This species is most prominent in the Thistle Member on Mill Creek, but it was also recorded from the underlying Dowling and Marshybank Members at various localities in the southern and central Foothills.

Remarks: This species bears a general resemblance to *Reophax* sp. 2 of this publication but possesses a coiled portion although this is somewhat indistinct.

Ammobaculites? sp. 3

Plate 14, figures 1-4

Description: Test fairly large, compressed, consisting of a partly evolute coiled portion only; shallow umbilici developed, periphery sharp, per-

ipheral outline somewhat indented; about eight chambers in outer whorl, partly scalloped, final chamber rectangular in outline; sutures indistinct, radial, flush to slightly depressed, their positions emphasized in part by crushing of the chambers; wall agglutinated with fairly coarse grains, moderate amount of cement, surface rough; aperture an elongate slit on the narrow septal face extending from outer point of periphery to base of last chamber; color grey.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5101 (figs. 1, 2)	0.95	0.13
Specimen MF 5102 (figs. 3, 4)	0.95	0.18

Types: The figured specimens are from the transition beds of the Wapiabi Formation.

Specimen MF 5101 is from Mill Creek, 79 feet below a 30-foot massive sandstone unit regarded as the base of the Belly River Formation.

Specimen MF 5102 is from Dungarvan Creek.

Distribution: This species as herein described and illustrated is associated with the transition beds on Mill and Dungarvan Creeks, although it is probably present lower in the Wapiabi Formation. The latter representatives, however, are considerably smaller and may not belong to this species.

Genus Flabellammina Cushman, 1928

Flabellammina magna Alexander and Smith

Plate 8, figure 5; Plate 10, figures 1-4

Flabellammina magna Alexander and Smith, 1932, Jour. Paleont., vol. 6, no. 4, p. 306-307, pl. 46, figs. 10, 11—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 25, pl. 4, figs. 7-8—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 64, pl. 3, figs. 13, 14.

Description: Test large, thick, somewhat compressed; early portion coiled, indistinct, of three to four chambers; later portion uniserial, of three to six chambers, increasing in width as added, more rapidly in presumed microspheric form than in megalospheric form, where apertural end may be somewhat pointed (pl. 10, figs. 3, 4); sutures indistinct, arched and depressed in uniserial portion; wall agglutinated with generally coarse grains, moderate amount of cement, surface rough in most specimens; aperture terminal, elliptical, indistinct; color usually grey, occasionally light orange.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5103 (pl. 8 ,fig. 5) =microspheric? form	1.37	0.84	0.15
Hypotype MF 5104 (pl. 10, fig. 1) =juvenile, microspheric? form	1.38	0.99	0.22
Hypotype MF 5105 (pl. 10, fig. 2) =adult, microspheric? form	2.34	1.35	0.34
Hypotype MF 5106 (pl. 10, fig. 3) =juvenile, megalospheric? form	1.61	0.79	0.24
Hypotype MF 5107 (pl. 10, fig. 4) =adult, megalospheric? form	1.84	0.82	0.21

Types: Hypotype MF 5103 is from the Dowling Member of the Wapiabi Formation on Ram River, 356 feet above the base of the formation.

Hypotypes MF 5104 to 5107 are from the lowest part of the Thistle Member of the Wapiabi Formation on Mill Creek, in beds transitional to the underlying Dowling Member, 654 feet above the base of the formation.

Distribution: This species seems best developed near the upper boundary of the *Brachycythere-Bullopora* assemblage of this publication, which changes position along the Foothills with respect to the rock-stratigraphic units of the Wapiabi Formation. In the Crowsnest Pass and Turner Valley areas, this species is most prominent in the lower part of the Thistle Member or upper part of the Dowling Member, whereas to the north in the Nordegg and Cadomin areas, it is most prominent in the lower part of the Dowling Member or in the Marshybank Member. In the farthest north section studied, on Mistanusk Creek, this species is weakly developed in the Muskiki Member.

In Texas the species is reported by Cushman and by Frizzell from the Taylor Group of Late Cretaceous age.

Remarks: Hypotype MF 5103 from the Ram River differs somewhat from the Mill Creek specimens in being more compressed and in having more distinct sutures and a smoother, light orange surface.

Genus Coscinophragma Thalmann, 1951

Coscinophragma? codyensis (Fox)

Plate 7, figures 8-13

Clavulina? sp., Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 205-206, pl. 29, fig. 5.
Polyphragma sp., Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 51, pl. 15, figs. 15, 16.

Polyphragma codyensis Fox, 1954, U.S. Geol. Surv. Prof. Paper 254-E, p. 113-114, pl. 25, figs. 1-4.

Description: Test generally large, robust, cylindrical in cross section, some specimens curved; early portion close coiled, involute, indistinct, of about four chambers, broken off in nearly all specimens; later portion uniserial, with up to nine low chambers, gradually increasing in width in many specimens, last chamber usually longer than previous ones; sutures indistinct to very indistinct, depressed and nearly transverse in uniserial portion; wall thick, agglutinated with variable-size grains, moderate amount of siliceous cement, surface fairly smooth to somewhat rough; aperture terminal, obscure; color grey to greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5108 (fig. 8) =incomplete curved specimen	1.64	0.59
Hypotype MF 5109 (fig. 9) =incomplete curved specimen	1.07	0.45
Hypotype MF 5110 (fig. 10) =later portion of incomplete specimen	1.00	0.43
Hypotype MF 5111 (fig. 11) =complete specimen with coil	1.79	0.47
Hypotype MF 5112 (fig. 12) =later portion of incomplete specimen	1.55	0.50
Hypotype MF 5113 (fig. 13) =initial portion of incomplete specimen	0.99	0.32

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation on Mill Creek.

Hypotypes MF 5109, 5110, 5112 and 5113 are from 474 feet above the base of the formation.

Hypotypes MF 5108 and 5111 are from 544 and 614 feet, respectively, above the base.

Distribution: This species is common in the Dowling Member at Mill Creek and is also present in the underlying Marshybank Member there and at Oldfort Creek. It is rare in the Muskiki Member of the Wapiabi at Oldfort Creek, Ram River and Thistle Creek.

Wickenden reported this species in the subsurface Alberta Shale of the Plains of southern Alberta, about 420 to 530 feet below the top of the formation, and commented that it marks an easily recognized and consistent horizon. Fox described this species from the lower part of the Cody

Shale at Greybull, Wyoming, and drew attention to its widespread occurrence and stratigraphic significance. The author has collected this distinctive species from an exposure of the medial or second division of the Kevin Shale Member of the Marias River Formation on the MacGowan lease of the Kevin-Sunburst oil field, Toole County, northern Montana.

Remarks: There is some doubt as to whether this species is correctly assigned to the genus *Coscinophragma*. Although it seems to be identical to the one Fox described and assigned to *Polyphragma*, an invalid name replaced by *Coscinophragma* (Loeblich and Tappan, 1964, p. C248), it lacks or fails to reveal because of inferior preservation certain characters of this genus. For example, there is no indication of a cribrate aperture or labyrinthic wall structure, but it is likely that such characters, if present, would have been obliterated by the silicification which most or all of these Foothills specimens have undergone. Also, a few of these specimens seem to have an early coil, a character not included in the description of *Coscinophragma*.

Family TEXTULARIIDAE Ehrenberg, 1838

Genus SPIROPLECTAMMINA Cushman, 1927

SPIROPLECTAMMINA SEMICOMPLANATA (Carsey)

Plate 5, figures 22-29

Textularia semicomplanata Carsey, 1926, Univ. Texas Bull. 2612, p. 25, pl. 3, fig. 4.

Spiroplectammina semicomplanata (Carsey)—Plummer, 1931 (part), Univ. Texas Bull. 3101, p. 129, pl. 8, fig. 7 (not fig. 8)—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 28, pl. 6, figs. 5-14 (synonymy)—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 67, pl. 4, figs. 18a-b.

Description: Test elongate, tapering, compressed with greatest thickness median and edges usually rather sharp, diamond-shaped in cross section; early portion coiled, of about six chambers; later portion biserial, of five to seven pairs of interlocking chambers, considerably wider than high; sutures distinct, slightly depressed, gently curved in coil, curved gently backward toward periphery in biserial portion; wall finely agglutinated, much cement, surface smooth; aperture a broadly arched opening at the base of the last chamber; color buff to light orange.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5114 (figs. 22, 23)	0.37	0.24	0.14
Hypotype MF 5115 (figs. 24, 25)	0.39	0.23	0.13
Hypotype MF 5116 (figs. 26, 27)	0.49	0.25	0.18
Hypotype MF 5117 (figs. 28, 29)	0.59	0.30	0.21

Types: Hypotypes MF 5114 and 5115 are from the Marshybank Member of the Wapiabi Formation on Oldfort Creek, 213 feet above the base of the formation.

Hypotype MF 5116 is from the Muskiki Member of the Wapiabi Formation on Ram River, 214 feet above the base of the formation.

Hypotype MF 5117 is from the Muskiki Member of the Wapiabi Formation on Mistanusk Creek, 160 feet above the contact with the underlying Cardium Formation.

Distribution: This species is one of the most characteristic components of Wapiabi assemblages from the Foothills. Its range extends from the Muskiki into the Thistle Member, but it is rare in the latter except at the Mill Creek and Highwood River localities. It is also present in the Cardium Formation on Little Berland River but was nowhere observed in the underlying Blackstone Formation.

In the Gulf Coast region of the United States, Cushman and Frizzell both reported this species from the Taylor and Navarro Groups of Late Cretaceous age and from the Midway Group of Paleocene age.

Remarks: Hypotype MF 5117 from Mistanusk Creek represents a population in which the wall structure is coarser with the grains plainly visible, the sutures are quite indistinct and the edges tend to be rounded. This northern Foothills population could probably be distinguished from southern relatives and treated as a subspecies.

SPIROPLECTAMMINA sp. 1

Plate 7, figures 14-17

Description: Test small, tapering, very strongly compressed, with the edges sharp; early portion coiled, of five chambers; later portion biserial, of two to four pairs of interlocking chambers, considerably wider than high; sutures distinct, flush to very slightly depressed, curved in coil, oblique in biserial portion; wall thin, finely agglutinated, much cement, surface smooth; aperture a moderately arched opening at the base of the last chamber; color light buff.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5118 (figs. 14, 15) =megalospheric? form	0.21	0.17	0.07
Specimen MF 5119 (figs. 16, 17) =microspheric? form	0.23	0.13	0.07

Unfigured specimens range from 0.16 mm. to 0.32 mm. in length.

Types: The figured specimens are from the Dowling Member of the Wapiabi Formation on Thistle Creek, 667 feet above the base of the formation.

Distribution: In addition to about 12 specimens of this form observed at the above locality, representatives were also identified from the same member at Ram River. It is probably present at other Foothills localities, but as some specimens are gradational to S. *semicomplanata,* they may not have been distinguished from the latter.

Remarks: This form differs from S. *semicomplanata* in being smaller with a more strongly compressed, thin-walled test and in having fewer chambers.

SPIROPLECTAMMINA sp. 2

Plate 14, figures 9-12

Description: Test fairly small, elongate, slightly compressed with rounded periphery; sides of test only slightly tapering, nearly parallel; early portion coiled, of five to six chambers; later portion biserial, of about five pairs of interlocking chambers, somewhat wider than high; sutures distinct, slightly depressed, gently curved in coil, oblique in biserial portion; wall finely agglutinated, much cement, surface smooth; aperture a low opening at the base of the last chamber; color light buff.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5120 (figs. 9, 10) =microspheric? form	0.36	0.15	0.13
Specimen MF 5121 (figs. 11, 12) =megalospheric? form	0.26	0.16	0.11

Unfigured specimens range from 0.16 mm. to 0.45 mm. in length.

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: In addition to about 20 specimens of this form observed at the above locality, representatives were obtained from the underlying Hanson and Thistle Members in the Waterton area. It was also observed from the Thistle Member on Mistanusk Creek in the northern Foothills. It is probably present at other Foothills localities, but as some specimens are gradational to S. *semicomplanata,* they may not have been distinguished from the latter.

Remarks: This form differs from S. *semicomplanata* in having a rounded periphery and nearly parallel sides.

Genus Pseudobolivina Wiesner, 1931

Pseudobolivina rollaensis (Stelck and Wall)

Plate 4, figures 20-23; Plate 7, figures 21-26

Textularia rollaensis Stelck and Wall, 1954, Res. Coun. Alberta Rept. 68, p. 30-31, pl. 1, fig. 17—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 55, pl. 2, figs. 34, 35—Wall, 1960, Res. Coun. Alberta Bull. 6, p. 21-22, pl. 4, figs. 16-19.

Description: Test elongate, tapering, slightly to moderately compressed with the edges rounded to subrounded; initial portion slightly twisted in some specimens and broken off in many others; six to eight pairs of chambers in an interlocking biserial arrangement, of nearly equal dimensions, increasing regularly in size with the last two pairs comprising one third to nearly one half of length of test in most specimens; sutures distinct, oblique, depressed; wall finely agglutinated, partially replaced by pyrite in many specimens, much cement, surface smooth; aperture a prominent notch at the inner margin of the last-formed chamber extending well up onto the terminal face; color buff to light orange in nonpyritized specimens.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5122 (pl. 4, figs. 20, 21)	0.37	0.13	0.09
Hypotype MF 5123 (pl. 4, figs. 22, 23)	0.32	0.12	0.08
Hypotype MF 5124 (pl. 7, figs. 21, 22)	0.71	0.18	0.08
Hypotype MF 5125 (pl. 7, fig. 23)	0.50	0.18	0.07
Hypotype MF 5126 (pl. 7, figs. 24, 25) (initial portion broken off)	0.59	0.17	0.11
Hypotype MF 5127 (pl. 7, fig. 26)	0.53	0.16	0.11

Types: Hypotypes MF 5122 and 5123 are from the Opabin Member of the Blackstone Formation on Ghost River, 26 feet below the base of the overlying Cardium Formation.

Hypotypes MF 5124 and 5125 are from the Dowling Member on Meander Creek (tributary of Belcourt Creek), 150 feet above the Bad Heart Sandstone.

Hypotypes MF 5126 and 5127 are from the Dowling Member of the Wapiabi Formation on Mistanusk Creek, 138 and 164 feet, respectively, above the top of the Bad Heart Sandstone.

Distribution: In the Foothills this species was found to extend from the Haven Member of the Blackstone Formation to the Hanson Member of the Wapiabi Formation, being most prominent in the Dowling Member of the Wapiabi in the upper Wapiti River area.

Its occurrences in the Peace River area reported by Stelck and Wall (1954, 1955) and by Wall (1960) also indicate a long range, from the lower part of the Kaskapau Formation (late Cenomanian) to the lower part of the Puskwaskau Formation (early Santonian).

Remarks: The few specimens observed in the Blackstone are smaller than those from the Wapiabi Formation. A similar size differential was noted by the author (1960) in the Peace River area, where the type specimens from the Kaskapau are considerably smaller than those from the Puskwaskau Formation.

When the authors proposed this species they realized that its slender and slightly twisted test together with its high notch-like aperture were not typical characters of the genus *Textularia*. The author had not been aware of the existence of the genus *Pseudobolivina* Wiesner, to which this species should have been referred, until the publication of the foraminiferal portion of the Geological Society of America Treatise on Invertebrate Paleontology (Loeblich and Tappan, 1964).

Pseudobolivina sp. 1

Plate 4, figure 24; Plate 11, figures 17-24

Description: Test small to medium size, elongate, tapering, slightly compressed with the edges typically rounded, but extremely compressed with sharp periphery in some apparently collapsed specimens; five to six pairs of chambers in an interlocking biserial arrangement, the early pairs quite small and of about equal dimensions, the later pairs increasing regularly in height as added tending to be somewhat higher than wide; sutures distinct, depressed, moderately to strongly oblique; wall finely agglutinated, much cement, surface smooth, thin and collapsed in some specimens, partly replaced by pyrite in some others; aperture terminal, round, slightly produced, not in contact with the base of the last chamber; color light buff to buff in nonpyritized specimens.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5128 (pl. 4, fig. 24)	0.39	0.13	0.09
Specimen MF 5129 (pl. 11, figs. 17, 18)	0.47	0.17	0.11
Specimen MF 5130 (pl. 11, figs. 19, 20)	0.38	0.18	0.12
Specimen MF 5131 (pl. 11, figs. 21, 22)	0.50	0.15	0.10
Specimen MF 5132 (pl. 11, figs. 23, 24)	0.56	0.22	0.03

Types: Specimen MF 5128 is from the Haven Member of the Blackstone Formation on Luscar Creek near Cadomin, about 250 feet below the base of the Cardium Formation.

Specimen MF 5130 is from the Thistle Member of the Wapiabi Formation on Belcourt Creek, 310 feet below the base of the Chinook Sandstone.

Specimens MF 5129 and 5131 are from the Hanson Member of the Wapiabi Formation on Belcourt Creek, 170 feet below the base of the Chinook Sandstone.

Specimen MF 5132 is from the Hanson Member of the Wapiabi Formation on Mill Creek, about 200 feet below the base of the Belly River Formation.

Distribution: The range of this species in the Foothills extends from the Haven Member of the Blackstone Formation to the transition beds of the Wapiabi Formation. Small specimens with high chambers and strongly oblique sutures seem characteristic of the Haven Member. Collapsed specimens with indistinct features are fairly common in the Thistle and Hanson Members of the Wapiabi Formation in the Crowsnest Pass and Waterton areas. This species also was recorded in the upper part of the Kaskapau Formation on Mistanusk Creek, from beds approximately equivalent in stratigraphic position to the Haven Member to the south.

Remarks: This species is similar in chamber arrangement to *P. rollaensis* but has a definite terminal aperture. In poorly preserved material it may be difficult to separate these two species.

The specimens from the Haven Member of the Blackstone Formation with their higher chambers and more oblique sutures possibly should be regarded as representing another taxonomic unit.

Family Trochamminidae Schwager, 1877

Genus Trochammina Parker and Jones, 1859

Trochammina ribstonensis Wickenden

Plate 10, figures 20-25

Trochammina ribstonensis Wickenden, 1932, Trans. Roy. Soc. Can., 3rd ser., vol. 26, sec. 4, p. 90-91, pl. 1, figs. 12a-c—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 50, pl. 15, figs. 9a-c—Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 340, pl. 49, figs. 6a-c—Wall, 1960 (part), Res. Coun. Alberta Bull. 6, p. 27, pl. 5, figs. 10-12 (not figs. 7-9)—Tappan, 1962 (part), U.S. Geol. Surv. Prof. Paper 236-C, p. 154-155, pl. 39, figs. 16, 17 (not figs. 15a-c).

Description: Test very small, compressed, periphery somewhat narrowly rounded, peripheral margin nearly entire; test very low trochospiral, of two and one-half whorls, umbilical side partly evolute with shallow umbilicus; chambers increasing very gradually in size, seven to eight in final whorl; sutures distinct, depressed, curved on both sides of test; wall finely agglutinated, much cement, surface smooth; aperture obscure, apparently a slit at the base of the last chamber extending toward the umbilicus; color grey-buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5133 (figs. 20-22)	0.14	0.05
Hypotype MF 5134 (figs. 23-25)	0.16	0.04

Types: The hypotypes are from the Thistle Member of the Wapiabi Formation.

Hypotype MF 5133 is from Belcourt Creek, 327 feet below the base of the Chinook Sandstone.

Hypotype MF 5134 is from Mistanusk Creek, 390 feet above the top of the Bad Heart Sandstone.

Distribution: Most occurrences of this species were recorded from the Dowling, Thistle and Hanson Members of the Wapiabi Formation in the upper Wapiti River area, that is, from beds above the upper or first white-speckled shale "zone". The species is rare in the Foothills to the south, a few specimens being obtained from the Dowling Member at Little Berland River, Thistle Creek and Ram River.

In the central Foothills it is difficult to determine the relative positions of *T. ribstonensis* and the upper white-speckled shale "zone" or its associated pelagic microfauna, as one or both of the latter features may be absent or weakly developed. It would appear, however, that these positions are nearly coincident, with the range of this species perhaps extending below the upper white-speckled shale "zone".

This species has a wide distribution in the Plains region of Alberta and Saskatchewan, being recorded usually over a short interval above the top of the Colorado Group, which is marked by the uppermost occurrence of the first or upper white-speckled shale "zone". Nauss stated that it is restricted to the lower 40 feet of the Lea Park Formation in the Vermilion area of east-central Alberta, and Wickenden earlier (1941) had mentioned its common occurrence in the same strata of western Saskatchewan. The author reported this species from the Puskwaskau Formation along the lower Smoky River in northern Alberta in association with the upper white-speckled shale "zone" and in beds immediately below this zone. Tappan recorded this species from the Seabee and Schrader Bluff Formations of northern Alaska, but the hypotype (pl. 39, figs. 15a-c) from the latter formation shows such deviation from the holotype and topotypes of this species, that its identification appears doubtful.

Remarks: The Foothills specimens lack the chamber inflation of type-area specimens from east-central Alberta. This factor does not seem to be related to fossilization, as the former do not appear crushed and the peripheral margins are almost entire.

TROCHAMMINA sp. cf. T. RIBSTONENSIS Wickenden

Plate 8, figures 18-20; Plate 10, figures 13-15

Trochammina ribstonensis Wickenden. Wall, 1960 (part), Res. Coun. Alberta Bull. 6, p. 26-27, pl. 5, figs. 7-9 (not figs. 10-12).

Description: Test small to medium size, periphery subangular to narrowly rounded, peripheral margin nearly entire; test low to moderate trochospiral, of two and one-half whorls, umbilical side involute, flat to concave with fairly prominent umbilicus; chambers very gradually increasing in size, the five to seven in final whorl slightly inflated; sutures distinct, slightly depressed, curved on spiral side, slightly curved on umbilical side; wall finely agglutinated, much cement, surface smooth; aperture a low arched slit on the inner margin of the umbilical side of the last chamber extending into the umbilicus; color grey to light orange.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5135 (pl. 8, figs. 18-20)	0.21	0.05
Specimen MF 5136 (pl. 10, figs. 13-15)	0.24	0.09

Types: Specimen MF 5135 is from the Dowling Member of the Wapiabi Formation on Mistanusk Creek, 262 feet above the top of the Bad Heart Sandstone.

Specimen MF 5136 is from the Thistle Member of the Wapiabi Formation on Belcourt Creek, 300 feet below the base of the Chinook Sandstone.

Distribution: This form was recorded from the Dowling, Thistle and Hanson Members of the Wapiabi Formation in the northern and central Foothills, and with a few exceptions it is restricted to strata above the level of the upper or first white-speckled shale "zone". It is rare to uncommon at most localities but is fairly prominent in the Thistle Member on Belcourt Creek. It is generally found in association with specimens referred to *T. ribstonensis* in this report.

Remarks: This form differs from *T. ribstonensis s.s.* in being somewhat larger and in lacking the subglobular chambers and lobulate peripheral margin of type-area specimens, which generally have more chambers. It is identical to a form from the upper white-speckled shale "zone" in the Puskwaskau Formation on the lower Smoky River, which the author (1960) assigned in error to *T. ribstonensis*.

Differences between this form, the one identified in this report as *T. ribstonensis* and type-area specimens, although perceptible, are perhaps of insufficient magnitude to warrant any taxonomic separation.

TROCHAMMINA RUTHERFORDI Stelck and Wall

Plate 2, figures 8-31; Plate 4, figures 8-13

Trochammina rutherfordi (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 10, 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 56-57, pl. 1, figs. 11, 12—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 899-900, pl. 105, figs. 1a-c.

Trochammina rutherfordi variety 1, Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 57-58, pl. 1, figs. 14a-c; pl. 3, figs. 20, 21.

Trochammina rutherfordi variety 2, Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 58-59, pl. 1, figs. 15, 16; pl. 3, figs. 36-37—Stelck and Wall, 1958, *in* Stelck, Wall and Wetter, Res. Coun. Alberta Bull. 2, p. 34, pl. 4, figs. 1-5.

Trochammina sp. cf. *T. rutherfordi* Stelck and Wall, 1958, *in* Stelck, Wall and Wetter, Res. Coun. Alberta Bull. 2, p. 33-34, pl. 4, figs. 6-10.

Trochammina ribstonensis Wickenden subspecies *rutherfordi* Stelck and Wall. Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 155-156, pl. 39, figs. 18-20.

Description: Test small to medium size, periphery rounded (except in compressed specimens), peripheral margin nearly straight to somewhat lobulate; test low trochospiral, of two to three whorls, umbilical side involute with fairly prominent umbilicus; chambers gradually enlarging in size, somewhat inflated, five to eight in final whorl; sutures distinct, depressed, slightly curved on spiral side, radial on umbilical side, thickened in some specimens; wall finely agglutinated, considerable cement, surface smooth; aperture a low opening on the umbilical side of the final chamber between umbilicus and periphery, obscure in most specimens; color buff to mottled buff-brown.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5137 (pl. 2, figs. 8-10)	0.50	0.13
Hypotype MF 5138 (pl. 2, figs. 11-13)	0.29	0.08
Hypotype MF 5139 (pl. 2, figs. 14-16)	0.30	0.07
Hypotype MF 5140 (pl. 2, figs. 17-19)	0.47	0.17
Hypotype MF 5141 (pl. 2, figs. 20-22)	0.40	0.15
Hypotype MF 5142 (pl. 2, figs. 23-25)	0.29	0.09
Hypotype MF 5143 (pl. 2, figs. 26-28)	0.32	0.11
Hypotype MF 5144 (pl. 2, figs. 29-31)	0.36	0.12
Hypotype MF 5145 (pl. 4, figs. 8-10)	0.38	0.16
Hypotype MF 5146 (pl. 4, figs. 11-13)	0.33	0.14

Types: Hypotypes MF 5137 to 5144 are from the Sunkay Member of the Blackstone Formation on Ghost River, 2 feet above the contact with the underlying Blairmore Group.

Hypotype MF 5145 is from the Haven Member of the Blackstone Formation on Ghost River, 241 feet below the base of the Cardium Formation.

Hypotype MF 5146 is from the Haven Member on Luscar Creek near Cadomin, about 270 feet below the base of the Cardium Formation.

Distribution: This species was recorded from the Sunkay and Haven Members of the Blackstone Formation in the Foothills.

It was described originally from the lower part of the Kaskapau Formation in the Peace River Plains region of northern Alberta, and was subsequently reported from the underlying Dunvegan Formation and upper part of the St. John Shale by Stelck, Wall and Wetter (1958). The author also has observed this species in the subsurface of central Alberta from that part of the Colorado Group between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above). Tappan reported this species from the Grandstand (upper Albian) and Ninuluk (Cenomanian) Formations of northern Alaska. Eicher recorded this species from the upper part of the Mowry Shale and from the Graneros Shale in Colorado.

Remarks: Hypotypes MF 5137, 5140, 5141 and 5144 are somewhat larger than the type specimens of *T. rutherfordi s.s.* from the Kaskapau Formation.

Hypotypes MF 5138 and 5139 are compressed and nearly flat but appear to belong to the same taxonomic unit as the previously mentioned hypotypes from the same assemblage.

Hypotypes MF 5142 and 5143 have eight chambers with thickened sutures and formerly would have been designated as *T. rutherfordi* variety 1. It now seems probable, however, as indicated by Tappan (1962), that this variety and also "variety 2" represent only individual variations within the species.

TROCHAMMINA WETTERI Stelck and Wall

Plate 8, figures 21-26; Plate 10, figures 7-9

Trochammina wetteri (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 10, 11, 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 59-60, pl. 2, figs. 1-3, 6a-c—Wall, 1960, Res. Coun. Alberta Bull. 6, p. 27-28, pl. 5, figs. 1-6.

Description: Test medium size, periphery fairly broad and round, peripheral margin lobulate; test low trochospiral in most specimens, of about two and one-half whorls, umbilical side involute with moderate umbilicus developed; four to five chambers in final whorl considerably larger than those in earlier whorls, inflated, globigerinoid; sutures distinct, depressed, very slightly curved on spiral side, straight on umbilical side; wall finely agglutinated, partially replaced by pyrite in some specimens,

much cement, surface smooth; aperture a broadly arched opening on the umbilical side at the base of the last chamber, obscure in these specimens; color grey to yellow-buff in nonpyritized specimens.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Hypotype MF 5147 (pl. 8, figs. 21-23)	0.28	0.20
Hypotype MF 5148 (pl. 8, figs. 24-26)	0.31	0.12
Hypotype MF 5149 (pl. 10, figs. 7-9)	0.33	0.13

Types: The hypotypes are from the Wapiabi Formation on Mistanusk Creek.

Hypotypes MF 5147 and 5148 are from the Dowling Member, 262 feet above the top of the Bad Heart Sandstone.

Hypotype MF 5149 is from the Thistle Member, 390 feet above the top of the Bad Heart Sandstone.

Distribution: The range of this species in the Foothills seems to extend through most of the Wapiabi Formation, although it is more prominent in the Dowling, Thistle and Hanson Members in the upper Wapiti River area.

This species was described originally from the lower part of the Kaskapau Formation in the Peace River area of the Plains region of northern Alberta and was also reported by the author (1960) from the Puskwaskau Formation on the lower Smoky River in northern Alberta.

Trochammina sp. 1

Plate 5, figures 12-20

Description: Test medium size, compressed, plano-convex with spiral side nearly flat, periphery angular, peripheral outline slightly lobulate; test trochospiral, of two and one-half whorls, umbilical side nearly involute with moderate umbilicus developed; chambers gradually enlarging in size, the six and one-half to seven in final whorl inflated on umbilical side; sutures distinct, slightly thickened, gently curved, flush on spiral side, depressed on umbilical side; wall finely agglutinated, much cement, surface smooth; aperture obscure, apparently a low slit-opening at the base of the last chamber; color light buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5150 (figs. 12-14)	0.28	0.08
Specimen MF 5151 (figs. 15-17)	0.28	0.11
Specimen MF 5152 (figs. 18-20)	0.29	0.09

Types: The figured specimens are from the Muskiki Member of the Wapiabi Formation.

Specimen MF 5150 is from Oldfort Creek, 52 feet above the base of the formation.

Specimens MF 5151 and 5152 are from Highwood River, 27 feet above the base of the formation.

Distribution: This species is a characteristic component of the microfauna of the Muskiki Member of the Wapiabi Formation in the southern and central Foothills, which has been designated as the *Trochammina* sp. 1 assemblage in this publication.

The author also has collected this species from an exposure of the middle unit of the Kevin Shale Member of the Marias River Formation, below the MacGowan concretionary bed, in the Kevin-Sunburst oil field, Toole County, northern Montana.

Remarks: This species with its plano-convex, *Gyroidina*-like outline is similar in this respect to *T. gyroides* Cushman and Waters from the Upper Cretaceous Navarro Group of Texas, but the Foothills form is considerably less convex and has more chambers and better defined sutures than the Texas species. *Trochammina* sp. 1 has probably not been hitherto described, but as new names are not being proposed herein, it is left as a *nomen apertum*.

TROCHAMMINA sp. 2

Plate 11, figures 1-8

Description: Test medium to fairly large size, strongly compressed, flattened, periphery acute, peripheral margin lobulate; whorls and chambers indistinct, between five and six chambers in outer whorl; sutures indistinct, nearly straight; wall thin, finely agglutinated, with much siliceous cement imparting resinous luster, surface smooth; aperture not observed; color light brown.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5153 (figs. 1-3)	0.41	0.05
Specimen MF 5154 (figs. 4, 5)	0.37	0.04
Specimen MF 5155 (figs. 6-8)	0.49	0.09

Unfigured specimens range from 0.23 mm. to 0.55 mm. in diameter.

Types: The figured specimens are from the Hanson Member of the Wapiabi Formation on Mill Creek, about 200 feet below the base of the Belly River Formation.

Distribution: This form apparently ranges through most of the Wapiabi Formation but is more prevalent in the upper part. It is quite common in some samples from the Thistle and Hanson Members and the transition beds in the Crowsnest Pass and Waterton areas.

Remarks: This rather featureless collapsed form probably represents a thin-walled variation of *T. wetteri* or a similar species. In the northern Foothills some specimens were observed which appear transitional to *T. wetteri*.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Genus VERNEUILINA d'Orbigny, 1839

VERNEUILINA CANADENSIS Cushman

Plate 1, figures 14, 15

Verneuilina canadensis Cushman, 1927, Trans. Roy. Soc. Can., 3rd ser., vol. 21, sec. 4, p. 131-132, pl. 1, fig. 11—Cushman, 1937, Cushman Lab. Foram. Res. Spec. Pub. 7, p. 13, pl. 1, figs. 16, 17—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 31, pl. 7, figs. 2,3—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 67-68, pl. 5, figs. 1, 2—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 901, pl. 105, fig. 5.

Description: Test triserial, tapering, triangular in cross section with the edges subrounded, the sides slightly concave resulting from depressions along the contacts of the vertical series; chambers inflated, increasing gradually in size, about five whorls in most specimens; sutures fairly distinct, depressed; wall agglutinated with mostly fine grains, considerable siliceous cement, surface fairly smooth to smooth; aperture an arched opening on the inner side of the last chamber; color greyish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5156 (fig. 14)	0.49	0.28
Hypotype MF 5157 (fig. 15)	0.47	0.24

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotype MF 5156 is from just above a 1-foot sandstone bed marking the base of the exposure of the Blackstone Formation on Cripple Creek, about 15 feet above the exposed top of the underlying Blairmore Group.

Hypotype MF 5157 is from the railroad cut at Cadomin, 13 to 15 feet above the contact with the underlying Mountain Park Formation.

Distribution: In the Foothills this species was observed only in the Sunkay Member at the above-mentioned localities in the Nordegg and Cadomin areas, where it is rare. It is more prominent in the Colorado

Shale in the subsurface of central Alberta, where it is an index component of the so-called *Miliammina manitobensis* microfauna from the interval between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above). The author has also observed it in the lower part of the Shaftesbury Formation in the Peace River Plains region of northern Alberta. Eicher (1960) reported this species as being one of the most common in the Shell Creek Shale of Wyoming. Further, Eicher (1965) remarked that it is abundant in three samples from the pre-*mellariolum* interval of the Graneros Shale in Colorado.

Genus VERNEUILINOIDES Loeblich and Tappan, 1949

VERNEUILINOIDES BEARPAWENSIS (Wickenden)

Plate 4, figures 31-34; Plate 5, figure 21; Plate 14, figures 13-15

Verneuilina bearpawensis Wickenden, 1932, Trans. Roy. Soc. Can., 3rd ser., vol. 26, sec. 4, p. 87, pl. 1, fig. 8—Cushman, 1937, Cushman Lab. Foram. Res. Spec. Pub. 7, p. 13, pl. 1, fig. 18—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 31, pl. 7, figs. 4-6.

Verneuilinoides bearpawensis (Wickenden). Wall, 1960, Res. Coun. Alberta Bull. 6, p. 22-23, pl. 4, figs. 20-21.

?*Verneuilinoides* cf. *bearpawensis* (Wickenden). North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 15-16, pl. 2, figs. 3a-b.

Description: Test elongate, tapering, nearly circular in transverse section in undeformed individuals; adult test consisting of from five to six convolutions of three chambers each, arranged in a *Buliminella*-like spiral; chambers very small in early whorls, somewhat inflated and gradually increasing in size in later whorls, those of the last two whorls comprising half or more of length of test; sutures indistinct to distinct, depressed; aperture an arched opening at the base of the last-formed chamber, obscure in most specimens; color light buff to dark brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5158 (pl. 4, fig. 31)	0.30	0.20
Hypotype MF 5159 (pl. 4, fig. 32)	0.42	0.22
Hypotype MF 5160 (pl. 4, figs. 33, 34)	0.47	0.25
Hypotype MF 5161 (pl. 5, fig. 21)	0.64	0.29
Hypotype MF 5162 (pl. 14, fig. 13)	0.31	0.14
Hypotype MF 5163 (pl. 14, fig. 14)	0.43	0.17
Hypotype MF 5164 (pl. 14, fig. 15)	0.49	0.20

Types: Hypotypes MF 5158 to 5160 are from the Opabin Member of the Blackstone Formation on Ghost River, 26 feet below the base of the overlying Cardium Formation.

Hypotype MF 5161 is from the Muskiki Member of the Wapiabi Formation on Little Berland River, 195 feet (estimated) above the base of the formation.

Hypotypes MF 5162 and 5163 are from the upper part of the Wapiabi Formation on Belcourt Creek, in beds herein regarded as the equivalent of the Nomad Member, 58 feet below the base of the Chinook Sandstone and 10 feet above a conglomerate bed.

Hypotype MF 5164 is from the Nomad Member of the Wapiabi Formation on Highwood River near Longview, 25 feet above the top of the Highwood Sandstone.

Distribution: In the Foothills the range of this species extends from the Opabin Member of the Blackstone Formation to the Nomad Member of the Wapiabi Formation. It is most prominent in the Nomad Member, where the specimens are generally dark brown with indistinct characters.

This species was described originally from the Bearpaw Formation (late Campanian) of southern Alberta and was also reported by Wickenden (1941, p. 154) from the upper part of the Lea Park Formation (early Campanian) in east-central Alberta. Wall (1960) illustrated it from the lower part of the Puskwaskau Formation (early Santonian) along the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: It is possible that the hypotypes from the Opabin Member of the Blackstone may differ sufficiently from Wickenden's type material to warrant removal from this species. They are somewhat less slender and elongate and show some deviation from the coiling pattern of the types.

This species appears to have limited stratigraphic value because of its extensive range, but is recurrences may have some ecological significance.

VERNEUILINOIDES KANSASENSIS Loeblich and Tappan

Plate 2, figures 1-7

Verneuilinoides kansasensis Loeblich and Tappan, 1950, Univ. Kansas Paleont. Contrib., Protozoa, Art. 3, p. 10, pl. 2, figs. 1, 2—Eicher, 1960, Peabody Mus. Nat. Hist. Bull. 15, p. 69-70, pl. 5, figs. 6-10—Crespin, 1963, Australia Bur. Min. Resources Bull. 66, p. 57-58, pl. 15, figs. 4-7.

Verneuilinoides perplexus (Loeblich). Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 60-61, pl. 2, fig. 37; pl. 3, figs. 29, 30 (not *Verneuilina perplexa* Loeblich, 1946).

Verneuilinoides perplexus gleddiei Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 61-62, pl. 2, figs. 40, 41.

Description: Test elongate, tapering, subtriangular to nearly circular in cross section with the edges rounded; test triserial, of from five to seven whorls, the later whorls twisting in some specimens and appearing biserial

as exhibited in figures 3 to 5; chambers very small in the earliest whorls, inflated and increasing regularly in size in later whorls; sutures distinct, depressed; wall finely agglutinated, much cement, surface smooth; aperture a rather highly arched opening on the inner side of the last chamber; color usually light buff, occasionally light orange or dark brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5165 (figs. 1, 2)	0.40	0.18
Hypotype MF 5166 (fig. 3)	0.39	0.13
*Hypotype MF 5167 (fig. 4)	0.41	0.18
*Hypotype MF 5168 (fig. 5)	0.43	0.20
Hypotype MF 5169 (figs. 6, 7)	0.51	0.21

*Incomplete specimens with initial portions missing.

Unfigured specimens range from 0.22 mm. to 0.63 mm. in length.

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotypes MF 5165 to 5168 are from Ghost River, 2 feet above the contact with the underlying Blairmore Group.

Hypotype MF 5169 is from Cripple Creek, about 55 feet above the exposed top of the underlying Blairmore Group and 3 feet above a 12-foot sandstone bed, which is possibly the equivalent of the "fish-scale sand" of the Plains region.

Distribution: This species occurs regularly in the central Foothills above the *Miliammina manitobensis* microfauna, within the Sunkay Member of the Blackstone Formation. It is also present in the basal part of the Kaskapau Formation (=Sunkay Member) above the Dunvegan Sandstone on Little Berland River. Its occurrence at the extreme base of the Blackstone on Ghost River in the Morley area indicates it is probably absent south of here because of the onlap of younger marine beds on the Blairmore Group.

This species is present in the Peace River Plains region of northwestern Alberta in the lower part (Cenomanian) of the Kaskapau Formation. The species was described originally from the Lower Cretaceous Kiowa Shale of Kansas and also reported (Eicher, 1960) from the Lower Cretaceous Thermopolis and Skull Creek Shales of Wyoming.

Remarks: It appears that the specimens from the Kaskapau Formation identified as *V. perplexus* (Loeblich and Tappan) by Stelck and Wall should instead be referred to this species.

Although the figured hypotypes from the Ghost River locality are larger than the specimens from Kansas and Wyoming, some of the unfigured smaller specimens in the former suite are of comparable size.

Eicher (1965, pl. 105, figs. 10, 11, 14, 15) has illustrated specimens referred to *V. perplexus*, some of which (figs. 10, 14) the present author would have been inclined to assign to *V. kansasensis*. However, Dr. Eicher (oral communication, November, 1965) informed the writer that he had examined the types of these species and considered them identical. The author is, however, provisionally retaining the name *V. kansasensis* for these specimens with the realization that it very likely should be placed in the synonymy of *V. perplexus*.

Genus Uvigerinammina Majzon, 1943

Uvigerinammina sp. cf. U. athabascensis (Mellon and Wall)

Plate 1, figures 10-13

?*Tritaxia athabascensis* Mellon and Wall, 1956, Res. Coun. Alberta Rept. 72, p. 27, pl. 1, figs. 16, 17—Stelck and Wall *in* Stelck, Wall, Bahan and Martin, Res. Coun. Aberta Rept. 75, p. 53, pl. 2, figs. 15, 16.

?*Uvigerinammina athabascensis* (Mellon and Wall). Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 144-145, pl. 33, fig. 12.

Description: Test variable in size, compressed; initial end rounded, sides of test nearly parallel in most specimens; chamber arrangement obscure, early triserial portion of about two whorls followed by five or six chambers in an interlocking biserial pattern much larger than earlier chambers; sutures somewhat indistinct, depressed; wall very finely agglutinated or siliceous, with much cement, surface smooth; aperture terminal, constricted, slightly produced in some specimens; colorless.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5170 (fig. 10)	0.39	0.32
Specimen MF 5171 (fig. 11)	0.36	0.21
Specimen MF 5172 (fig. 12)	0.50	0.26
Specimen MF 5173 (fig. 13)	0.60	0.25

Types: The figured specimens are from the basal part of the Sunkay Member of the Blackstone Formation on Cripple Creek, 20 to 32 feet above the top of the underlying Blairmore Group.

Distribution: In the Foothills this species was observed only in the Sunkay Member at the above locality, where about 25 specimens were recorded.

A somewhat similar form has been observed by the author in the subsurface Colorado Group in central Alberta from the interval between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above).

Remarks: This form differs from *U. athabascensis* (Mellon and Wall), described originally from the Clearwater Formation of northeastern Alberta, in having a rounded rather than a pointed initial end followed by an adult test with nearly parallel as compared with divergent sides, and in lacking the distinct lipped aperture of the latter.

This form also differs from *U. manitobensis* (Wickenden), described originally from the Ashville Formation of Manitoba, in becoming biserial in the later portion and in lacking a distinct neck.

Uvigerinammina? sp. 1

Plate 14, figures 19, 20

Description: Test medium size, compressed, flaring slightly from bluntly pointed initial end; chamber arrangement obscure, early portion triserial although appearing biserial because of flattening, later portion irregularly biserial; chambers small in triserial portion of about three whorls, much enlarged in biserial part of three to four chambers; sutures indistinct, slightly depressed; wall finely agglutinated, moderate amount of cement, surface fairly smooth and vitreous; aperture a simple opening at end of a pronounced neck; color light brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5174 (fig. 19)	0.53	0.26
Specimen MF 5175 (fig. 20)	0.53	0.29

Unfigured specimens range from 0.39 mm. to 0.63 mm. in length.

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Mill Creek, 79 feet below a 30-foot massive sandstone unit regarded as the base of the Belly River Formation.

Distribution: This species seems best developed in the transition beds at the above locality, but it is also present in the underlying Hanson and Thistle Members in the Crowsnest Pass and Waterton areas.

Remarks: This somewhat nondescript species with its obscure chamber arrangement is questionably referred to *Uvigerinammina.* It does not appear similar to any previously published species, but it is difficult to make comparisons as representatives of this genus are subject to considerable distortion on fossilization.

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA SPIRITENSIS Stelck and Wall

Plate 1, figures 16-19

Gaudryina spiritensis (*nomen nudum*), 1954, Res. Coun. Alberta Rept. 68, p. 13—Stelck and Wall, 1955, Res. Coun. Alberta Rept. 70, p. 43-44, pl. 2, figs. 9, 10; pl. 3, figs. 8-12—Eicher, 1965, Jour. Paleont., vol. 39, no. 5, p. 902-903, pl. 105, figs. 17a-b.

Description: Test small to medium size, twisted; early portion triserial, of about three whorls; later portion biserial, of about two whorls; chambers very small in triserial portion, somewhat inflated and much larger in biserial portion, the terminal chamber rather sharply rectangular in outline; sutures somewhat indistinct, depressed; wall agglutinated, moderate amount of cement, surface fairly smooth; aperture a prominent notch at the inner margin of the final chamber, extending well up onto the terminal face; color buff to light brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5176 (figs. 16, 17)	0.42	0.18
Hypotype MF 5177 (figs. 18, 19)	0.32	0.13

Types: The hypotypes are from the Sunkay Member of the Blackstone Formation.

Hypotype MF 5176 is from just above a 1-foot sandstone bed marking the base of the exposure of the Blackstone Formation on Cripple Creek, about 15 feet above the exposed top of the underlying Blairmore Group.

Hypotype MF 5177 is from the railroad cut at Cadomin, 19 to 22 feet above the contact with the underlying Mountain Park Formation.

Distribution: In the Foothills this species was recorded only from the Sunkay Member at the above localities, where it is rather rare.

It has been observed by the author in the subsurface Colorado Group in central Alberta from the interval between the top of the Viking Sand (below) and the base of the "fish-scale sand" (above). The species was described from the lower part (Cenomanian) of the Kaskapau Formation in the Peace River Plains region of northwestern Alberta. Eicher recorded this species from the pre-*mellariolum* interval of the Graneros Shale in Colorado.

Genus DOROTHIA Plummer, 1931

DOROTHIA GLABRATA Cushman

Plate 12, figures 1-8

Dorothia glabrata Cushman, 1933, Cushman Lab. Foram. Res. Contrib., vol. 9, pt. 3, p. 56-57, pl. 6, figs. 10a-c—Cushman, 1937, Cushman Lab. Foram. Res. Spec.

Pub. 8, p. 85, pl. 9, fig. 15—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 46-47, pl. 13, figs. 5a-c—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 75, pl. 6, figs. 22a-b.

Description: Test elongate, initial portion tapering to a rather sharp point, the sides nearly parallel in later portion; earliest portion obscure with apparently four or more chambers per whorl; intermediate portion somewhat indistinct, triserial; latest portion biserial, of about six interlocking chambers comprising at least half of length of test; chambers inflated and increasing fairly rapidly in size in biserial portion; sutures indistinct in early and intermediate portions, fairly distinct and depressed in latest portion; wall finely agglutinated, with much cement seemingly more calcareous in apertural end, surface smooth with disseminated minute black specks; aperture a large semicircular opening at the base of the last chamber; color greyish-white.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5178 (figs. 1, 2)	0.46	0.20
Hypotype MF 5179 (figs. 3, 4)	0.36	0.20
Hypotype MF 5180 (figs. 5, 6)	0.30	0.20
Hypotype MF 5181 (figs. 7, 8)	0.80	0.26

Types: The hypotypes are from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species was not recorded in the Alberta Foothills outside of the Waterton area, where it is fairly prominent in the Hanson Member.

Remarks: The Alberta specimens in general seem to fit the original description of this Gulfian species from Texas, although the sutures of the former are somewhat indistinct.

The restriction of this species to the extreme southern Alberta Foothills and its association with other species from the Gulf Coast area such as *Anomalinoides henbesti* (Plummer) suggest that the microfauna in this area is approaching in composition those of the apparently normal neritic marine environment of the Niobrara seaway.

Dorothia smokyensis Wall

Plate 11, figures 25-28

Gaudryina filiformis Berthelin. Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 205, pl. 29, fig. 4 (not *Gaudryina filiformis* Berthelin, 1880).

Dorothia smokyensis Wall, 1960, Res. Coun. Alberta Bull. 6, p. 23-25, pl. 4, figs. 22-28.

Description: Test mostly elongate, fairly robust, twisted slightly; early portion of test of four to five whorls beginning with at least four chambers per whorl and reducing to three per whorl; later adult portion biserial with an average of about five pairs of interlocking chambers; chambers very small but increasing rapidly in size in early portion, inflated and increasing very gradually in size in adult portion; sutures usually somewhat indistinct in early portion, in later portion distinct, depressed, nearly horizontal; wall finely agglutinated, replaced or partially replaced by pyrite in most specimens, much cement, surface smooth; aperture a rather highly arched opening at the base of the inner margin of the final chamber; color greyish-white to light orange in nonpyritized specimens.

Dimensions:

	Length (mm.)	Maximum Width (mm.)
Hypotype MF 5182 (figs. 25, 26)	0.57	0.20
Hypotype MF 5183 (figs. 27, 28)	0.41	0.18

Types: The hypotypes are from the Hanson Member of the Wapiabi Formation on Belcourt Creek, 179 feet below the base of the Chinook Sandstone.

Distribution: In the Foothills the range of this species extends from the Haven Member of the Blackstone Formation to the Hanson and possibly into the Nomad Members of the Wapiabi Formation. It is rare in the Blackstone but is present in nearly every Wapiabi section sampled, and may be locally common in the Dowling and Hanson Members.

Wickenden recorded this species in the upper part of the Alberta Shale in the subsurface of the Plains of southern Alberta. The author, in describing this species from the lower Smoky River area of the Plains region of northwestern Alberta, noted its presence in both the Kaskapau and Puskwaskau Formations with it being more common in the latter.

Dorothia sp. 1

Plate 4, figures 35-40

Dorothia sp. Wall, 1960, Res. Coun. Alberta Bull. 6, p. 25-26, pl. 3, figs. 5-7.

Description: Test rather stubby to elongate, medium size, fairly robust, slightly tapering; early portion of test spiral, of about two whorls with four chambers per whorl, the chambers enlarging rapidly; later portion biserial, of up to five pairs of interlocking, nearly equidimensional chambers, inflated and increasing very gradually in size; sutures indistinct to distinct, slightly depressed, thickened in biserial portion of some specimens; wall agglutinated, of mostly fine material with the occasional coarse grain, considerable amount of cement, surface nearly smooth to somewhat rough;

aperture a deep notch at the inner margin of the final chamber extending well up onto the terminal face; color light orange to reddish-brown.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5184 (figs. 35, 36)	0.45	0.24
Specimen MF 5185 (figs. 37, 38)	0.50	0.22
Specimen MF 5186 (figs. 39, 40)	0.53	0.21

Types: The figured specimens are from the Opabin Member of the Blackstone Formation on Indian Creek, 50 feet below the base of the overlying Cardium Formation.

Distribution: This species is present in the Haven and Opabin Members of the Blackstone Formation in the central and southern Foothills, and in the Muskiki Member of the Wapiabi Formation on Highwood River. A few specimens were also collected from the Cardium Formation in the central Foothills.

Remarks: This form appears the same as that illustrated by the author from the upper part of the Kaskapau Formation on the lower Smoky River in the Plains region of northwestern Alberta, although the wall structure and preservation are quite different. The Smoky River specimens are rather coarsely arenaceous with only moderate amounts of cement and somewhat rough exteriors, whereas the Foothills individuals tend to be finely arenaceous with considerable amounts of cement and generally smooth exteriors. The Foothills specimens show a color gradation from light orange to dark brown, the characters of the test being quite distinct in the former (figs. 39, 40) but indistinct in the latter (figs. 35, 36). Gradational specimens such as in figures 37 and 38 indicate, however, that all of these individuals belong to the same species.

A peculiar feature visible in the better preserved Foothills specimens is the change directly from a spiral to a biserial pattern in which the triserial stage has apparently been bypassed.

Genus Marssonella Cushman, 1933

Marssonella oxycona (Reuss)

Plate 8, figures 7-9

Gaudryina oxycona Reuss, 1860, K. Akad. Wiss. Wien, Math.-Naturwiss. Cl., Sitzungsber., vol. 40, p. 229, pl. 12, figs. 3a-b—Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 205, pl. 29, figs. 3a-b.

Marssonella oxycona (Reuss). Cushman, 1933, Cushman Lab. Foram. Res. Contrib., vol. 9, pt. 2, p. 36, pl. 4, figs. 13a-b—Loetterle, 1937, Nebraska Geol. Surv.,

2nd ser., Bull. 12, p. 59-60, pl. 10, figs. 7a-b—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 43-44, pl. 12, figs. 3-5 (synonymy including several species, according to Frizzell)—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 75, pl. 6, figs. 17a-b.

Dorothia oxycona (Reuss). Trujillo, 1960, Jour. Paleont., vol. 34, no. 2, p. 309-310, pl. 44, figs. 5a-b.

Marrsonella [*sic*] *conica* Gauger, 1953,*in* Peterson, Gauger and Lankford, Utah. Geol. and Mineral. Surv. Bull. 47 (Contrib. Micropaleont. 1), p. 62, pl. 6, figs. 14-16.

Description: Test conical, tending to flare from the bluntly rounded initial end to the wide apertural surface; chambers spirally arranged in the earliest portion beginning with four to a whorl and reducing to three; adult portion biserial with about three pairs of interlocking chambers, much larger than those in early portion; sutures somewhat indistinct in most specimens, depressed and nearly horizontal in biserial portion; wall finely agglutinated, considerable amount of cement, surface smooth; aperture a low opening at the inner margin of the final chamber, obscure in these specimens; color brown.

Dimensions:

	Length (mm.)	Width (mm.)
*Hypotype MF 5187 (figs. 7, 8)	0.32	0.68
Hypotype MF 5188 (fig. 9)	0.61	0.48

*Specimen crushed.

Types: Hypotypes MF 5187 and 5188 are from the Dowling Member of the Wapiabi Formation on Mill Creek, 474 and 554 feet, respectively, above the base of the formation.

Distribution: In the Foothills this species seems restricted stratigraphically to the lower part of the Wapiabi Formation and geographically to the country from Nordegg south.

In the subsurface of the Plains of southern Alberta, Wickenden recorded this species about 300 feet below the top of the Alberta Shale. The present author also collected it from an exposure of the medial division of the Kevin Shale Member of the Marias River Formation in the Kevin-Sunburst oil field, northern Montana. It has been reported from various levels in the Cretaceous of several regions of this continent and of South America and Europe (Cushman, 1946; Trujillo, 1960).

Remarks: Most specimens are crushed with indistinct sutures, but as noted by Wickenden, "the broad flare of the apertural end of this species makes it easily recognized".

M. conica Gauger from the Upper Cretaceous Hilliard Formation of southwestern Wyoming probably represents a distorted form of fossilization or at most an aberrant variation of *M. oxycona* entitled to no more than subspecific status.

Trujillo proposed suppressing *Marssonella* as a junior synonym of *Dorothia* on the basis that there is no distinction in the generic descriptions between the number of chambers per whorl in the early stages and that the flat or concave apertural end of *Marssonella* is not excluded as a characteristic of *Dorothia*. Loeblich and Tappan (1964) accepted Trujillo's conclusions and similarly placed *Marssonella* in the synonymy of *Dorothia*. While conceding the validity of these arguments, the author holds that the characteristic flaring conical shape of this and closely related species, such as *M. trochus* (d'Orbigny), is sufficiently distinctive to warrant the continued recognition of a higher taxonomic unit—the genus *Marssonella* —to embrace these forms.

Genus Pseudoclavulina Cushman, 1936

Pseudoclavulina sp.

Plate 4, figures 25-30

?*Pseudoclavulina hastata* (Cushman). Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 151, pl. 36, figs. 10, 11.

Not *Bigenerina hastata* Cushman, 1927, Trans. Roy. Soc. Can., 3rd ser., vol. 21, sec. 4, p. 131, pl. 1, fig. 9—Cushman, 1946, U.S. Geol. Surv. Prof. Paper 206, p. 30, pl. 6, fig. 25.

Description: Test medium size, elongate, fairly robust; early portion triserial, of about four whorls of small chambers, increasing rapidly in width with the widest part of the test at the distal end of this portion; later portion uniserial, cylindrical in cross section, of two to four nearly equal-sized chambers, about twice as wide as high; sutures distinct, flush, horizontal and thickened in the uniserial portion; wall finely agglutinated, much cement, surface smooth; aperture terminal, central, a simple round opening; color light brown.

Dimensions:

	Length (mm.)	Maximum Width (mm.)
Specimen MF 5189 (figs. 25, 26) =incomplete specimen	0.31	0.15
Specimen MF 5190 (figs. 27, 28)	0.46	0.15
Specimen MF 5191 (figs. 29, 30) =uniserial portion only.	0.46	0.20

Types: The specimens are from the upper part of the Haven Member of the Blackstone Formation on Ghost River, 135 feet below the base of the Cardium Formation.

Distribution: In the Foothills from Nordegg south, this species is restricted to a fairly short interval embracing the upper beds of the Haven

Member and the lower beds of the Opabin Member of the Blackstone Formation. At Cadomin it appears somewhat higher stratigraphically, being found in the Opabin Member within 50 feet of the base of the overlying Cardium Formation.

In the Peace River Plains region of northwestern Alberta, this species seems to be present in the upper part of the Kaskapau Formation, about 50 feet below the overlying Bad Heart Sandstone, although the author had previously stated that the form recorded here was probably not identical (Wall and Germundson, 1963, p. 337).

Remarks: Tappan referred a form from the Ayiyak Member (Turonian) of the Seabee Formation, which is about the stratigraphic equivalent of the upper parts of the Blackstone and Kaskapau Formations of Alberta, to *Bigenerina hastata* Cushman=*Pseudoclavulina hastata* (Cushman) Tappan. Although the author has not seen the Alaskan specimens, Tappan's illustrations suggest that they are closely related, if not identical, to this Foothills form. The author has, however, compared the Foothills form with the holotype of *Bigenerina hastata,* from an unknown depth and stratigraphic level of a well in Manitoba, and is convinced that they belong to different species. Cushman's type is considerably more elongate with additional chambers in the uniserial part; its outline differs in lacking the constriction at the junction of the triserial and uniserial portions in the Foothills specimens; its sutures are very indistinct and lack the pronounced thickening present in the uniserial portion of the Foothills form.

Although *Pseudoclavulina* has been placed in the synonymy of *Clavulina* by Loeblich and Tappan (1964), it is herein retained provisionally to embrace this and other species lacking the apertural valvular tooth and sharply triangular triserial portion, typical characters of *Clavulina,* which reportedly appears in the early Tertiary.

This species is of considerable value in the recognition of upper Blackstone beds in the Foothills. Some specimens are broken near the junction of the triserial and uniserial portions, but the wide distinct sutures permit identification of the detached later portions.

Suborder MILIOLINA Delage and Hérouard, 1896

Superfamily MILIOLACEA Ehrenberg, 1839

Family MILIOLIDAE Ehrenberg, 1839

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA SPHAERA Nauss

Plate 6, figures 16-18

Quinqueloculina sphaera Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 340, pl. 48, figs. 14a-c—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 157, pl. 37, figs. 6a-c—North and Caldwell, 1964, Saskatchewan Res. Coun. Rept. 5, p. 17, pl. 3, figs. 1a-c.

Description: Test small, nearly circular in side view, moderately robust with the edges subround; chambers arranged in a quinqueloculine pattern, four visible from one side, three on the other side; sutures fairly distinct, slightly depressed; wall calcareous, porcellaneous, some specimens represented only by recrystallized internal casts, surface smooth; aperture a slit at the end of the last chamber, obscure in these specimens; colorless or brown.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5192	0.28	0.22

Types: The hypotype is from the Muskiki Member of the Wapiabi Formation on Thistle Creek, 105 feet above the base of the formation.

Distribution: In the Foothills eight representatives of this species were recorded from the Muskiki Member and one from the overlying Marshybank Member on Thistle Creek. One specimen was obtained from the Cardium Formation on Cripple Creek.

Occurrences in other regions are from somewhat higher stratigraphic levels in the Upper Cretaceous. Nauss originally described the species from the lower part of the Lea Park Formation in east-central Alberta. North and Caldwell considered it a guide fossil for the microfauna from the middle portion of the Lea Park in south-central Saskatchewan. Tappan reported it from the Seabee and Schrader Bluff Formations of northern Alaska.

Remarks: The Foothills specimens in general seem less robust than those from the type area. Some of them also have a rather deep longitudinal depression on the side with three chambers visible, which appears accentuated through some distortion of the test.

Suborder ROTALIINA Delage and Hérouard, 1896

Superfamily NODOSARIACEA Ehrenberg, 1838

Family NODOSARIIDAE Ehrenberg, 1838

Genus LENTICULINA Lamarck, 1804

LENTICULINA sp. 1

Plate 15, figures 27, 28

Description: Test rather small, compressed, planispiral, periphery sharply rounded; proloculum and early chambers obscure, about six chambers in final whorl, with the later chambers showing tendency to uncoil; sutures strongly curved, depressed; wall calcareous, perforate, with specimens preserved as recrystallized internal casts; aperture at the peripheral angle, obscure but apparently radiate; colorless to red-tinged.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5193	0.43	0.10

Types: The figured specimen is from the upper part of the Wapiabi Formation on Belcourt Creek, in beds herein regarded as the equivalent of the Nomad Member, 58 feet below the base of the Chinook Sandstone and 10 feet above a conglomerate bed.

Distribution: This form is rare with only one specimen being observed from the Nomad Member at Longview in addition to the one figured.

LENTICULINA sp. 2

Plate 15, figures 23, 24, 29, 30

Description: Test medium size, lenticular, robust, biumbonate, planispiral, periphery subacute; proloculum and early chambers obscure, nine to ten chambers in final whorl; sutures gently curved, flush; wall calcareous, perforate; aperture not observed; colorless to grey-buff.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5194 (figs. 23, 24)	0.59	0.34
Specimen MF 5195 (figs. 29, 30)	0.58	0.38

Types: Specimen MF 5194 is from the upper part of the Wapiabi Formation on Mistanusk Creek, in beds herein regarded as the equivalent of the Nomad Member, 26 feet above the top of a sandstone unit designated by Wall and Germundson (1963) as "lower Chinook", and 60 feet below the base of the main Chinook Sandstone.

Specimen MF 5195 is from the Nomad Member of the Wapiabi Formation on Thistle Creek, 85 feet below the base of the overlying Brazeau Formation.

Distribution: This form is rare with one questionable specimen being observed from the Nomad Member on Thistle Creek in addition to the two figured.

Remarks: Specimen MF 5194 is a recrystallized internal cast.

Genus NODOSARIA Lamarck, 1812

NODOSARIA sp. 1

Plate 12, figure 15

Description: Test elongate, tapering, the chambers increasing gradually in width while maintaining approximately the same height as added;

sutures horizontal, depressed, constricted; wall calcareous, finely perforate, surface ornamented with continuous slightly elevated costae, about eight on proloculum, twelve to fourteen on last chambers of incomplete tests; aperture terminal, central, round; color light grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5196 (incomplete)	0.54	0.14

Types: The figured specimen is from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species is rare, only one specimen being observed in the Thistle Member of the Wapiabi Formation at Mill Creek in addition to the one figured.

NODOSARIA sp. 2

Plate 12, figure 16

Description: Tests found as two-chambered fragments, the chambers elongate with the final chamber produced at apertural end; sutures horizontal, depressed, somewhat constricted; wall calcareous, finely perforate, surface ornamented with fourteen continuous slightly elevated costae; aperture terminal, at end of neck; color grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5197 (fragment)	0.51	0.20

Types: The figured specimen is from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species is rare, five specimens being recorded from the above locality and two from the Thistle and Dowling Members of the Wapiabi Formation on Mill Creek.

Genus DENTALINA Risso, 1826

DENTALINA SUMMITENSIS Peterson

Plate 9, figure 21

Dentalina summitensis Peterson, 1953, *in* Peterson, Gauger and Lankford, Utah Geol. and Mineral. Surv. Bull 47 (Contrib. Micropaleont. 1), p. 39, pl. 2, figs. 5, 6.

Description: Test large, elongate, slightly arcuate, robust; eight chambers in most complete specimen found, increasing slightly in width as added; sutures oblique, somewhat obscured by the costae, flush between earlier chambers, depressed in later portion; wall calcareous, finely perforate, surface ornamented with numerous continuous slightly elevated longitudinal costae; aperture not observed in available material; color buff-brown mottled.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5198	2.54	0.45

Types: The hypotype is from the Wapiabi Formation on Castle River in the Crowsnest Pass area, from either the upper part of the Dowling or lower part of the Thistle Member.

Distribution: This species seems rare in the Foothills with two additional specimens being observed at the above locality and two at Highwood River from about the same stratigraphic level.

It is common to the south in northeastern Utah, where it was described from the upper middle part of the Frontier Formation (Upper Cretaceous).

Dentalina sp. 1

Plate 6, figure 27

Description: Test arcuate, found in fragmentary state of three to four chambers, with the final chamber produced at apertural end; sutures distinct, slightly oblique, depressed; wall calcareous, finely perforate, surface smooth; aperture terminal, radiate, produced; colorless to grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5199	0.46	0.19

Types: The figured specimen is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Distribution: This species is rare with only one other specimen being recorded from the Thistle Member of the Wapiabi Formation on Mill Creek.

Genus Vaginulina d'Orbigny, 1826

Vaginulina sp.

Plate 15, figures 25, 26

Description: Test elongate, moderately compressed, nearly rectilinear; subovate proloculum followed by five low chambers increasing gradually

in height as added; sutures thickened, flush, oblique; wall calcareous, finely perforate, surface smooth; aperture radiate, somewhat produced at the dorsal angle; color buff-yellow.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5200	0.87	0.27	0.14

Types: The figured specimen is from the Nomad Member of the Wapiabi Formation on Burnt Timber Creek, about 35 feet below the base of the overlying Brazeau Formation.

Distribution: This species was recorded only from the Nomad Member at Burnt Timber and Thistle Creeks, where it is rare with most of the specimens being broken.

Genus Frondicularia Defrance, 1826

Frondicularia sp. cf. F. greybullensis Fox

Plate 12, figure 14

?*Frondicularia greybullensis* Fox, 1954, U.S. Geol. Surv. Prof. Paper 254-E, p. 118, pl. 26, figs. 4-6.

Description: Test elongate-palmate, somewhat asymmetrical, compressed; chambers uniserial, strongly equitant, slightly inflated, of nearly equal height; sutures fairly distinct, depressed; wall calcareous, finely perforate, surface smooth; color buff-grey.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Specimen MF 5201 (fragment)	0.80	0.47	0.09

Types: The figured specimen is from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: In the Foothills this species was observed only at the above level and locality, where it is found in a fragmentary condition.

Remarks: The description is based on two joined fragments representing five chambers from the intermediate part of the test, with neither the initial nor the terminal portions being available. Nevertheless, the close relationship, if not identity, with *F. greybullensis* from the basal part of the Cody Shale near Greybull, Wyoming, is quite apparent as shown by the similarity of outline, the slightly inflated chambers and the highly arched sutures.

Family Polymorphinidae d'Orbigny, 1839

Genus Bullopora Quenstedt, 1856

Bullopora laevis (Sollas)

Plate 9, figures 12-16

Webbina laevis Sollas, 1877, Geol. Mag., n.s., 2nd dec., vol. 4, p. 103, pl. 6, figs. 1-3.

Vitriwebbina laevis (Sollas). Chapman, 1896, Jour. Roy. Micr. Soc., p. 585, pl. 12, fig. 12—Frizzell, 1954, Texas Bur. Econ. Geol. Rept. Invest. 22, p. 107, pl. 15, fig. 5 (synonymy).

Bullopora laevis (Sollas). Wickenden, 1932, Jour. Paleont., vol. 6, no. 2, p. 206, pl. 29, figs. 6-8.

Description: Test usually found in free condition, rarely attached, consisting of a series of subglobular to fusiform chambers apparently connected by stoloniferous necks in original state, but almost invariably found as individuals; wall calcareous, finely perforate, smooth in most specimens, slightly rough or finely spinose in others; aperture simple, the open end of the stoloniferous neck; usually colorless, some specimens light orange.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5202 (fig. 12)	0.64	0.20
Hypotype MF 5203 (fig. 13)	0.56	0.22
Hypotype MF 5204 (fig. 14)	0.58	0.20
Hypotype MF 5205 (fig. 15)	0.58	0.28
Hypotype MF 5206 (fig. 16)	0.41	0.22

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation on Mill Creek, 564 feet above the base of the formation.

Distribution: In the Foothills this species was recorded from the Muskiki to the Thistle Member of the Wapiabi Formation, being most prominent in the Dowling Member at Mill Creek. Its maximum development occurs consistently in the lower part of the *Brachycythere-Bullopora* assemblage of this publication, which falls within the Dowling Member in the southern area and the Muskiki Member in the central and northern areas.

Wickenden reported this species from the Alberta Shale in the subsurface of the Plains of southern Alberta and commented on its being a "good guide fossil for a horizon about 420 feet below the top . . . . ." This would place it at the same stratigraphic level as in the Foothills, where, however, it may be farther below the upper or first white-speckled shale "zone" because of thickening of the strata within this interval toward the west.

Fox (1954) listed this species as a component of his faunal assemblages 3 and 4 from the basal part of the Cody Shale near Greybull, Wyoming. The author has obtained this species from an exposure of the medial division of the Kevin Shale Member of the Marias River Formation in the Kevin-Sunburst oil field, northern Montana.

Superfamily BULIMINACEA Jones, 1875

Family TURRILINIDAE Cushman, 1927

Genus NEOBULIMINA Cushman and Wickenden, 1928

NEOBULIMINA sp.

Plate 6, figures 19-21; Plate 13, figures 32, 33

Neobulimina sp. Wall, 1960, Res. Coun. Alberta Bull. 6, p. 31-32, pl. 5, figs. 15-22.

Description: Test small, elongate, twisted, slightly tapering; early portion of test triserial, of about three whorls comprising from one third to one half of length of test; later portion biserial, of two to three whorls; chambers in triserial portion small and low, in biserial portion more inflated and longer than wide; sutures distinct, depressed; wall calcareous, perforate, smooth, replaced or partially replaced by pyrite in some specimens; aperture a highly arched opening in a large oval depression in the inner face of the terminal chamber; colorless in nonpyritized specimens.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5207 (pl. 6, figs. 19, 20)	0.28	0.09
Specimen MF 5208 (pl. 6, fig. 21)	0.22	0.09
Specimen MF 5209 (pl. 13, fig. 32)	0.17	0.08
Specimen MF 5210 (pl. 13, fig. 33)	0.22	0.08

Types: Specimens MF 5207 and 5208 are from the first or upper white-speckled shale "zone" in the Dowling Member of the Wapiabi Formation on Meander Creek (tributary of Belcourt Creek), 112 to 116 feet above the Bad Heart Sandstone.

Specimens MF 5209 and 5210 are from the same "zone" in the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: This species is characteristically associated with the microfauna of the first or upper white-speckled shale "zone", which is found in the Hanson Member of the Wapiabi Formation in the southern Foothills and in the Dowling Member in the northern area. There are also a few occurrences both below and above this level in the Wapiabi of the Foothills.

The author described this species from the upper white-speckled shale "zone" in the Puskwaskau Formation on the lower Smoky River in the Plains region of northwestern Alberta.

Remarks: As noted by the author (1960) this species differs from *N. canadensis* Cushman and Wickenden, described originally from the Lea Park Formation of east-central Alberta, in having much longer chambers in its biserial portion.

Genus PRAEBULIMINA Hofker, 1953

PRAEBULIMINA VENUSAE (Nauss)

Plate 15, figures 19-22

Bulimina venusae Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 334-335, pl. 48, fig. 10—Tappan, 1951 (part), Cushman Found. Foram. Res. Contrib., vol. 2, pt. 1, p. 6, pl. 1, figs. 23, 25, 26 (not fig. 24)—Tappan, 1951, *in* Payne and others, U.S. Geol. Surv. Oil and Gas Invest. Map OM-126, sheet 3, fig. 21(7).

Praebulimina venusae (Nauss). Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 188, pl. 49, figs. 19-21.

Not *Praebulimina venusae* (Nauss). North and Caldwell, Saskatchewan Res. Coun. Rept. 5, p. 21, pl. 3, figs. 13a-b.

Description: Test small, tapering, triserial, of four to five whorls; early chambers low, those of last one to two whorls inflated and increasing rapidly in height; sutures fairly distinct, depressed; wall calcareous, perforate, smooth; aperture a comma-shaped opening on the inner face of the last chamber; colorless.

Dimensions:

	Length (mm.)	Width (mm.)
Hypotype MF 5211 (figs. 19, 20)	0.24	0.13
Hypotype MF 5212 (figs. 21, 22)	0.26	0.14

Types: The hypotypes are from the Nomad Member of the Wapiabi Formation on Thistle Creek, 85 feet below the base of the overlying Brazeau Formation.

Distribution: In the Foothills this species was observed only at the above locality where six specimens were recorded.

In east-central Alberta, Nauss reported it as common in the upper part of the Lea Park Formation and in the Vanesti marine tongue of the lower part of the Belly River Formation. Tappan (1962) recorded this species from the Schrader Bluff Formation of northern Alaska.

Remarks: The form which North and Caldwell assigned to this species seems identical to *Neobulimina canadensis* Cushman and Wickenden, illustrated by Nauss (1947, pl. 48, fig. 5) from the Lea Park Formation of east-central Alberta.

PRAEBULIMINA sp. 1

Plate 15, figures 13-18

Description: Test tiny, tapering, triserial, of four to five whorls; chambers increasing gradually in size and becoming more inflated as added; sutures distinct, depressed; wall calcareous, perforate, smooth; aperture distinct, a small but deeply notched opening on the inner face of the last chamber; color white.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5213 (figs. 13, 14)	0.14	0.08
Specimen MF 5214 (figs. 15, 16)	0.20	0.09
Specimen MF 5215 (figs. 17, 18)	0.16	0.08

Unfigured specimens range from 0.11 mm. to 0.18 mm. in length.

Types: The figured specimens are from the transition beds of the Wapiabi Formation on Dungarvan Creek.

Distribution: This species was positively recognized only at the above level and locality where 18 specimens were recorded. There are a few questionable specimens present in the Hanson Member of the Wapiabi Formation on Mill Creek.

Remarks: This species seems closely related to *Praebulimina venusae* (Nauss) but differs in being somewhat smaller, in showing a more gradual increase in the size of the chambers and in having a more distinct, deeply notched aperture.

Family BOLIVINITIDAE Cushman, 1927

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA ELKENSIS Nauss

Plate 6, figures 4, 5

Bolivina elkensis Nauss, 1947, Jour. Paleont., vol. 21, no. 4, p. 334, pl. 48, figs. 7a-b.

Description: Test small to medium size, elongate, tapering, compressed; early portion twisted and generally broken; edges rounded; ten to twelve chambers in biserial arrangement, the last three pairs considerably higher than earlier ones; sutures fairly distinct, depressed; wall presumed calcareous, perforate, smooth, replaced by pyrite in all specimens observed; aperture a large arched opening on the inner face of the last chamber.

Dimensions:

	Length (mm.)	Width (mm.)	Thickness (mm.)
Hypotype MF 5216 (fig. 4)	0.27	0.10	0.08
Hypotype MF 5217 (fig. 5)	0.31	0.10	0.07

Types: The hypotypes are from the Dowling Member of the Wapiabi Formation on Highwood River, 424 and 463 feet, respectively, above the base of the formation.

Distribution: In the Foothills this species has been observed from the Muskiki to the Thistle Members of the Wapiabi Formation. It seems rare except in the Dowling Member on Highwood River where 40 specimens were obtained. The small pyritized tests, however, may have been overlooked at other localities.

Nauss described this species from the Lea Park Formation of east-central Alberta which marks a somewhat higher stratigraphic level than these Foothills occurrences.

Bolivina sp. cf. B. elkensis Nauss

Plate 12, figures 9-11

Gumbelina sp. Wall, 1960 (part), Res. Coun. Alberta Bull. 6, p. 28-30, pl. 5, figs. 23, 24, 29, 30 (not figs. 25-28).

Description: Test elongate, compressed, flaring slightly in early portion from bluntly pointed twisted initial end, sides nearly parallel in later portion; test biserial, of about nine pairs of chambers, partially inflated but appearing flat in most specimens as a result of the fossilization process; early chambers very low, later chambers increasing gradually in height with dimensions nearly equal in last two pairs; sutures distinct, depressed, slightly oblique; wall calcareous, hyaline, perforate, smooth; aperture a highly arched opening at the inner margin of the last chamber; colorless to buff-grey.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5218 (fig. 9)	0.32	0.10
Specimen MF 5219 (fig. 10)	0.26	0.09
Specimen MF 5220 (fig. 11)	0.28	0.08

Types: The figured specimens are from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: In the Foothills this species was observed in quantity only at the above locality from beds in or just below the upper or first white-speckled shale "zone".

In the Plains region of northwestern Alberta, the author (1960) obtained this species from the upper white-speckled shale "zone" in the Puskwaskau Formation.

Remarks: This species seems closely related to *B. elkensis*, but has more chambers which are somewhat lower than those of *B. elkensis*.

The author's (1960) description of *Gümbelina* sp. from the upper white-speckled shale "zone" embraced some quite elongate forms which appear identical to this Foothills form. The author also included under *Gümbelina* sp. some shorter forms (*op. cit.*, pl. 5, figs. 25-28) that are identical to *Heterohelix* sp. 1 of this publication, which is present in both the so-called lower and upper pelagic faunal assemblages in the Foothills. It seems that *Gümbelina* sp. was based perhaps on too broad a concept and it may now be split to advantage.

Bolivina sp. 1

Plate 6, figure 6; Plate 12, figures 12, 13

Description: Test elongate, slender, compressed, slightly tapering, initial portion slightly twisted; test biserial, chambers increasing regularly in height as added, higher than wide in all but earliest portion, about 8 pairs present, partially inflated but appearing flat in most specimens as a result of the fossilization process; sutures fairly distinct, depressed, nearly horizontal; wall calcareous, finely perforate, smooth; aperture a high slit-opening on the inner face of the last chamber, obscure in most specimens as a result of flattening; grey to grey-buff.

Dimensions:

	Length (mm.)	Width (mm.)
Specimen MF 5221 (pl. 6, fig. 6)	0.41	0.11
Specimen MF 5222 (pl. 12, fig. 12)	0.48	0.13
Specimen MF 5223 (pl. 12, fig. 13)	0.56	0.12

Types: Specimen MF 5221 is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Specimens MF 5222 and 5223 are from the Hanson Member of the Wapiabi Formation, on a tributary of the north fork of the Belly River in Waterton National Park.

Distribution: In the Foothills this species was collected mainly from the Hanson Member of the Wapiabi Formation in Waterton National Park, with 35 specimens being recorded there. It is also present, but much rarer, to the north at Highwood River and Thistle Creek in lower members of the Wapiabi Formation, where it is invariably pyritized.

Remarks: This species appears similar to *Loxostomum tegulatum* (Reuss), a species of wide distribution in the Upper Cretaceous of Europe and North America including the Niobrara Formation of Nebraska (Loetterle, 1937). The aperture in this Foothills form apparently does not become terminal, however, and the author is reluctant to refer it to *L. tegulatum.*

This species is also rather similar to *B. elkensis* Nauss but is considerably more elongate with higher chambers. There are, however, pyritized specimens from the lower part of the Wapiabi Formation (Pl. 6, fig. 6) which appear transitional to *B. elkensis* and may not be readily distinguished from it.

Superfamily DISCORBACEA Ehrenberg, 1838

Family DISCORBIDAE Ehrenberg, 1838

Genus EOEPONIDELLA Wickenden, 1949

EOEPONIDELLA sp. cf. E. LINKI Wickenden

Plate 15, figures 34-39

?*Eoeponidella linki* Wickenden, 1949, Trans. Roy. Soc. Can., 3rd ser., vol. 42 (1948), sec. 4, p. 81-82, figs. 1a-c—Tappan, 1962, U.S. Geol. Surv. Prof. Paper 236-C, p. 195, pl. 54, figs. 9, 10.

Description: Test small, planoconvex, spiral side convex and umbilical side slightly concave, periphery subrounded, peripheral margin slightly indented; two to three whorls of chambers with all regular chambers visible on spiral side, only those of last formed coil and some supplementary ones forming an inner coil visible on umbilical side; six chambers in outer whorl and same number of supplementary stellar chambers; sutures indistinct, slightly curved, flush to slightly depressed on spiral side, straight, radial and moderately depressed on umbilical side; wall calcareous, perforate, smooth; aperture obscure, apparently a small arch on umbilical side of last chamber.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5224 (figs. 34-36)	0.22	0.11
Specimen MF 5225 (figs. 37-39)	0.22	0.13

Types: The figured specimens are from the Nomad Member of the Wapiabi Formation on Thistle Creek, 85 feet below the base of the overlying Brazeau Formation.

Distribution: In the Foothills this species was observed only in the Nomad Member on Thistle Creek, where it is rare.

Remarks: Although closely related to *E. linki* from the upper part of the Lea Park Formation and marine tongues in the lower part of the overlying Belly River Formation in the Alberta-Saskatchewan Plains region, this Foothills form lacks the more inflated chambers and apparently also the very prominent umbilical aperture of *E. linki*.

Genus VALVULINERIA Cushman, 1926

VALVULINERIA sp. cf. V. UMBILICATA (d'Orbigny)

Plate 6, figures 28-33; Plate 9, figures 22-24

?*Rotalina* (*Rotalina*) *umbilicata* d'Orbigny, 1840, Mem. Soc. Geol. France, tome 4, no. 1, p. 32, pl. 3, figs. 4-6.

Gyroidina umbilicata (d'Orbigny). Cushman, 1931, Cushman Lab. Foram. Res. Contrib., vol. 7, pt. 2, p. 43, pl. 6, figs. 3a-c.

Valvulineria cf. *umbilicata* (d'Orbigny). Cushman, 1931 (part), Tennessee Div. Geol. Bull. 41, p. 53, pl. 9, figs. 2-4 (not fig. 5; figs. 2c and 3c transposed)—Cushman, 1946 (part), U.S. Geol. Surv. Prof. Paper 206, p. 139, pl. 57, figs. 10-12 (not fig. 9; figs. 11c and 12c transposed; synonymy)—Frizzell, 1954, Texas. Bur. Econ. Geol. Rept. Invest. 22, p. 123, pl. 18, figs. 38, 39.

Description: Test small, rotaloid, planoconvex with spiral side flat to slightly concave and umbilical side strongly convex, periphery broadly rounded, peripheral outline slightly lobulate; two whorls of chambers, the six to eight chambers in outer whorl much larger than earlier chambers, final chamber with a large flap or extension covering the umbilicus and the ends of the previous chambers; sutures distinct, slightly curved, slightly depressed; wall calcareous, replaced or partially replaced by pyrite in many specimens, finely perforate, smooth; aperture a low slit at the base of the last chamber extending from near the periphery into the umbilicus, obscure in these specimens; colorless in nonpyritized specimens.

Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5226 (pl. 6, figs. 28-30)	0.22	0.13
Specimen MF 5227 (pl. 6, figs. 31-33)	0.22	0.14
Specimen MF 5228 (pl. 9, figs. 22-24)	0.20	0.13

Types: Specimen MF 5226 is from the Muskiki Member of the Wapiabi Formation on Mistanusk Creek, 102 feet above the top of the underlying Cardium Formation.

Specimen MF 5227 is from the Marshybank Member of the Wapiabi Formation on Thistle Creek, 232 feet above the base of the formation.

Specimen MF 5228 is from the Dowling Member of the Wapiabi Formation on Highwood River, 424 feet above the base of the formation.

Distribution: This species seems rather rare in the Dowling Member in the southern Foothills and in the Marshybank Member in the central Foothills. It is present in the Muskiki Member on Mistanusk Creek in association with a similar form which lacks the umbilical flap of this species.

Remarks: The Foothills representatives of this species seem identical to those from the Upper Cretaceous Ripley Formation of Tennessee illustrated by Cushman (1946, figs. 10, 11 and 12). As noted by Frizzell (1954), Cushman apparently included more than one species under his comparison with *R.* (*R.*) *umbilicata* d'Orbigny, as shown by the variation in form from planoconvex to almost equally biconvex (figure 9 of Cushman).

Valvulineria sp. 1

Plate 6, figures 7-9

Description: Test medium to fairly large size, rotaloid, planoconvex with spiral side nearly flat and umbilical side moderately convex and umbilicate, periphery rounded, peripheral margin entire to slightly lobulate; two whorls of chambers increasing gradually in size as added, inflated, seven to eight in final whorl, last chamber with a large flap or extension covering the umbilicus and the ends of the previous chambers; sutures fairly distinct, somewhat thickened and slightly depressed between early chambers of outer whorl, plain and depressed between later chambers, curved on spiral side, nearly straight or radial on umbilical side; wall calcareous, distinctly perforate, smooth; aperture a slit at the base of the septal face between the periphery and umbilicus.

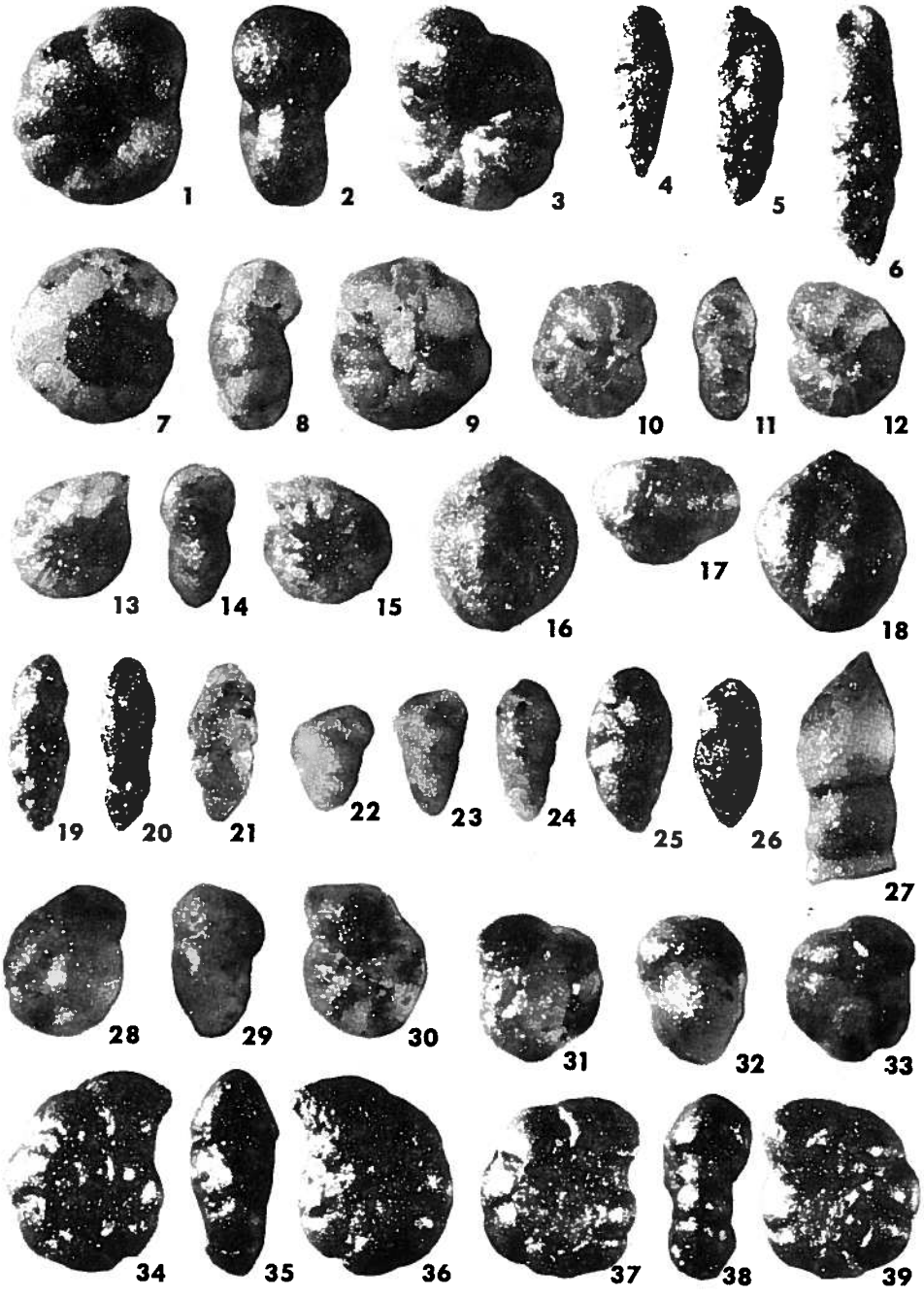
Dimensions:

	Diameter (mm.)	Thickness (mm.)
Specimen MF 5229	0.32	0.13

Types: The figured specimen is from the Muskiki Member of the Wapiabi Formation on Mistanusk Creek, 120 feet above the top of the underlying Cardium Formation.

Distribution: This species is rare with only two additional specimens, somewhat smaller than the one figured, being observed in the same member at the above locality.

PLATE 6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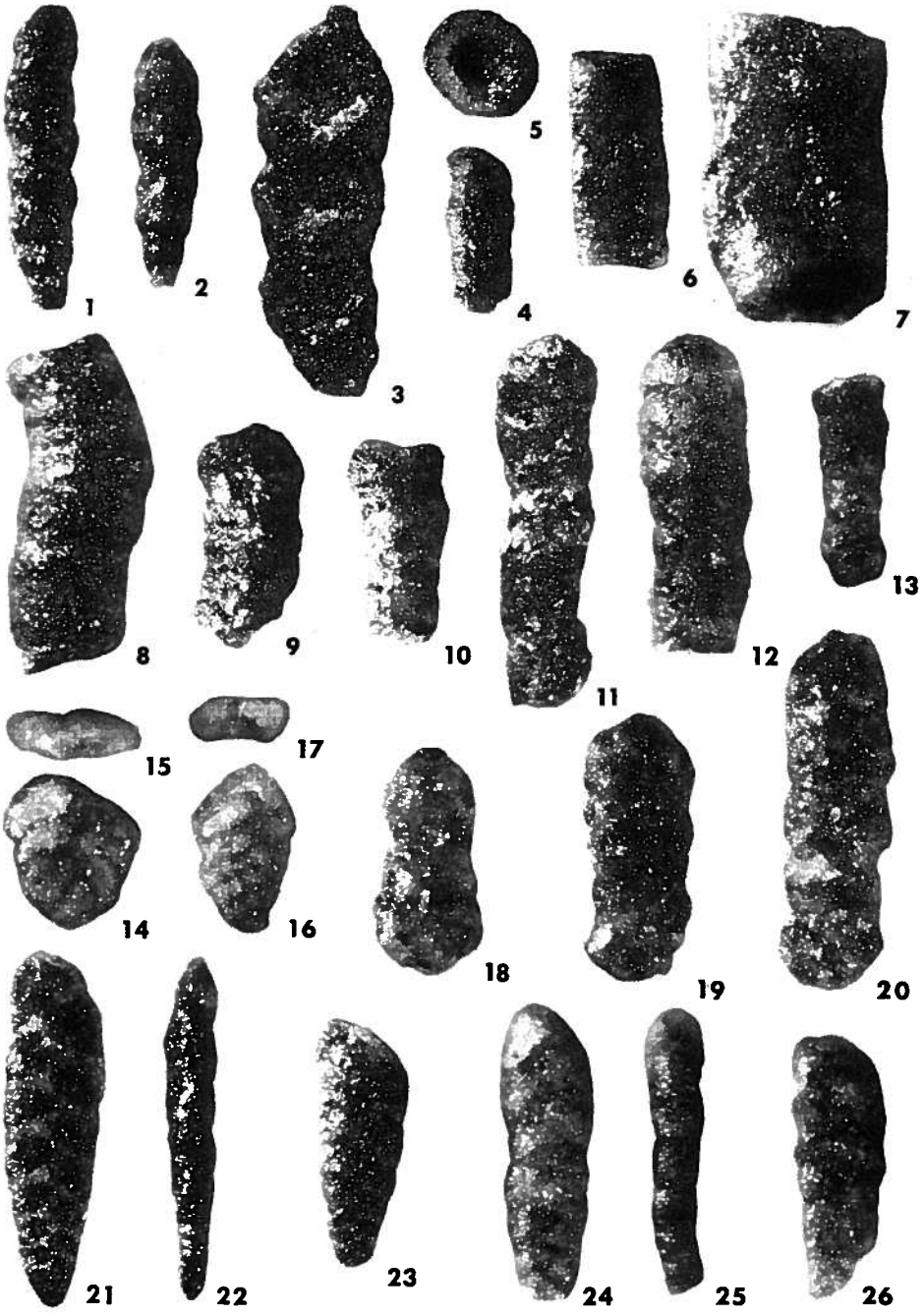
Explanation of Plate 7

Wapiabi Formation

Dowling Member

Figure		Page
1, 2	*Reophax pepperensis* Loeblich, 1—Hypotype MF 5056, X63, Thistle Creek; 2—Hypotype MF 5057, X66, Mistanusk Creek	43
3	*Reophax* sp. 3, Specimen MF 5063, X 29, Mill Creek	45
4-7	*Bathysiphon vitta* Nauss, 4—Hypotype MF 5042, X28, Ram River; 5—Hypotype MF 5043, X32, Thistle Creek, apertural view; 6—Hypotype MF 5044, X28, Thistle Creek; 7—Hypotype MF 5045, X26, Thistle Creek	38
8-13	*Coscinophragma? codyensis* (Fox), X28, Mill Creek; 8—Hypotype MF 5108, incomplete curved specimen; 9—Hypotype MF 5109, incomplete curved specimen; 10—Hypotype MF 5110, later portion of incomplete specimen; 11—Hypotype MF 5111, complete specimen with coil; 12—Hypotype MF 5112, later portion of incomplete specimen; 13—Hypotype MF 5113, initial portion of incomplete specimen	60
14-17	*Spiroplectammina* sp. 1, X100, Thistle Creek; 14, 15—Specimen MF 5118, megalospheric? form, side and apertural views; 16, 17—Specimen MF 5119, microspheric? form, side and apertural views	63
18-20	*Ammobaculites* sp. cf. *A. fragmentarius* Cushman, X65, Mill Creek; 18—Specimen MF 5093; 19—Specimen MF 5094; 20—Specimen MF 5095	56
21-26	*Pseudobolivina rollaensis* (Stelck and Wall), X68; 21, 22—Hypotype MF 5124, side and apertural views, 23—Hypotype MF 5125, Meander Creek; 24, 25—Hypotype MF 5126, side and apertural views, 26—Hypotype MF 5127, Mistanusk Creek	65

PLATE 7



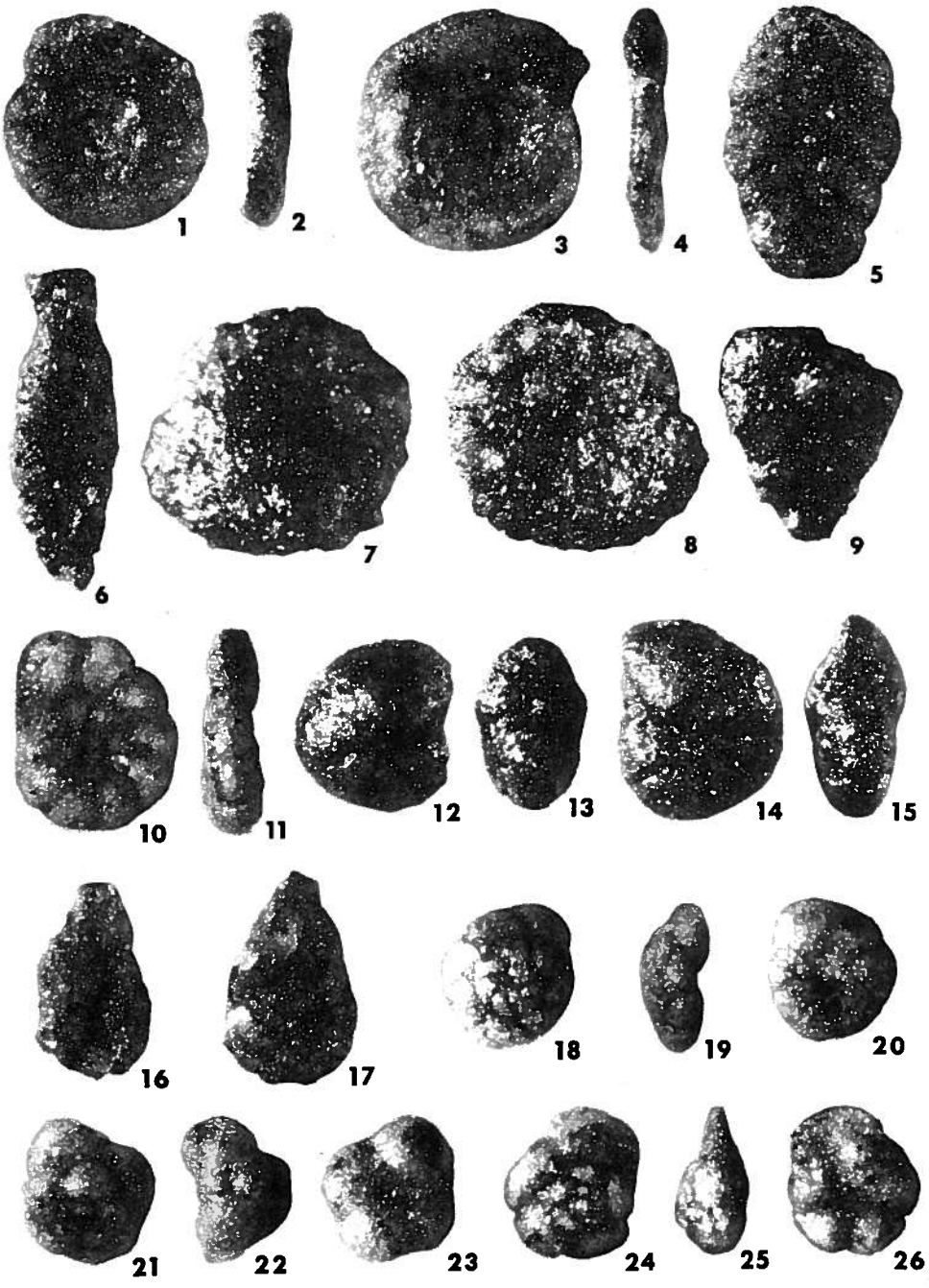
Explanation of Plate 8

Wapiabi Formation

Dowling Member

Figure		Page
1-4	*Ammodiscus* sp. 2, X47; 1, 2—Specimen MF 5054, Thistle Creek, side and peripheral views; 3, 4—Specimen MF 5055, Mistanusk Creek, side and peripheral views	42
5	*Flabellammina magna* Alexander and Smith, X27, Ram River; Hypotype MF 5103, microspheric? form	59
6	*Hippocrepina* sp., Specimen MF 5046, X47, Mill Creek	39
7-9	*Marssonella oxycona* (Reuss), X50, Mill Creek; 7, 8—Hypotype MF 5187, crushed specimen, basal and apertural views; 9—Hypotype MF 5188, side view	83
10, 11	*Haplophragmoides howardense manifestum* Stelck and Wall, X45, Mistanusk Creek; Hypotype MF 5081, side and peripheral views	51
12-15	*Haplophragmoides crickmayi* Stelck and Wall, X47; 12, 13—Hypotype MF 5073, Seebe, side and peripheral views; 14, 15—Hypotype MF 5074, Oldfort Creek, side and peripheral views	49
16, 17	*Saccammina* sp. cf. *S. alexanderi* (Loeblich and Tappan), X48, Mill Creek; 16—Specimen MF 5048; 17—Specimen MF 5049	40
18-20	*Trochammina* sp. cf. *T. ribstonensis* Wickenden, X95, Mistanusk Creek; Specimen MF 5135, spiral, peripheral and umbilical views	69
21-26	*Trochamnina wetteri* Stelck and Wall, X70, Mistanusk Creek; 21, 22, 23—Hypotype MF 5147, spiral, peripheral and umbilical views; 24, 25, 26—Hypotype MF 5148, spiral, peripheral and umbilical views	71

PLATE 8



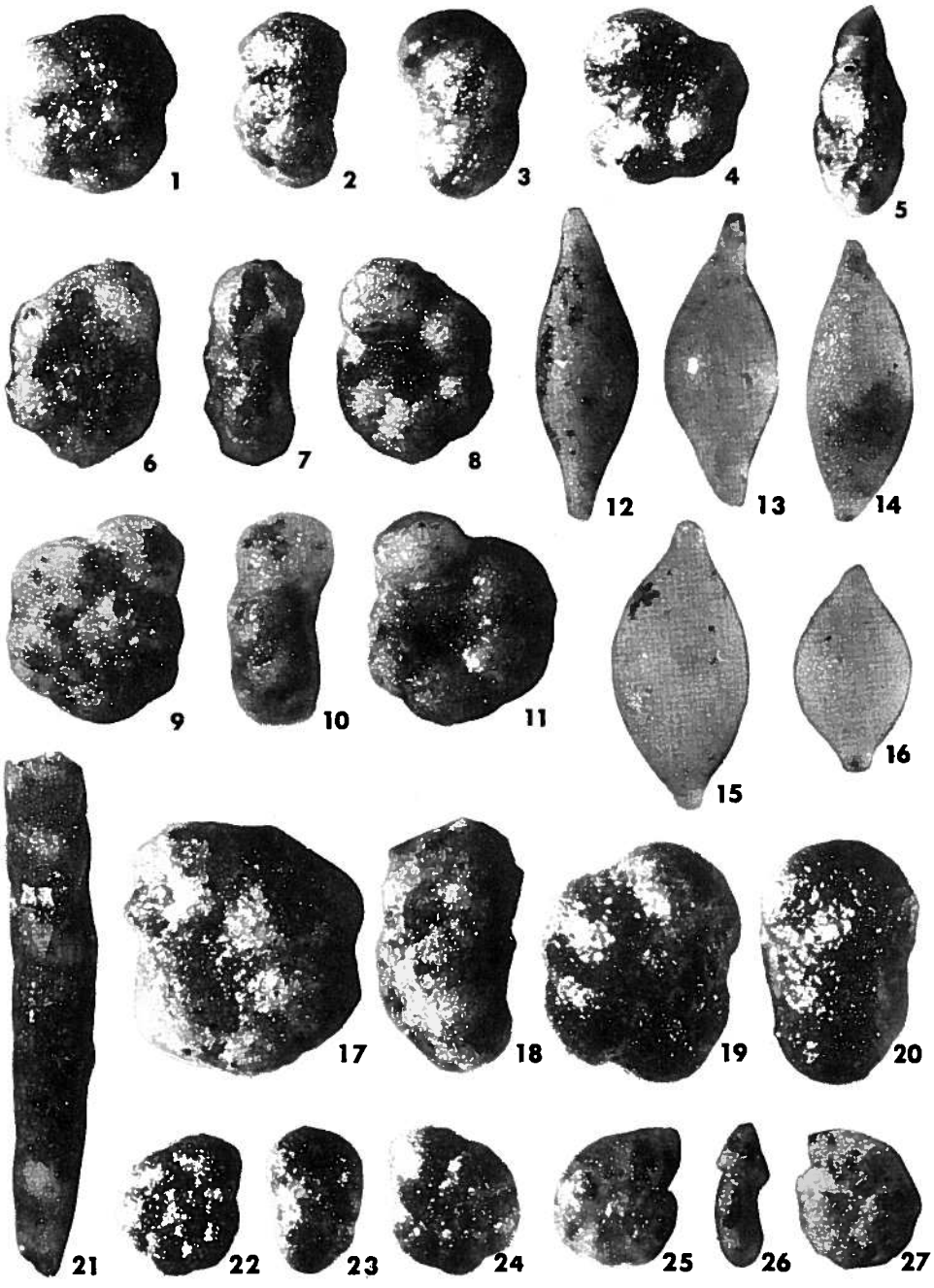
Explanation of Plate 9

Wapiabi Formation

Dowling Member

Figure		Page
1-11	*Praeglobotruncana* sp. 1, X65, Mill Creek; 1, 2, 3, 4—Specimen MF 5259, spiral, peripheral and umbilical views (Fig. 3 shows dark band on dorsal margin indicating presence of keel); 5—Specimen MF 5260, dorsal margin showing dark band; 6, 7, 8—Specimen MF 5261, spiral, peripheral and umbilical views (Fig. 8 shows apertural flap on last chamber); 9, 10, 11—Specimen MF 5262, spiral, peripheral and umbilical views (Fig. 11 shows apertural flap on last chamber)	109
12-16	*Bullopora laevis* (Sollas), X68, Mill Creek; 12—Hypotype MF 5202, 13—Hypotype MF 5203, 14—Hypotype MF 5204, 15—Hypotype MF 5205, 16—Hypotype MF 5206	92
17-20	*Pullenia*? sp., 17, 18—Specimen MF 5266, X72, Ram River, side and peripheral views; 19, 20—Specimen MF 5267, X66, Oldfort Creek, side and peripheral views	110
21	*Dentalina summitensis* Peterson, Hypotype MF 5198, X28, Castle River	89
22-24	*Valvulineria* sp. cf. *V. umbilicata* (d'Orbigny), X95, Highwood River; Specimen MF 5228, spiral, peripheral and umbilical views	99
25-27	*Anomalinoides talaria* (Nauss), X66, Mill Creek; Hypotype MF 5274, spiral, peripheral and umbilical views	112

PLATE 9



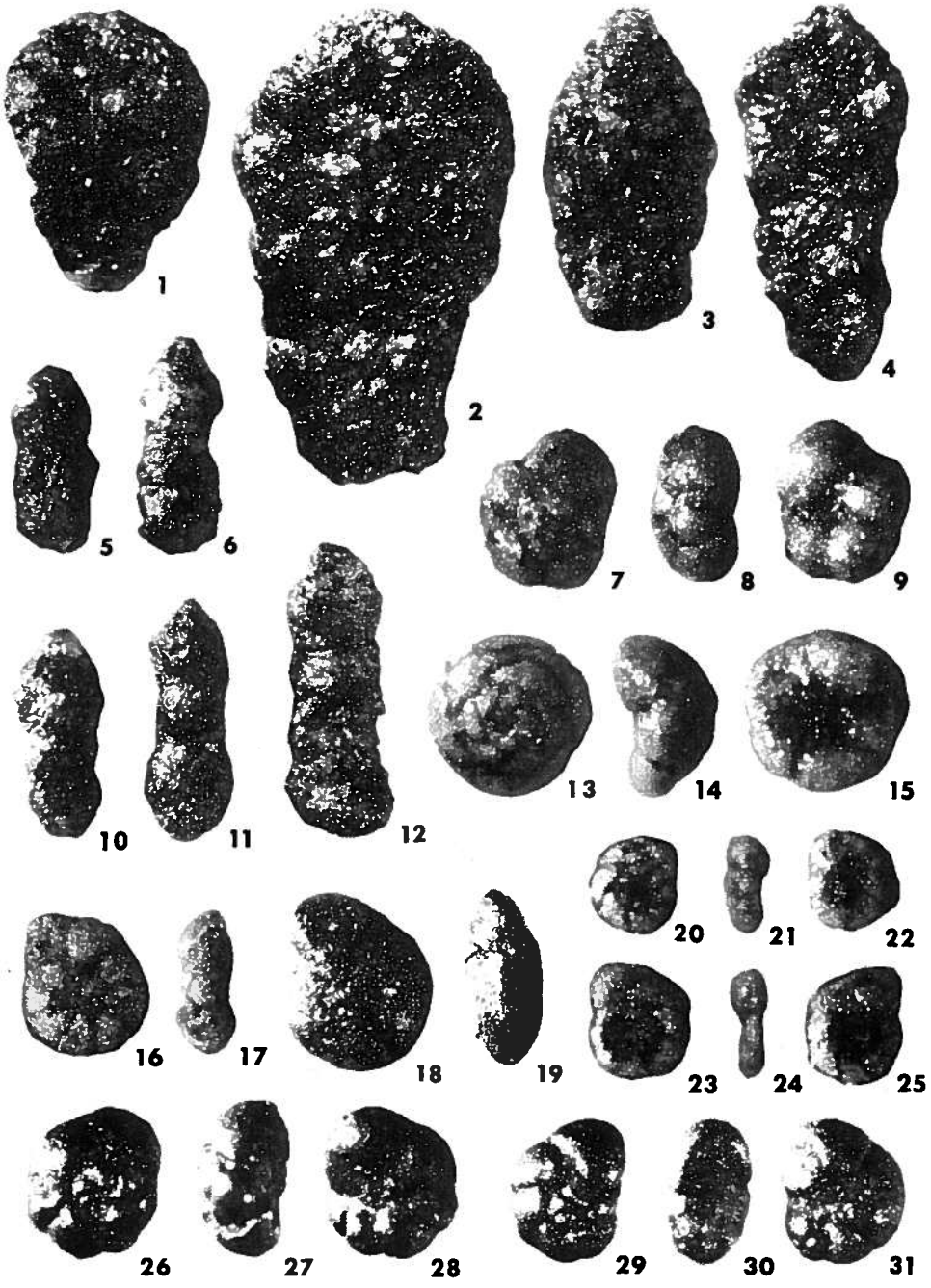
Explanation of Plate 10

Wapiabi Formation

Thistle Member

Figure		Page
1-4	*Flabellammina magna* Alexander and Smith, X28, Mill Creek; 1—Hypotype MF 5104, juvenile, microspheric? form; 2—Hypotype MF 5105, adult, microspheric? form; 3—Hypotype MF 5106, juvenile, megalospheric? form; 4—Hypotype MF 5107, adult, megalospheric? form	59
5, 6	*Reophax* sp. 2, X28, Mill Creek; 5—Specimen MF 5061; 6—Specimen MF 5062	44
7-9	*Trochammina wetteri* Stelck and Wall, X67, Mistanusk Creek; Hypotype MF 5149, spiral, peripheral and umbilical views	71
10-12	*Ammobaculites* sp. 2, X28, Mill Creek; 10—Specimen MF 5098; 11—Specimen MF 5099; 12—Specimen MF 5100	58
13-15	*Trochammina* sp. cf. *T. ribstonensis* Wickenden, X94, Belcourt Creek; Specimen MF 5136, spiral, peripheral and umbilical views	69
16, 17	*Haplophragmoides howardense* Stelck and Wall, X65, Belcourt Creek; Hypotype MF 5080, side and peripheral views	50
18, 19	*Haplophragmoides crickmayi* Stelck and Wall, X45, Mill Creek; Hypotype MF 5075, side and peripheral views	49
20-25	*Trochammina ribstonensis* Wickenden, X98; 20, 21, 22—Hypotype MF 5133, Belcourt Creek, spiral, peripheral and umbilical views; 23, 24, 25—Hypotype MF 5134, Mistanusk Creek, spiral, peripheral and umbilical views	67
26-31	*Ceratobulimina* sp., X63, Ram River; 26, 27, 28—Specimen MF 5280, spiral, peripheral and umbilical views; 29, 30, 31—Specimen MF 5281, spiral, peripheral and umbilical views	115

PLATE 10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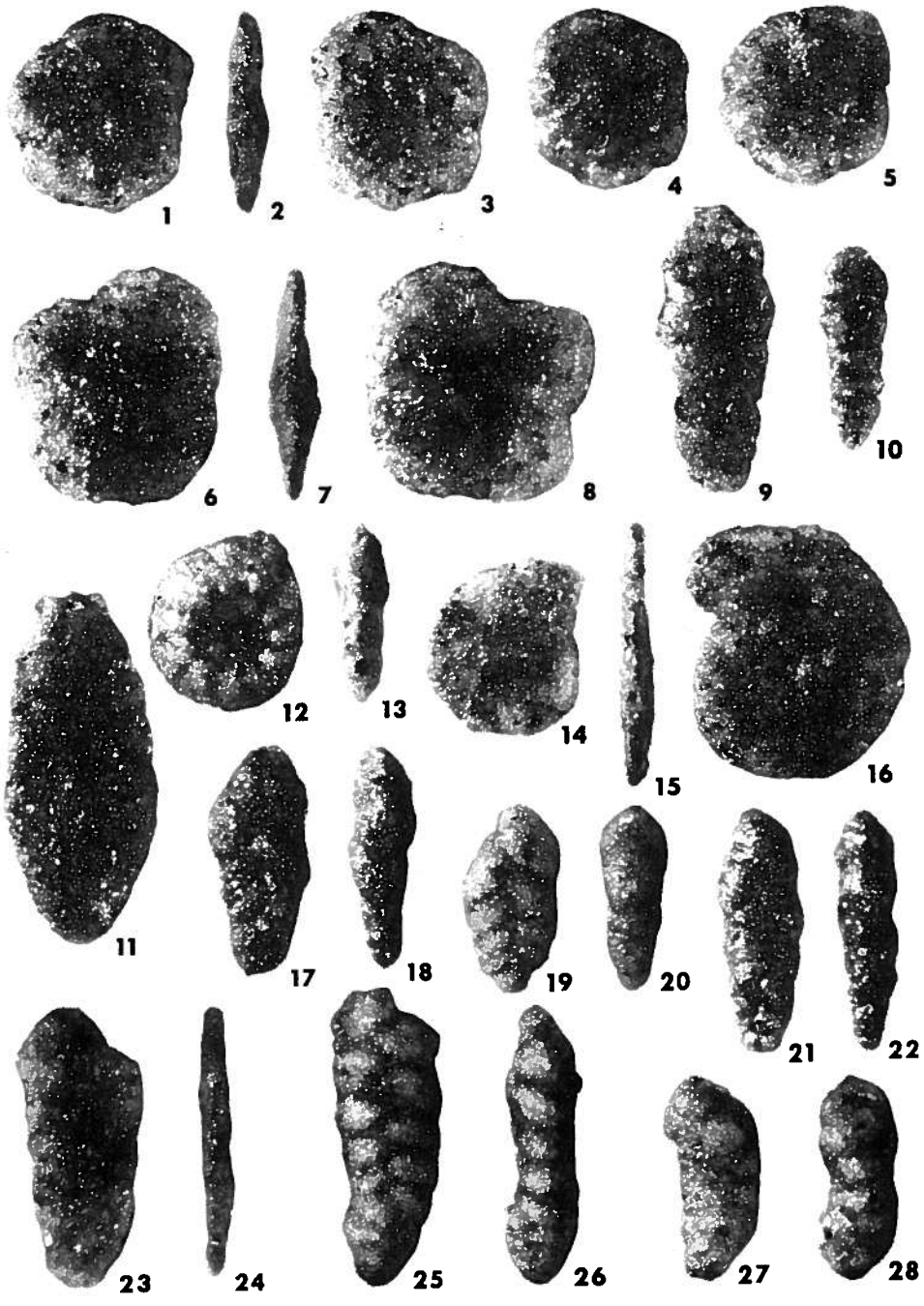
Explanation of Plate 11

Wapiabi Formation

Thistle and Hanson Members

Figure		Page
1-8	*Trochammina* sp. 2, X66, Hanson Member, Mill Creek; 1, 2, 3—Specimen MF 5153, spiral, peripheral and umbilical views; 4, 5—Specimen MF 5154, spiral and umbilical views; 6, 7, 8—Specimen MF 5155, spiral, peripheral and umbilical views	73
9, 10	*Reophax* sp. 4, X48; 9—Specimen MF 5064, Hanson Member, Mill Creek; 10—Specimen MF 5065, Thistle Member, Dungarvan Creek	46
11	*Hippocrepina* sp., Specimen MF 5047, X48, Thistle Member, Mill Creek	39
12, 13	*Haplophragmoides howardense manifestum* Stelck and Wall, X63, Hanson Member, Belcourt Creek; Hypotype MF 5082, side and peripheral views	51
14-16	*Haplophragmoides* sp. 2, X47, Hanson Member, Mill Creek; 14—Specimen MF 5088; 15, 16—Specimen MF 5089, peripheral and side views	54
17-24	*Pseudobolivina* sp. 1, X67; 17, 18—Specimen MF 5129, Hanson Member, Belcourt Creek, side and edge views; 19, 20—Specimen MF 5130, Thistle Member, Belcourt Creek, side and edge views; 21, 22—Specimen MF 5131, Hanson Member, Belcourt Creek, side and edge views; 23, 24—Specimen MF 5132, Hanson Member, Mill Creek, side and edge views	66
25-28	*Dorothia smokyensis* Wall, X69, Hanson Member, Belcourt Creek; 25, 26—Hypotype MF 5182, side and apertural views; 27, 28—Hypotype MF 5183, side and apertural views	81

PLATE 11



Explanation of Plate 12

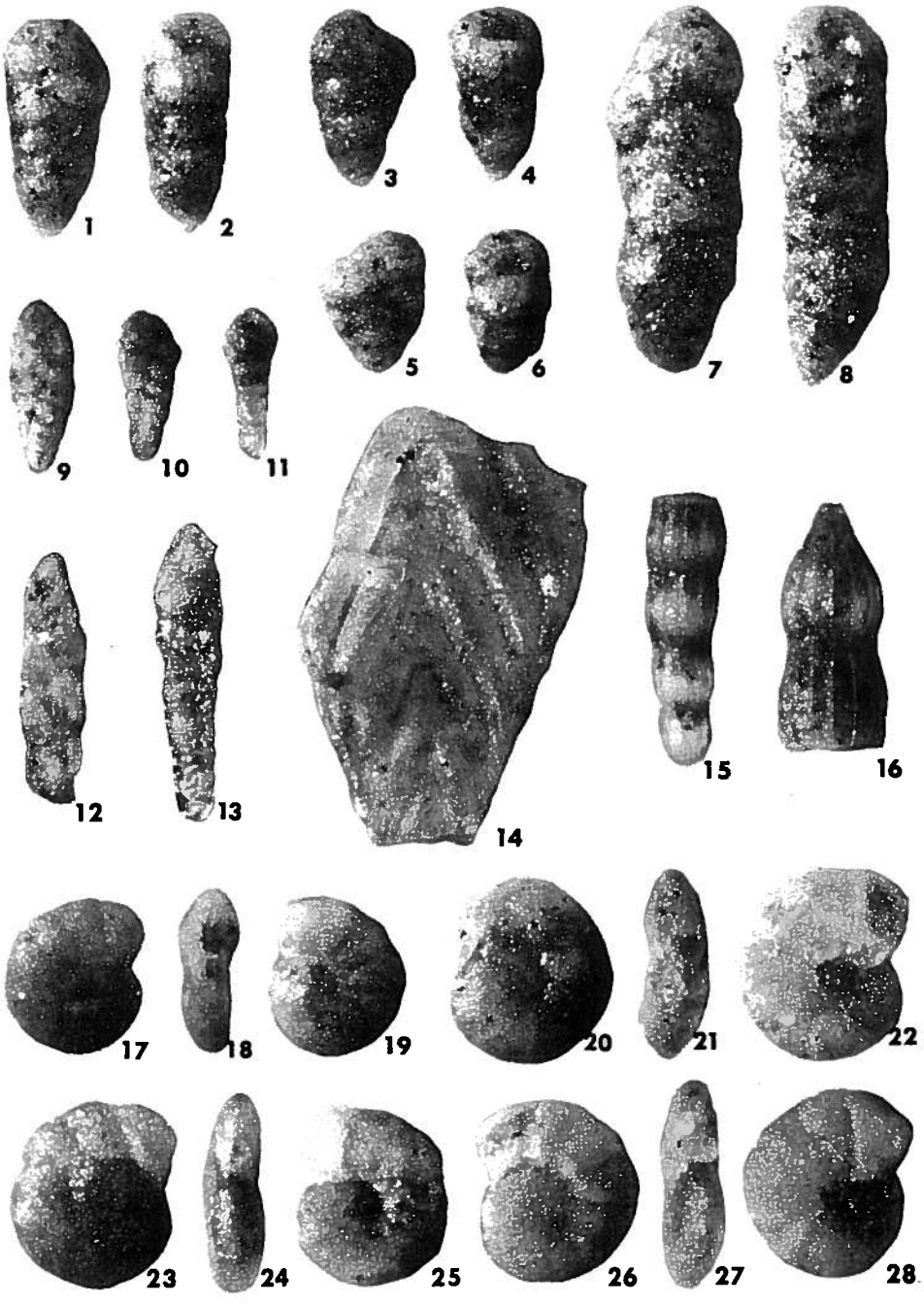
Wapiabi Formation

Hanson Member

North fork Belly River, Waterton National Park

Figure		Page
1-8	*Dorothia glabrata* Cushman, X65; 1, 2—Hypotype MF 5178, side and apertural views; 3, 4—Hypotype MF 5179, side and apertural views; 5, 6—Hypotype MF 5180, side and apertural views; 7, 8—Hypotype MF 5181, side and apertural views	80
9-11	*Bolivina* sp. cf. *B. elkensis* Nauss, X74; 9—Specimen MF 5218; 10—Specimen MF 5219; 11—Specimen MF 5220	96
12, 13	*Bolivina* sp. 1, X72; 12—Specimen MF 5222; 13—Specimen MF 5223	97
14	*Frondicularia* sp. cf. *F. greybullensis* Fox, Specimen MF 5201 (two joined fragments), X74	91
15	*Nodosaria* sp. 1, Specimen MF 5196, X68	88
16	*Nodosaria* sp. 2, Specimen MF 5197, X66	89
17-28	*Anomalinoides henbesti* (Plummer), X65; 17, 18, 19—Hypotype MF 5268, spiral, peripheral and umbilical views; 20, 21, 22—Hypotype MF 5269, spiral, peripheral and umbilical views; 23, 24, 25—Hypotype MF 5270, spiral, peripheral and umbilical views; 26, 27, 28—Hypotype MF 5271, spiral, peripheral and umbilical views	111

PLATE 12



Explanation of Plate 13

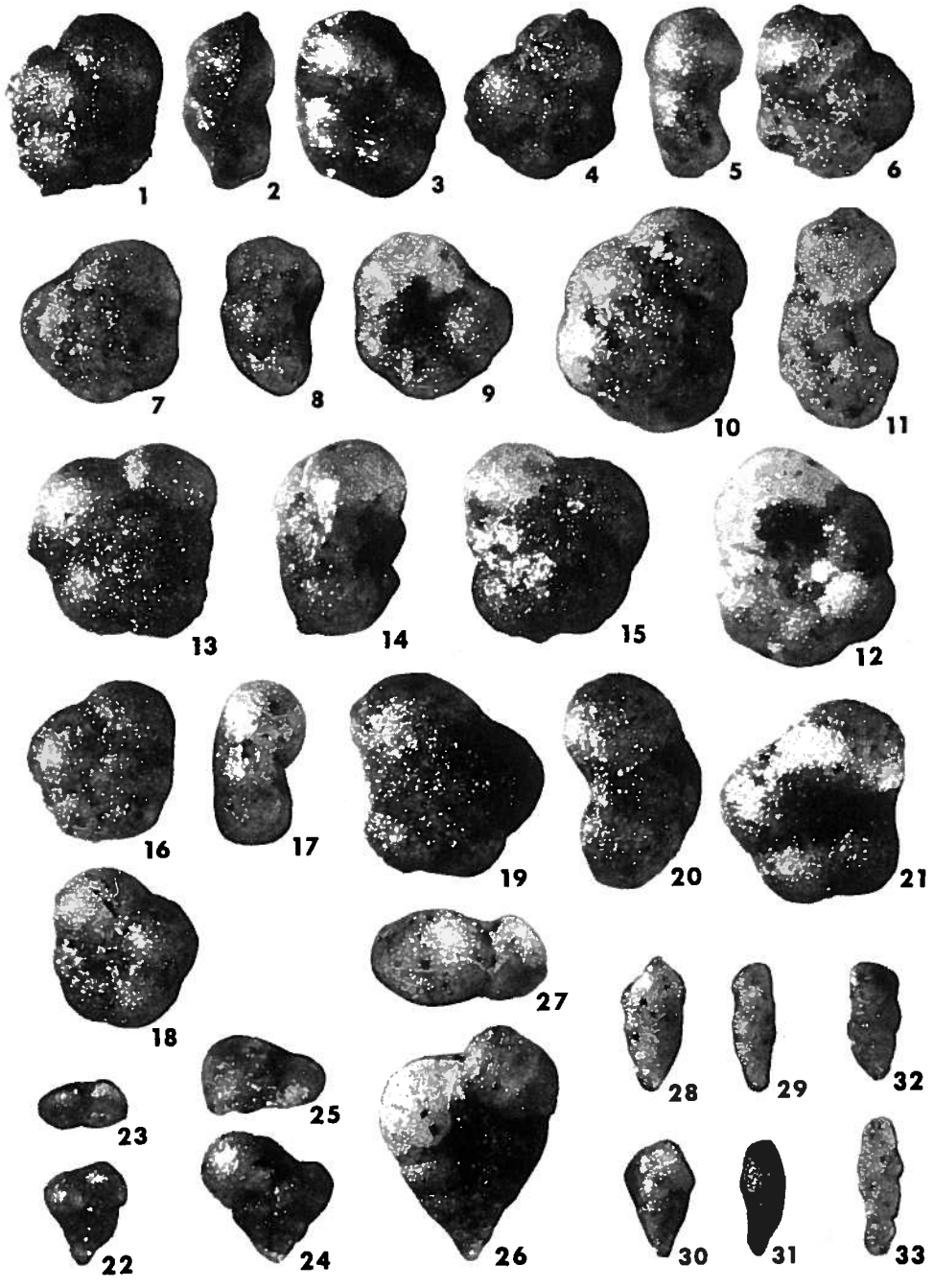
Wapiabi Formation

Hanson Member

Magnification X85-90

Figure		Page
1-6	*Praeglobotruncana* sp. cf. *P. coarctata* Bolli, Mill Creek; 1, 2, 3—Specimen MF 5257, spiral, peripheral and umbilical views; 4, 5, 6—Specimen MF 5258, spiral, peripheral and umbilical views	108
7-12	*Praeglobotruncana* sp. 1, Mill Creek; 7, 8, 9—Specimen MF 5263, spiral, peripheral and umbilical views; 10, 11, 12—Specimen MF 5264, spiral, peripheral and umbilical views	109
13-21	*Hedbergella delrioensis* (Carsey), Mill Creek; 13, 14, 15—Hypotype MF 5251, spiral, peripheral and umbilical views; 16, 17, 18—Hypotype MF 5252, spiral, peripheral and umbilical views; 19, 20, 21—Hypotype MF 5253, spiral, peripheral and umbilical views	105
22-27	*Heterohelix* sp. cf. *H. reussi* (Cushman), Mill Creek; 22, 23—Specimen MF 5241, side and apertural views; 24, 25—Specimen MF 5242, side and apertural views; 26, 27—Specimen MF 5243, side and apertural views	103
28-31	*Heterohelix* sp. 1, Mill Creek; 28, 29—Specimen MF 5246, side and apertural views; 30, 31—Specimen MF 5247, side and apertural views	104
32, 33	*Neobulimina* sp., north fork Belly River; 32—Specimen MF 5209; 33—Specimen MF 5210	93

PLATE 13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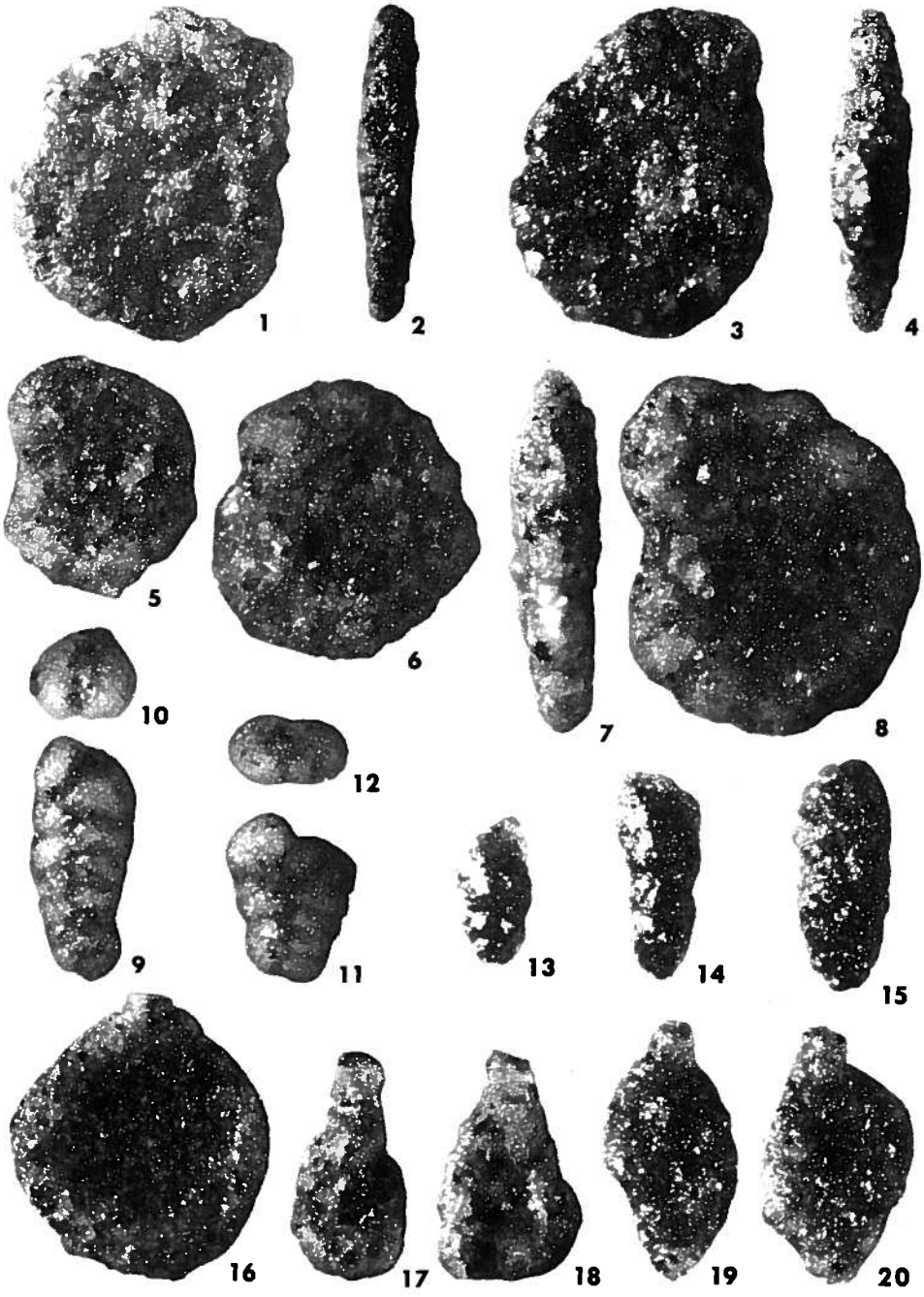
Explanation of Plate 14

Wapiabi Formation

Transition beds of southern Foothills (except where noted)

Figure		Page
1-4	*Ammobaculites*? sp. 3, X47; 1, 2—Specimen MF 5101, Mill Creek, side and peripheral views; 3, 4—Specimen MF 5102, Dungarvan Creek, side and peripheral views	58
5-8	*Haplophragmoides* sp. cf. *H. rota* Nauss, X45, Dungarvan Creek; 5—Specimen MF 5083; 6—Specimen MF 5084; 7, 8—Specimen MF 5085, peripheral and side views	52
9-12	*Spiroplectammina* sp. 2, X87, Dungarvan Creek; 9, 10—Specimen MF 5120, microspheric? form, side and apertural views; 11, 12—Specimen MF 5121, megalospheric? form, side and apertural views	64
13-15	*Verneuilinoides bearpawensis* (Wickenden), X65; 13—Hypotype MF 5162, 14—Hypotype MF 5163, Nomad equivalent, Belcourt Creek; 15—Hypoytpe MF 5164, Nomad Member, Highwood River	75
16	*Saccammina* sp. 1, Specimen MF 5052, X64, Mill Creek	41
17, 18	*Saccammina* sp. cf. *S. alexanderi* (Loeblich and Tappan), X65, Dungarvan Creek; 17—Specimen MF 5050; 18—Specimen MF 5051	40
19, 20	*Uvigerinammina*? sp. 1, X68, Mill Creek; 19—Specimen MF 5174; 20—Specimen MF 5175	79

PLATE 14



Explanation of Plate 15

Wapiabi Formation

Nomad Member or equivalent (except where noted)

Figure		Page
1-6	*Anomalinoides*? sp. 2, X87, Thistle Creek; 1, 2, 3—Specimen MF 5278, spiral, peripheral and umbilical views; 4, 5, 6—Specimen MF 5279, spiral, peripheral and umbilical views	114
7-12	*Anomalinoides talaria* (Nauss), X92; 7, 8, 9—Hypotype MF 5275, Thistle Creek, spiral, peripheral and umbilical views; 10, 11, 12—Hypotype MF 5276, McLeod River, spiral, peripheral and umbilical views	112
13-18	*Praebulimina* sp. 1, X94, transition beds, Dungarvan Creek; 13, 14—Specimen MF 5213, side and apertural views; 15, 16—Specimen MF 5214, side and apertural views; 17, 18—Specimen MF 5215, side and apertural views	95
19-22	*Praebulimina venusae* (Nauss), X87, Thistle Creek; 19, 20—Hypotype MF 5211, side and apertural views; 21, 22—Hypotype MF 5212, side and apertural views	94
23, 24	*Lenticulina* sp. 2, X48; 23, 24—Specimen MF 5194, Mistanusk Creek, side and peripheral views; 29, 30—Specimen MF 5195, Thistle Creek, side and peripheral views	88
29, 30		
25, 26	*Vaginulina* sp., X48, Burnt Timber Creek; Specimen MF 5200, side and peripheral views	90
27, 28	*Lenticulina* sp. 1, X65, Belcourt Creek; Specimen MF 5193, side and peripheral views	87
31-33	*Cibicides*? sp., X65, Thistle Creek; Specimen MF 5265, spiral, peripheral and umbilical views	109
34-39	*Eoeponidella* sp. cf. *E. linki* Wickenden, X90, Thistle Creek; 34, 35, 36—Specimen MF 5224, spiral, peripheral and umbilical views; 37, 38, 39—Specimen MF 5225, spiral, peripheral and umbilical views	98

PLATE 16

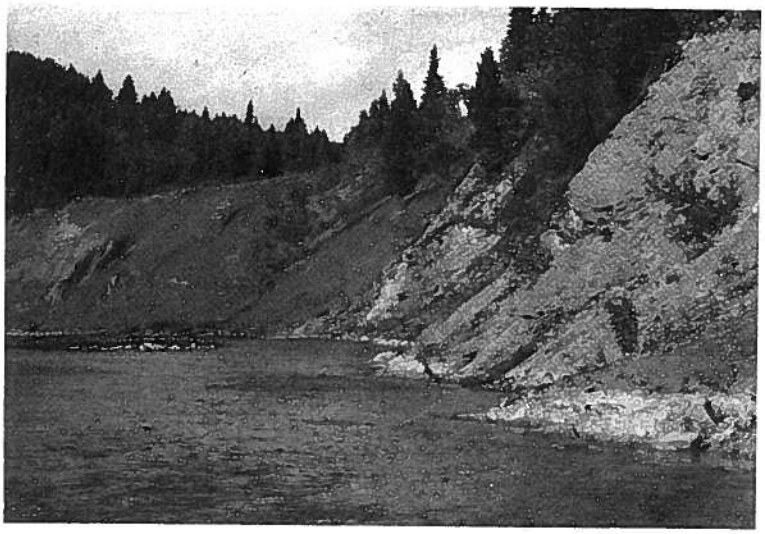
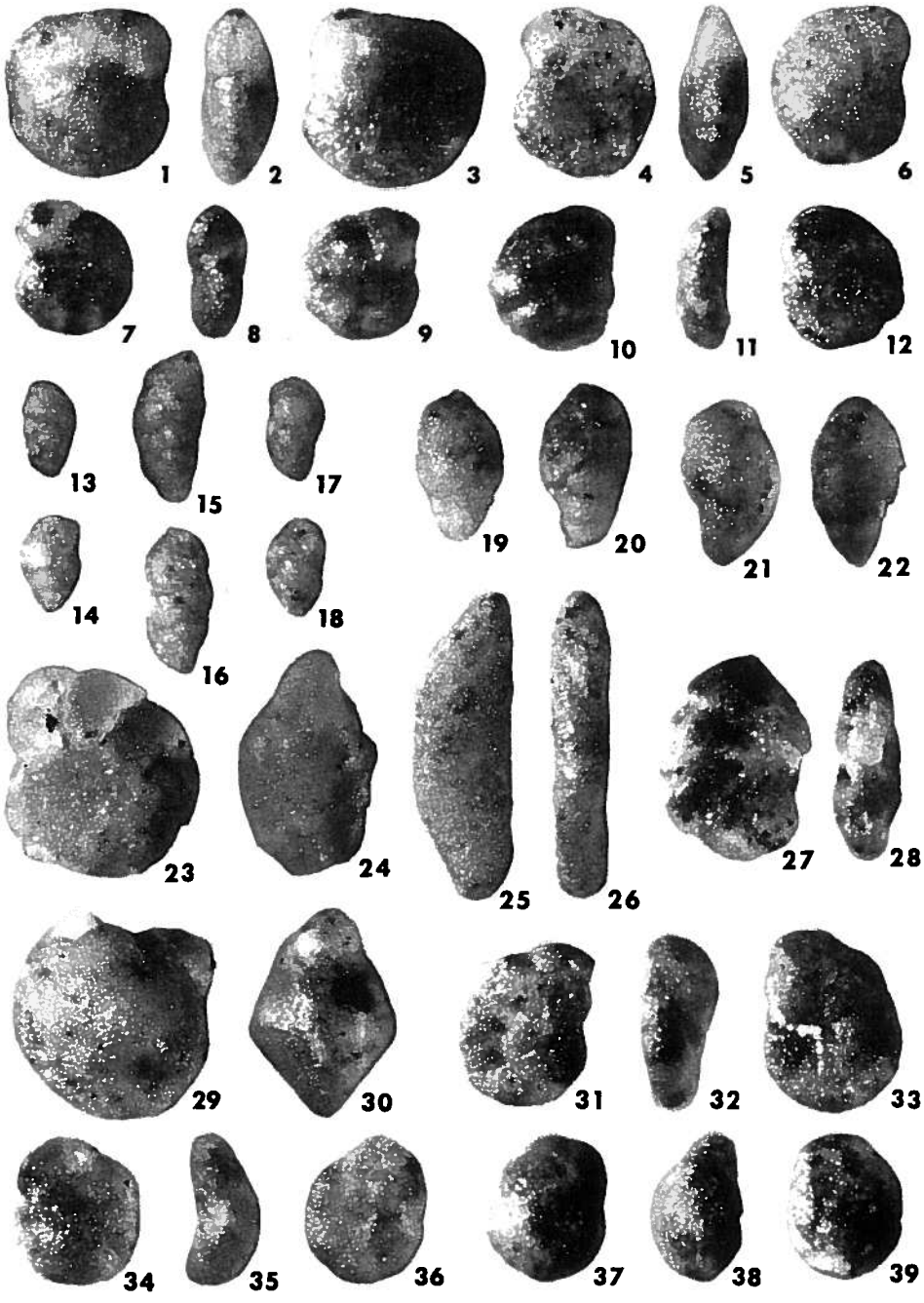


FIGURE 1. Lower part of the Blackstone Formation on Mill Creek (JW 59-8) looking downstream. Silver-grey shale of Vimy Member in foreground carries Inoceramus labiatus *and upper pelagic microfauna with* Hedbergella loetterlei. *Dark-grey shale of Sunkay Member in background carries* Dunveganoceras.

FIGURE 2. Blackstone-Cardium transition near mouth of Luscar Creek (JW 63-1). Arrow indicates contact between Opabin Member of Blackstone Formation to left and Ram Member of Cardium Formation to right. Pseudoclavulina *sp. microfauna is present in the Opabin shales.*

PLATE 15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37
38
39

PLATE 17

FIGURE 1. Cardium-Wapiabi contact at Ram River Falls (JW 60-3). The falls are formed by the Sturrock Member of the Cardium Formation. The shales above the falls are part of the Muskiki Member of the Wapiabi Formation and carry the Trochammina *sp. 1 microfauna. Paleozic rocks of the Ram Range in background.*

FIGURE 2. Alignment of ferruginous concretions in the Dowling Member of the Wapiabi Formation in a side gully of the Cardinal River (JW 59-4).

PLATE 18

FIGURE 1. Exposure of the Thistle Member of the Wapiabi Formation on Oldfort Creek (JW 59-2), showing the typically finely interbedded shale and siltstone, usually unproductive of microfossils. Limestone concretion at man's knee level.

FIGURE 2. Upper part of the Wapiabi Formation on Dungarvan Creek (JW 60-1). Man is standing at level of first or upper white-speckled shale "zone" with pelagic foraminifera. Siltstone ledges near top of bank mark base of transition beds. Cavities in bank are sample pits.

PLATE 19

FIGURE 1. Upper part of the Wapiabi Formation at headwaters of Thistle Creek (JW 59-3), looking downstream. Arrow indicates contact between sandstone of the Chungo Member to left and shale of the Nomad Member, to right, in which the Lenticulina *microfauna is typically developed.*

FIGURE 2. Upper part of the Wapiabi Formation on Mistanusk Creek (JW 60-7). Exposed in ascending order are the shale of the Hanson Member with the Trochammina ribstonensis *microfauna, the lower Chinook sandstone (32 feet thick, indicated by arrow), the shale of the Nomad equivalent with the* Lenticulina *microfauna, and the upper or main Chinook sandstone.*

INDEX

(Italic numbers indicate description)

LEGEND

- V — Very Rare, 1 specimen
- U — Uncommon, 2-9 specimens
- X — Average, 10-99 specimens
- C — Common, 100-299 specimens
- A — Abundant, 300 or more specimens

Localities arranged from south to north →

ALBERTA GROUP

BLACKSTONE FORMATION and CARDIUM FORMATION

	SUNKAY MEMBER					VIMY MEMBER					HAVEN MEMBER				OPABIN MEMBER					CARDIUM FORMATION
Species	Ghost River	Burnt Timber Creek	Cripple Creek	Cadomin	Little Berland River	Mill Creek	Ghost River	Burnt Timber Creek	Cripple Creek	Cadomin	Ghost River	Burnt Timber Creek	Indian Creek	Cadomin	Mill Creek	Ghost River	Burnt Timber Creek	Indian Creek	Cadomin	Little Berland River
Bathysiphon vitta																				
Hippocrepina sp.																				
Saccammina sp. cf. S. alexanderi																				
S. sp. 1																				
Ammodiscus sp. 1				U																
A. sp. 2																				
Reophax pepperensis																				
R. sp. 1																				
R. sp. 2																				
R. sp. 3																				
R. sp. 4																				
Miliammina awunensis																X				
M. manitobensis			X	X																
Haplophragmoides bonanzaense											X					X	U	?	?	
H. crickmayi											U					U		V		U
H. howardense	U										C	X	X	U		X	U	X	U	X
H. howardense manifestum											X	V	U	V		V				
H. sp. cf. H. rota																				
H. sp. 1			X	X																
H. sp. 2																				
Ammobaculites fragmentarius			?	X																
A. sp. cf. A. fragmentarius																				U
A. sp. 1																				
A. sp. 2																				
A.? sp. 3																				
Flabellammina magna																				
Coscinophragma? codyensis																				
Spiroplectammina semicomplanata																				X
S. sp. 1																				
S. sp. 2																				
Pseudobolivina rollaensis											U					U				
P. sp. 1											X			X						
Trochammina ribstonensis																				
T. sp. cf. T. ribstonensis																				
T. rutherfordi	C										C	X		X						
T. wetteri																				
T. sp. 1																				
T. sp. 2																				
Verneuilina canadensis			U	U																
Verneuilinoides bearpawensis																X				X
V. kansasensis	X	U	X	X	X															
Uvigerinammina sp. cf. U. athabascensis			X																	
U.? sp. 1																				
Gaudryina spiritensis			X	U																
Dorothia glabrata																				
D. smokyensis											U					U		U		U
D. sp. 1											X				X	X	X	X	X	
Marssonella oxycona																				
Pseudoclavulina sp.											X	X	X		U	U	U		X	
Quinqueloculina sphaera																				
Lenticulina sp. 1																				
L. sp. 2																				
Nodosaria sp. 1																				
N. sp. 2																				
Dentalina summitensis																				
D. sp. 1																				
Vaginulina sp.																				
Frondicularia sp. cf. F. greybullensis																				
Bullopora laevis																				
Neobulimina sp.																				
Praebulimina venusae																				
P. sp. 1																				
Bolivina elkensis																				
B. sp. cf. B. elkensis																				
B. sp. 1																				
Eoeponidella sp. cf. E. linki																				
Valvulineria sp. cf. V. umbilicata																				
V. sp. 1																				
Guembelitria sp.																				
Heterohelix globulosa						C	C	X	C	X										
H. sp. cf. H. reussi																				
H. sp. 1						U	X	V	U											
Hedbergella delrioensis						X	X	U		?										
H. loetterlei						C	C	X	C	X										
Praeglobotruncana sp. cf. P. coarctata																				
P. sp. 1																				
Cibicides ? sp.																				
Pullenia ? sp.																				
Anomalinoides henbesti																				
A. talaria																				
A.? sp. 1																				
A.? sp. 2																				
Ceratobulimina sp.																				
Reinholdella ? sp.																				

WAPIABI FORMATION

	MUSKIKI MEMBER									MARSHYBANK MEMBER						
Species	Mill Creek	Highwood River	Oldfort Creek	Burnt Timber Creek	Ram River	Thistle Creek	Cardinal River	Little Berland River	Mistanusk Creek	Mill Creek	Highwood River	Oldfort Creek	Burnt Timber Creek	Ram River	Thistle Creek	Cardinal River
Bathysiphon vitta											V					
Hippocrepina sp.																
Saccammina sp. cf. S. alexanderi																
S. sp. 1																
Ammodiscus sp. 1																
A. sp. 2								U					V			
Reophax pepperensis																
R. sp. 1	U	U	X	U	X	X	U	U	U	X	U	X	U	U	U	
R. sp. 2															U	
R. sp. 3																
R. sp. 4																
Miliammina awunensis																
M. manitobensis																
Haplophragmoides bonanzaense																
H. crickmayi						U		X					U		U	X
H. howardense	U	X			U	X	X	X						U		X
H. howardense manifestum	V	V	V		V	U										
H. sp. cf. H. rota																
H. sp. 1																
H. sp. 2																
Ammobaculites fragmentarius																
A. sp. cf. A. fragmentarius		U	X	U	X	X	U	U	U		U	X		X	U	
A. sp. 1						X									U	
A. sp. 2					U	U				V			U	U	X	
A.? sp. 3										U						
Flabellammina magna									U						U	U
Coscinophragma? codyensis			U		U	U				X		X				
Spiroplectammina semicomplanata			X	X	X	X	U	X	X			X	X	X	X	X
S. sp. 1																
S. sp. 2																
Pseudobolivina rollaensis	U	X				U	V			V						
P. sp. 1		U														
Trochammina ribstonensis																
T. sp. cf. T. ribstonensis																
T. rutherfordi																
T. wetteri	V				U			X				U			X	
T. sp. 1	X	X	X	X	X	X	X		?		U					
T. sp. 2	V	U				V									V	
Verneuilina canadensis																
Verneuilinoides bearpawensis	V	?						X								
V. kansasensis																
Uvigerinammina sp. cf. U. athabascensis																
U.? sp. 1																
Gaudryina spiritensis																
Dorothia glabrata																
D. smokyensis		U	X	U	V	X	X	X	X	U			X		X	X
D. sp. 1		X														
Marssonella oxycona			U	X	X					U		X				
Pseudoclavulina sp.																
Quinqueloculina sphaera						U									V	
Lenticulina sp. 1																
L. sp. 2																
Nodosaria sp. 1																
N. sp. 2																
Dentalina summitensis																
D. sp. 1															V	
Vaginulina sp.																
Frondicularia sp. cf. F. greybullensis																
Bullopora laevis				U		U			V				V		V	
Neobulimina sp.									U							
Praebulimina venusae																
P. sp. 1																
Bolivina elkensis	U					U									U	
B. sp. cf. B. elkensis																
B. sp. 1															U	
Eoeponidella sp. cf. E. linki																
Valvulineria sp. cf. V. umbilicata						?			X						X	
V. sp. 1									U							
Guembelitria sp.	X	U			U	X			X	U		U			X	
Heterohelix globulosa						V			U							
H. sp. cf. H. reussi						V									V	
H. sp. 1																
Hedbergella delrioensis					?											
H. loetterlei																
Praeglobotruncana sp. cf. P. coarctata																
P. sp. 1																
Cibicides ? sp.																
Pullenia ? sp.									V				V			
Anomalinoides henbesti															?	
A. talaria	X	X		U	X	X		U	X			U		U	X	
A.? sp. 1															U	
A.? sp. 2																
Ceratobulimina sp.																
Reinholdella ? sp.						U									U	

	DOWLING MEMBER											THISTLE MEMBER										
Species	Mill Creek	Highwood River	Gorge Creek	Oldfort Creek	Burnt Timber Creek	Ram River	Thistle Creek	Cardinal River	Little Berland River	Mistanusk Creek	Belcourt Creek	Belly River (north fork)	Dungarvan Creek	Mill Creek	Highwood River	Oldfort Creek	Burnt Timber Creek	Ram River	Thistle Creek	Cardinal River	Mistanusk Creek	Belcourt Creek
Bathysiphon vitta			U	V		X	X															
Hippocrepina sp.	U											U		U								
Saccammina sp. cf. S. alexanderi	X	U		V			U					U		X	U							
S. sp. 1																						
Ammodiscus sp. 1																						
A. sp. 2		V	U		U	X	X	X	U	U	U			V	U	V		X		V		
Reophax pepperensis					U		X	V		X	U	U		V			U				V	U
R. sp. 1	X	U		X		X	V	U						?				X				
R. sp. 2			V			X	U							X								
R. sp. 3	X																					
R. sp. 4							U					C	X	X	X						X	
Miliammina awunensis																						
M. manitobensis																						
Haplophragmoides bonanzaense																						
H. crickmayi			X	X	U	X	X	X	U	V				X	U	U		X				
H. howardense	U					X	U	X	U	X	X					U		V	V		U	X
H. howardense manifestum	?					U	U	V		U						V		V	V			U
H. sp. cf. H. rota																						
H. sp. 1																						
H. sp. 2	X											X	X	A								
Ammobaculites fragmentarius																						
A. sp. cf. A. fragmentarius	A	X		X			U							C	X			V				
A. sp. 1																						
A. sp. 2	U	X	U			U	X							X	U							
A.? sp. 3	U		U											U								
Flabellammina magna			X		U	X	U							X	U							
Coscinophragma? codyensis	C																					
Spiroplectammina semicomplanata	X	X	X	X	X	C	C	X	X	U	X			X	X	U		U	U	U		U
S. sp. 1						X	X		U													
S. sp. 2			?									U									U	
Pseudobolivina rollaensis	V									X	A			X					V	X		
P. sp. 1		U			U	U	X			X	X	X	U	C	U			X	U		X	U
Trochammina ribstonensis						X	U		U	X	U										X	X
T. sp. cf. T. ribstonensis						U	V		V	U	U										U	X
T. rutherfordi																						
T. wetteri	U					U	U			X	X								U		X	C
T. sp. 1	U	X					V															
T. sp. 2	U	X					U				X		U	C	X	U	V		X	X	X	X
Verneuilina canadensis																						
Verneuilinoides bearpawensis						U	X		X	X	X				V							V
V. kansasensis																						
Uvigerinammina sp. cf. U. athabascensis																						
U.? sp. 1	U											U		U								
Gaudryina spiritensis																						
Dorothia glabrata																						
D. smokyensis	C	X	X	X	U	X	C	X	X	X	X			X	X	U	U	X	U	U		U
D. sp. 1																						
Marssonella oxycona	X	U	V	X																		
Pseudoclavulina sp.																						
Quinqueloculina sphaera		V																				
Lenticulina sp. 1																						
L. sp. 2																						
Nodosaria sp. 1														V								
N. sp. 2	V													V								
Dentalina summitensis		V													V							
D. sp. 1														V								
Vaginulina sp.																						
Frondicularia sp. cf. F. greybullensis																						
Bullopora laevis	X	U		U		?								X	V	V						
Neobulimina sp.											X	U		U								U
Praebulimina venusae																						
P. sp. 1																						
Bolivina elkensis		X			V		U				U						U					
B. sp. cf. B. elkensis																						V
B. sp. 1		U					V										U					
Eoeponidella sp. cf. E. linki																						
Valvulineria sp. cf. V. umbilicata		U		U																		
V. sp. 1																						
Guembelitria sp.	C	X		X										X	X							
Heterohelix globulosa	U	U									U	U	V		U							U
H. sp. cf. H. reussi	U											X		U								
H. sp. 1							V				U	U		V	U							V
Hedbergella delrioensis	?														U				?			
H. loetterlei																						
Praeglobotruncana sp. cf. P. coarctata																						
P. sp. 1	X																					
Cibicides ? sp.																						
Pullenia ? sp.				U		X									X							
Anomalinoides henbesti	?											X	U	C								
A. talaria	X	U	U	X	?	X	U	X	X					X	X			X		U		U
A.? sp. 1	?							V														
A.? sp. 2																						
Ceratobulimina sp.																		U				
Reinholdella ? sp.	X	U												U								

	HANSON MEMBER									NOMAD MEMBER or transition beds								
Species	Belly River (north fork)	Dungarvan Creek	Mill Creek	Oldfort Creek	Burnt Timber Creek	Thistle Creek	Cardinal River	Mistanusk Creek	Belcourt Creek	Dungarvan Creek	Mill Creek	Longview	Oldfort Creek	Burnt Timber Creek	Cadomin	Thistle Creek	Mistanusk Creek	Belcourt Creek
Bathysiphon vitta																		
Hippocrepina sp.																		
Saccammina sp. cf. S. alexanderi	X							U		X							V	
S. sp. 1											U							
Ammodiscus sp. 1																		
A. sp. 2																		
Reophax pepperensis	U							U										
R. sp. 1	V																	
R. sp. 2																		
R. sp. 3																		
R. sp. 4	X	X	X							X	X							
Miliammina awunensis																		
M. manitobensis																		
Haplophragmoides bonanzaense																		
H. crickmayi																		
H. howardense									X									
H. howardense manifestum									U									
H. sp. cf. H. rota			X						U	X	X	U	X	X	U	U	U	
H. sp. 1																		
H. sp. 2	A	X	A							X	X							
Ammobaculites fragmentarius																		
A. sp. cf. A. fragmentarius																		
A. sp. 1																		
A. sp. 2	U																	
A.? sp. 3			U							X	U							
Flabellammina magna																		
Coscinophragma? codyensis																		
Spiroplectammina semicomplanata																		
S. sp. 1																		
S. sp. 2	U									X								
Pseudobolivina rollaensis	X																	
P. sp. 1	C		X		?	U		X	X		X							
Trochammina ribstonensis									X									
T. sp. cf. T. ribstonensis						U		X	X									
T. rutherfordi																		
T. wetteri						X		X	X		V							
T. sp. 1																		
T. sp. 2	A	X	A		V	U				X	C							
Verneuilina canadensis																		
Verneuilinoides bearpawensis					X	U			V			X	X	X	U	X	X	X
V. kansasensis																		
Uvigerinammina sp. cf. U. athabascensis																		
U.? sp. 1	X										X							
Gaudryina spiritensis																		
Dorothia glabrata	C																	
D. smokyensis	U			V	U	X	X	X	C								U	
D. sp. 1																		
Marssonella oxycona																		
Pseudoclavulina sp.																		
Quinqueloculina sphaera																		
Lenticulina sp. 1												V						V
L. sp. 2																U	V	
Nodosaria sp. 1	V																	
N. sp. 2	U																	
Dentalina summitensis																		
D. sp. 1																		
Vaginulina sp.														U		U		
Frondicularia sp. cf. F. greybullensis	U																	
Bullopora laevis																		
Neobulimina sp.	C	X	X													U		
Praebulimina venusae																U		
P. sp. 1			?							X								
Bolivina elkensis																		
B. sp. cf. B. elkensis	X		V															
B. sp. 1	X																	
Eoeponidella sp. cf. E. linki																U		
Valvulineria sp. cf. V. umbilicata																		
V. sp. 1																		
Guembelitria sp.																		
Heterohelix globulosa	X	U	X															
H. sp. cf. H. reussi	C	X	X						U									
H. sp. 1	X	U	X															
Hedbergella delrioensis	X	U	X															
H. loetterlei																		
Praeglobotruncana sp. cf. P. coarctata			U															
P. sp. 1	X	U	X															
Cibicides ? sp.																U		
Pullenia ? sp.																		
Anomalinoides henbesti	A																	
A. talaria															U	X		V
A.? sp. 1																		
A.? sp. 2																X		V
Ceratobulimina sp.																		
Reinholdella ? sp.	?																	

To accompany Research Council of Alberta Bulletin 20, by J. H. Wall.

TABLE 3. RANGE CHART SHOWING DISTRIBUTION OF FORAMINIFERA IN THE CRETACEOUS OF THE FOOTHILLS.

Sector	Area	Locality Name	R.C.A. Number	Location	Topographic Map (National Topographic Series, 1 : 50,000)	Geologic Map	Formation Sampled	Thickness (measured or estimated)	Footage Sampled	Number of Samples	Sample Interval (feet)	Productive Samples	
												Number	Percentage
Southern	Waterton	North fork of Belly River	JW 60-2 JW 60-2A	Tp. 1, R. 28, W.4	Mountain View 82 H/4 east	Waterton G.S.C. Paper 52-10	Wapiabi	---	400	56	7	55	98
"	"	Dungarvan Creek	JW 60-1	Lsd. 11, Sec. 23, Tp. 3, R. 29, W.4	Waterton Lakes 82 H/4 west	"	"	---	160	23	7	17	74
"	Crowsnest Pass	Mill Creek	JW 59-7	Sec. 12, Tp. 5, R. 2, W.5	Beaver Mines 82 G/8 east	Beaver Mines G.S.C. Map 739A	"	1710	1200	90	13	77	86
"	"	"	JW 59-6	Secs. 12 and 13, Tp. 5, R. 2, W.5	"	"	Blackstone	500	400	21	19	15	71
"	"	Castle River	---	NW 1/4 Sec. 27, Tp. 6, R. 2, W.5	Cowley 82 G/9 east	Cowley G.S.C. Map 816A	Wapiabi	---	60	11	5	11	100
"	Turner Valley	Highwood River	KG 61-2	SE 1/4 Sec. 18, Tp. 18, R. 3, W.5	Turner Valley 82 J 9	Turner Valley G.S.C. Map 257A	"	1345	1000	123	8	61	50
"	"	Longview	JW 60-6	SW 1/4 Sec. 30, Tp. 18, R. 2, W.5	"	"	"	---	70	8	9	8	100
"	"	Gorge Creek	JW 60-4	NW corner of Tp. 19, R. 5, W.5	Dyson Creek 82 J/10 east	Dyson Creek G.S.C. Map 827A	"	---	240	25	10	12	48
Southern Foothills - Total or Average									3530	357	10	256	72
Central	Morley	Seebe	JW 58-5	Secs. 32 and 33, Tp. 24, R. 8, W.5	Morley 82 O/2 west Canmore 82 O/3 east	Morley G.S.C. Map 777A	Wapiabi	---					
"	"	Oldfort Creek	JW 59-2 KG 61-3	Tp. 25, R. 8, W.5	"	"	"	1745	1225	84	14	31	37
"	"	"	JW 59-1	"	"	"	Cardium	---	50	6	---	2	33
"	"	Ghost River	KG 61-4	Sec. 4, Tp. 27, R. 7, W.5	Wildcat Hills 82 O/7 west	Wildcat Hills G.S.C. Map 326A	Blackstone	868	820	113	7	40	35
"	"	Burnt Timber Creek	KG 61-5	Tp. 29, R. 9, W.5	Burnt Timber Creek 82 O/11 east	---	Wapiabi	2005	1900	127	15	42	33
"	"	"	"	"	"	---	Cardium	281	180	9	25	2	22
"	"	"	"	"	"	---	Blackstone	1426	1230	56	22	19	34
"	Nordegg	Ram River	JW 60-3	Tp. 36, R. 13, W.5	Cripple Creek 83 B/4 west	Cripple Creek G.S.C. Paper 46-22	Wapiabi	---	850	120	7	59	49
"	"	Cripple Creek	JW 62-1	Tp. 37, R. 14, W.5	"	"	Cardium	314	40	3	14	3	100
"	"	"	"	"	"	"	Blackstone	1100	620	36	17	23	64
"	"	Indian Creek	JW 63-3	Tp. 38, R. 15, W.5	Whiterabbit Creek 83 C/1 east	---	"	---	130	10	12	8	80
"	Cadomin	Thistle Creek	JW 59-3	Sec. 14, Tp. 44, R. 21, W.5	Grave Flats 83 C/15 west	Grave Flats G.S.C. Paper 40-15	Wapiabi	2350	1525	109	11	79	72
"	"	Cardinal River	JW 59-4	Sec. 13, Tp. 45, R. 20, W.5	"	"	"	1820	950	57	10	34	60
"	"	Cadomin	JW 63-2	Secs. 5 and 8, Tp. 47, R. 23, W.5	Cadomin 83 F/3 west	Cadomin G.S.C. Map 209A	Blackstone	---	200	15	---	9	60
"	"	Luscar Creek	JW 63-1	Sec. 17, Tp. 47, R. 23, W.5	"	"	"	---	190	13	---	8	62
"	"	McLeod River	KG 61-7	Sec. 22, Tp. 47, R. 23, W.5	"	"	Wapiabi	---	90	12	8	3	25
Central Foothills - Total or Average									10000	770	12	362	47
Northern	Little Berland River	Little Berland River	KG 61-6	NE corner Tp. 53, R. 3, W.6 SW corner Tp. 54, R. 2, W.6	Moberley Creek 83 E 9	Moon Creek G.S.C. Map 968A	Wapiabi	---	600	21	30	9	43
"	"	"	"	"	"	"	Cardium	200	200	10	20	6	60
"	"	"	"	"	"	"	Kaskapau	1100	900	48	18	3	06
"	"	"	"	"	"	"	Fort St. John	325	170	7	24	2	29
"	Upper Wapiti River, B.C.	Mistanusk Creek	JW 60-7	Latitude 54°40' Longitude 120°05'	Prince George-Dawson Creek Sheet 93 NE (8 miles : 1 inch)	---	Wapiabi	1248	900	60	15	40	67
"	"	"	"	"	"	---	Kaskapau	550	350	14	27	2	14
"	"	Belcourt Creek	JW 60-8	Latitude 54°36' Longitude 120°12'	"	---	Wapiabi	---	880	95	9	50	53
Northern Foothills - Total or Average									4000	255	16	112	44
Foothills Belt - Total or Average									17530	1382	12	730	53

To accompany Research Council of Alberta Bulletin 20, by J. H. Wall.

TABLE 4. SUMMARY OF APPENDIX.